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OF THE

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THEME:

**SECURING OUR FUTURE:
AI SOLUTIONS
FOR NATIONAL SECURITY
AND ECONOMIC STABILITY**

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Economic Stability**

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Preface

As the Chairman of the Organizing Committee for the 6th National Conference of the School of Applied Sciences, Kogi State Polytechnic, Lokoja, I am honored to present the proceedings of this landmark event, Themed “Securing Our Future: AI Solutions for National Security and Economic Stability,”. This conference has been a convergence point for scholars, researchers, industry professionals, and policymakers, all united by a common goal: to explore the vast potential of Artificial Intelligence (AI) in addressing the pressing issues of our time.

In an era marked by rapid technological evolution and global challenges, the need for innovative solutions is more urgent than ever. This conference has provided a platform for interdisciplinary dialogue, fostering collaborations across fields such as Physics, Chemistry, Biochemistry, Environmental Biology, Statistics, Mathematics, Computer Science, Management Sciences, Environmental Sciences, and Engineering. The insights and strategies shared during this conference will undoubtedly contribute to advancing our collective efforts to ensure a secure and prosperous future. I extend my gratitude to all participants and contributors for making this conference a resounding success.

Dr. (Mrs) Ayodele Oluwakemi Sade FNCS, MNIWIIT
Chairman, Organizing Committee



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BIG DATA ANALYTICS FOR NATIONAL SECURITY: A REVIEW

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Abstract

Talk has recently revolved around a variety of national security issues in Nigeria, including threats from Boko Haram and the Islamic State's West Africa Province, conflicts between farmers and herders, banditry and kidnapping, the Indigenous People of Biafra's separatist insurgency, and militants advocating for oil in the Niger Delta. Some of the deaths, property loss, and relocation brought about by these dangers have been connected to poverty and the economic slump. In order to effectively counter these threats in Nigeria, better intelligence gathering, and analysis are required in order to foresee and stop attacks. The purpose of this paper is to demonstrate how big data analytics may be used to enhance intelligence gathering and analysis in order to battle terrorism and other security concerns in Nigeria. In order to provide effective situational awareness and preparedness for safeguarding Nigeria's national security, this paper suggests implementing a Big Data Active collaborative framework for appropriate intelligence gathering, data analysis, and information sharing among security personnel.

Keywords: Big Data, Analytics, National Security, Intelligence Gathering, Collaboration



1.0 INTRODUCTION

According to Olajide (2015), a secured and safe environment is the desire of any nation that strives to harness its full potential towards achieving economic development and improving the lives of its citizens. Popp and Paindexter (2006) suggested that the ongoing battle against terrorist activities in Nigeria has become a national priority and the use of Big Data Analytics could greatly help in addressing this issue. Advanced and emerging information technologies play a crucial role in combating the secretive, asymmetrical, and networked cells of terrorists. Terrorists blend in with the local civilian population and operate as highly adaptable organizational networks based on tribal or religious affiliations. They engage in quasi-military operations using tools of legitimate activities found in society, leveraging the internet, cellphones, media, educational institutions, places of worship, correctional facilities, healthcare facilities, public transportation, and financial systems. Terrorists deliberately target civilians with the aim of causing maximum casualties, chaos, and destruction. Terrorist viewed weapons of mass destruction as a preferred choice rather than a last resort (Popp and Paindexter, 2006). Sageman (2004), observed that terrorist cells are interconnected through intricate networks of direct or indirect communication. Terrorism involves numerous data-driven activities, implying that terrorist activities can leave traces in big data (Homeland Security, 2012). Therefore, there is a necessity to develop algorithms that can identify and connect these traces in order to uncover the identities of terrorists.

1.1 WHAT IS BIG DATA?

Big data is the term used to describe the enormous and intricate amounts of data that are too big, too diverse, or too quickly to handle using standard data processing tools and procedures. According to Miller et al. (2012), the term Big Data has a variety of definitions and has been used in a variety of contexts. Although the term "big data" was initially used around 2000, it began to gain traction in 2011 or 2012. It can also be used to describe the amount of data generated every day. The primary assertions made here are not especially novel, sophisticated, or arguable. The "big data" thesis contends that decision-makers and policymakers can use most, if not all, of the data to inform their choices. The fundamental premise here is that more data available for analysis translates into better informed decision-making. When we attempt to define what "available data" actually means, things become a

little more nuanced. According to KDnuggets (2016), almost 2.5 billion terabytes of data are produced every day. The total amount of digital data generated annually is predicted to reach 163 trillion gigabytes by 2025. Future data generation is anticipated to continue growing quickly.

1.2 WHAT MAKES BIG DATA DISTINGUISHABLE?

Nascio Analytic Series (2012) expressed that big data is important for the nation because of the volume, diversity, complexity, and unpredictable nature of the data being generated. Nigeria is comparable to an enormous data-generating apparatus. Six qualities distinguish big data from simple or general data. These distinctive qualities include volatility, validity, veracity, velocity, volume, and variety.

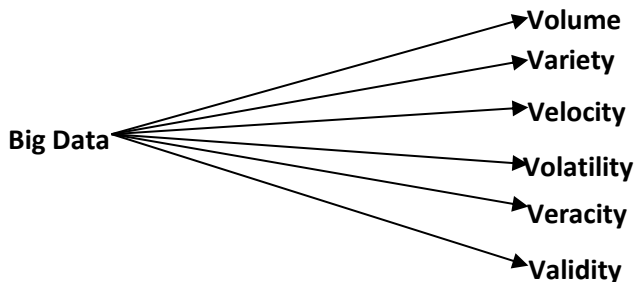


Figure 1: Distinguishing Factors of Big Data

From the diagram above, volume is an enormous amount of data generated every second, beyond what traditional relational database infrastructure can handle. The rate at which new data is created, recorded, and sent is referred to as velocity. Variety has to do with the growing array of data kinds that don't fit into a tidy, intuitive framework. Veracity is assessing how relevant the results are to the particular issue at hand; Validity is making sure the data is correct and accurate for that reason; and volatility is knowing how long the data must be accessible or stored. Big Data focuses on using a variety of data sets, finding and connecting previously unidentified correlations within the data, and producing data-driven insights to enable quicker and more accurate business choices.

1.3 BIG DATA ANALYTICS



According to Nascio Analytic Series (2012), new levels of competitiveness and efficacy are made possible by analytics. Analytics is the use of digital tools for data processing, analysis, and interpretation. The intention is to let the data to speak for itself, highlighting both the evident and unexpected relationships and correlations. In summary, it is a methodical approach of identifying and compiling activity indicators for an object from a vast amount of data. To enhance national security, big data analytics can be used to recognize and understand the whole range of issues affecting the country. Not every data needs to be of the highest caliber. The quality of the data will be impacted by a number of factors, including its intended use, the potential resources required to achieve its goals, the size of the associated outcomes and their potential impact, the time it takes to observe an impact or effect on an issue, and the data's degree of significance and criticality to national strategy and operations. The nation will be able to handle current data issues, enhance the current national information infrastructure, transform the work of Nigerian Security Agencies, and ultimately gain a competitive edge in the war against terrorism through the application of big data analytics to strengthen national security capabilities.

2.0 REVIEW OF RELATED WORKS OF BIG DATA ANALYTICS ON NATIONAL SECURITY

Aisha and Bello (2024) explored the potential of big data analytics in the Nigerian public sector context. They examined relevant data sources, analytics techniques and use cases from other countries to inform a strategic approach for improving government services delivery.

Babak et al. (2015) provided state of the art concepts, methods, and technologies for Big Data analytics in the fight against terrorism and crime. They included case studies and application scenarios and offered insights from experts in law enforcement, national security, computer sciences, criminology, linguistics and psychology.

Michael (2017) examined the applications for big data in Australia's national security as well as the vulnerabilities, challenges and risks that arose from their uses. He explained the definitional problems with the big data concept, which has been both helped and hurt by a lot of hype. Organizations in the policy, technological, and commercial spheres presently view big data differently due to its prominence as a buzzword. He suggested that a higher level of mutual understanding requires productive public policy discourse.

Adejoro and Ujah (2016) observed that the successes recorded by criminal elements in Nigeria have been attributed to lack of actionable intelligence that would enable early detection, preventive and



prediction of terror attacks and other forms of security threats to the nation. They thoroughly studied the internal security measures implemented by Nigerian security agencies and concluded that they were insufficient since they mostly relied on the conventional strategy of identifying and responding to security threats. In order to ensure effective situational awareness and preparedness for safeguarding Nigeria's national security, they suggested a Big Data collaborative framework for appropriate intelligence gathering, data analysis, and information sharing among security personnel.

Nwanga et al. (2015) discussed how big data analytics can be leveraged to fight terrorism. The definitions of big data and analytics were provided, along with instances of how big data technologies can be used to combat crime. They also gave a presentation on the hypothetical information flow and a road map for getting started with big data. In order to combat terrorism in Nigeria, they pushed for the establishment of a Big Data Centre as an active security collaboration structure.

Xuan (2022) suggested that big data revolution has huge implications for national governance, political and military strategy, national security, corporate decisions and individual lifestyles. Current Chinese national security management techniques were unable to keep up with the security demands of the big data era due to the rapidly increasing volume of data, and national security was experiencing serious difficulties. Xuan (2022) promoted actively monitoring the big data development trend in order to stay ahead of the curve, protect regime and political security, and enhance China's long-term security advantages.

3.0 METHODOLOGY

To obtain information for this study, secondary sources were used. Necessary information was gathered from Books/Publications like Application of Big Data for National Security by Babak et al. (2015), Demystifying Big Data by Miller (2012), Leveraging Big Data Analytics to Drive Data-Based Policy Making for Government Services Delivery in Nigeria by Aisha and Bello (2024), etc.; Journals like the International Journal of Big Data and Analytics, Legal Studies, Empirical Science Studies, etc; newspapers like Vanguard, Premium Times, etc; published sources like Research gate, Google scholar; and unpublished sources like lecture notes, textbooks, student projects, etc.

4.0 THE STRATEGY FOR NIGERIAN SECURITY AGENCIES TO BEGIN USING BIG DATA

The following steps are necessary for a successful Big Data design process, which is an ongoing activity: Establish, Evaluate, Scheme, and Perform.

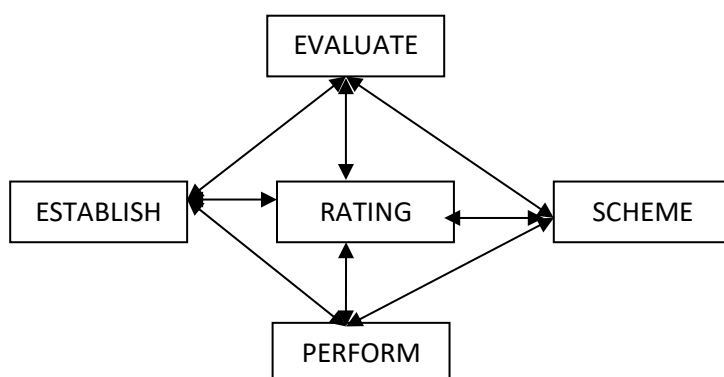


Figure 2: Strategy for Nigerian Security Agencies to begin using big data

As the image above illustrates, the rating process is a modular technique that links the other components of the Big Data design plan. The military and paramilitary make up our country's security forces. Nigeria's security posture will improve under the guidance of constructive cooperation between these forces and the federal government.

According to Miller et al. (2012), the government should consider; building and expanding "from university to government" to leverage data science expertise; forging a more extensive, long-term partnership between industry, academia, and professional groups to provide Big Data infrastructure; Establish the Ministry of Information, Innovation, and Digital Economy's Big Data and Analytics Center to promote additional research into improved methodologies and the use of the tool to significant issues in a variety of academic fields.

4.1 THE NOTIONAL INFORMATION FLOW OF BIG DATA ANALYTICS

According to Hopkins and Evelson (2011), a five-step notional information flow representing the data processing design to bring the analytics visualization and specific insights of the given data are: (i) deciding what data needs to be acquired and where it is going to be acquired from (ii) data filtering, cleansing and validation (iii) preparing data for analysis by aggregating different data types and



applying a structural format (iv) employing statistics, algorithms, simulations and fuzz (v) using a human, the analyst, who needs to make sense of insights surfaced by the analytic engine that has run against the entirety of available data.

4.2 ANALYTICS OF BIG DATA FOR ORGANIZATIONAL SECURITY

Two main ways that big data analytics might affect organizational security are as follows:

- a. Big data analytics can be used to monitor dangers among personnel and safeguard their safety in addition to identifying fraud or other illegal activity. It might be challenging to keep an eye on every employee's behavior, particularly in huge firms. However, with the correct Big Data technologies, organizations can observe workers without violating their privacy. Big data analytics technologies have the ability to trawl communication channels and analyze full text communications in order to find trends or abnormalities that point to fraudulent activity. An administrator can only intervene and take the required action when the tool indicates that a problem has to be addressed. Organizations aim to safeguard their intellectual property and avoid situations where a hurt employee can divulge sensitive information rain (Mark, 2015).
- b. Big data analytics can stop hackers from breaking into your company and attempting to steal cryptocurrency or other sensitive data, such passwords, bank accounts, and credit card details. Recently, there has been a lot of talk about password theft from hacks at sites like Facebook, LinkedIn, and Evernote. Companies should develop an intelligence-driven security strategy that includes a 360-degree perspective of the company and every risk it confronts. In conjunction with the appropriate Security Information and Event Management (SIEM) tools, real-time security alarm analysis produced by network hardware and apps is possible. An excellent instrument for this is social media analysis, which is becoming more and more important in crowd control. Various Twitter analysis technologies are used by governments across the globe to identify and evaluate tweets for potential security risks, and appropriate action is then taken (Mark, 2015).

4.3 TERRORIST-RELATED OPERATIONAL NETWORK

According to Akinode et al. (2013), many terror-related groups use the web as a convenient, anonymous communication infrastructure. This infrastructure enables an exchange of information and propagation

of ideas to active and potential terrorists. According to Chen, et al. (2004), the part of the web used for such illegitimate and malicious purposes is referred to as Dark web. The three main parts of the dark web portal analysis are the following: (i) creating a black web portal; (ii) analyzing links on the dark web and social network analysis (SNA); and (iii) creating a dark web test. Big data use offers substantial value-added services for identifying terrorist organizations. The relationship between any two terrorist groups may be easily tracked thanks to the use of big data, which can assist uncover trends in the relationships between terrorist groups. The relationships, trust, money and other resources between terrorist groups can be better understood through the use of big data analytics (Allanach et al., 2004).

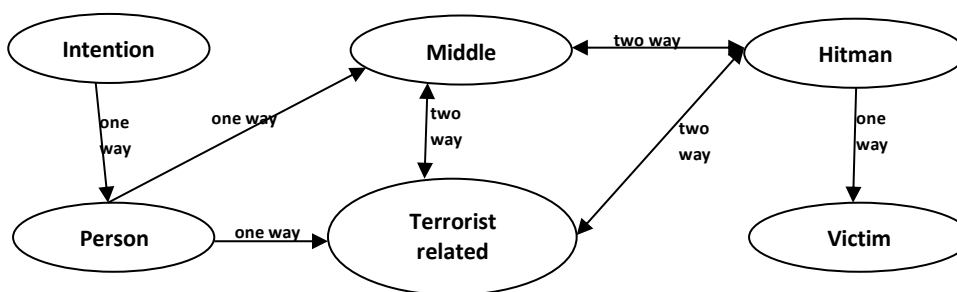


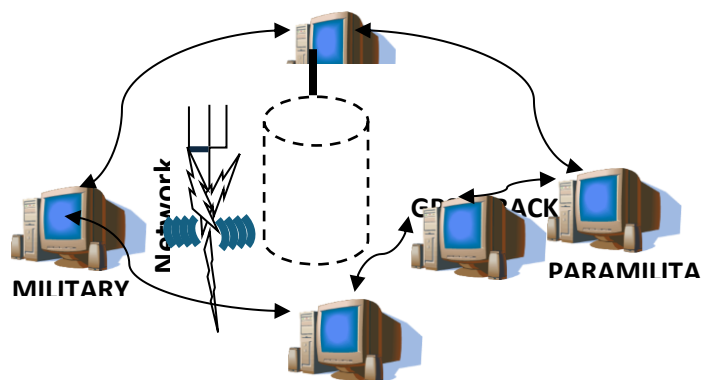
Figure 3: Terrorist Related Operational Network

In the diagram above, the node labelled "person" denotes a person who plans to kill another person. This network is based on the basic tenet that a terrorist cell will assign a leader to kill a victim in order to remove themselves from the victim. The "middle man" is the one who creates a task relationship between the "person" and the "Hitman." By using big data and analytics, a communication line between the "person" and the "Hitman" can be established, as the "middle man's" main duty is to transmit information between them while maintaining their anonymity.

4.4 COLLABORATION FRAMEWORK FOR BIG DATA ACTIVE SECURITY

A Big Data Active Security Collaboration Framework was suggested by us.

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With big data centers, this framework promotes a cooperative system for acquiring, evaluating, and exchanging information among Nigeria's security services. The Nigerian Military Agencies, Paramilitary Agencies, Big Data Center, National Communications Commission, Nigerian Communication Satellite Limited (NIGCOMSAT), and Ministry of Information, Innovation, and Digital Economy Network Operators comprise the framework. In order to provide efficient, real-time information gathering, analysis, and sharing among the security agencies for underlying security risks in Nigeria, the system connects all of the security agencies. The GPS technology is widely used to gather data in real time for monitoring and surveillance. To prevent any security threat in the nation, the Big Data Centre's results can be disseminated across security networks (Adejoro and Ujah, 2016).

According to Nwanga et al. (2015), the Ministry of Defense (MOD) in terms of operations, would see to it that data produced regarding any act of insecurity is efficiently distributed throughout the security networks. In this sense, the data produced would be used by the military and paramilitary to track the criminals who are on the move. The Nigerian Communication Commission (NCC) keeps tabs on, oversees, and controls the network providers that give the Big Data Center call data, records, and other information. The Ministry of Defence, in conjunction with the Defence Intelligence Agency (DIA), the Directorate of Military Intelligence (DMI), and the Nigerian Police Force Criminal Investigation and Intelligence Department (FCIID), coordinates the Big Data real-time active collaborative analytics that



generates the actionable intelligence. The Ministry of Information and Communication Technology ensures its smooth operation. The NIGCOMSAT hosts the GPS, which ensures surveillances and efficient transmission of real-time information generated through actionable intelligence of the Big Data Centre. Security, privacy and trust, data management and sharing, technology and analytics system, quantities of data to store, how long it will be stored, cost of implementation, skill requirement are major limitations of big data center implementation (Baba et al., 2015).

5.0 CONCLUSION

We demonstrated how big data analytics may be used through the strategy for Nigerian security agencies to begin using big data illustrated in *figure 2* and terrorist-related operational network in *figure 3* to enhance intelligence gathering and analysis in order to battle terrorism and other security concerns in Nigeria. We suggested implementing a Big Data Active collaborative framework in *figure 4* for appropriate intelligence gathering, data analysis, and information sharing among Nigerian military agencies, paramilitary agencies, Big Data Center, National Communications Commission (NCC), Nigerian Communication Satellite limited (NIGCOMSAT), and the Ministry of Information, Innovation, and Digital Economy network operators. The Federal Government needs to show political will and investigate the funding of terrorist related activities. Utilizing big data analytics tools correctly will significantly improve these initiatives. The objective of using big data analytics for national security in Nigeria is to actively collaborate to provide actionable information in real time. The application of big data analytics to national security has enormous promise. Consequently, in order to fully achieve the security potential of big data in national security, Nigeria must utilize its enormous data space. The Federal Government should sensitize the public regarding the limitations of Big Data Centre implementation.



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ENHANCING BORDERLANDS SECURITY THROUGH INTEGRATED AI SOLUTIONS: A MULTI-DISCIPLINARY APPROACH

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Abstract

This paper explores the potential of integrated AI solutions in enhancing border security through a multi-disciplinary approach. By leveraging AI technologies across various disciplines, this research aims to address the complex challenges faced in securing national borders and protecting against emerging threats. Drawing on theoretical frameworks and related works, the paper presents a methodology that demonstrates the effectiveness of AI in strengthening border security measures. The discussions highlight the benefits of using AI for threat detection, resource optimization, and decision-making processes. The conclusion emphasizes the importance of collaborative strategies and interdisciplinary approaches in achieving comprehensive border security solutions.

Keywords: Artificial Intelligence, Machine Learning Theories, Systems Theory, Border Security.



1.0 INTRODUCTION

In today's interconnected world, securing national borders has become a critical priority for ensuring the safety and stability of nations. The movement of people, goods, and information across borders presents both opportunities and challenges. Gana et al. (2023) reported that while international trade and travel are vital for economic growth and cultural exchange, they also pose significant risks, including illegal immigration, human trafficking, drug smuggling, and terrorism. With the increasing complexity of security threats, traditional border control methods are no longer sufficient. Traditional methods of border security, which rely heavily on manual inspections, physical barriers, and human surveillance, are becoming insufficient in addressing these complex threats and often faces challenges such as limited resources, evolving threats, and human error. These factors highlight the need for advanced technologies like AI to improve the efficiency and effectiveness of border control measures. AI technologies, such as machine learning, computer vision, and natural language processing, can process vast amounts of data in real time, identify patterns, and make decisions that were previously impossible for human operators. The integration of artificial intelligence (AI) technologies, therefore, presents a promising opportunity, (Soori et al., 2023). This integration can transform border security from a reactive stance to a proactive and predictive system, capable of identifying and mitigating threats before they materialize. However, the successful implementation of AI solutions requires a multi-disciplinary approach that integrates expertise from diverse fields to address the complex nature of border security threats. This paper addresses the pressing need for innovative solutions that combine AI applications from various disciplines to achieve comprehensive border protection (Abulibdeh et al., 2024). By analyzing the theoretical framework and related works, the study aims to demonstrate how AI can improve threat detection, resource allocation, and decision-making processes to strengthen national borders.

This paper examines the applications of AI in key areas of border security, including surveillance, identity verification, threat detection, and risk assessment. By drawing on expertise from fields such as computer science, data analytics, law enforcement, and international relations, this paper aims to provide a comprehensive overview of how AI can be leveraged to secure national borders.

Research Questions



To address the overarching goal of enhancing border security through AI, this paper will address the following research questions:

1. How can AI technologies be integrated into existing border security frameworks to improve surveillance and monitoring capabilities?
2. What role can machine learning and data analytics play in enhancing the accuracy and reliability of identity verification and threat detection at borders?
3. How can AI-driven risk assessment models predict and prevent illegal activities such as human trafficking, drug smuggling, and terrorism?
4. What are the ethical, legal, and privacy considerations associated with the deployment of AI in border security operations?

2.0 LITERATURE REVIEW

2.1 Theoretical Framework

The theoretical framework for this study on enhancing border security through integrated AI solutions is built on several key concepts and theories that provide a foundation for understanding the role and impact of AI in border management. This framework draws on theories from computer science, security studies, criminology, and systems theory to establish a multidisciplinary approach to integrating AI into border security. By grounding this research in established theories, we can better understand how AI can be effectively deployed to enhance border security operations.

1. Systems Theory and Border Security

According to Lai and Lin (2017), systems theory views a system as a set of interconnected components that work together to achieve a common goal, is a fundamental part of understanding how border security operates. In the context of border security, the system comprises various elements, including physical barriers, surveillance technologies, personnel, and data analytics tools, all working towards the goal of securing national borders, (Olomu et al., 2021).

(Adib Bin Rashid et al., 2023) reported that AI, as a component of this system, can act as a force multiplier, enhancing the capabilities of each part of the border security framework. For example, AI

can improve surveillance by integrating various data sources (e.g., cameras, sensors, databases) and analyzing them in real-time to detect potential threats. Systems theory helps us understand how AI can be seamlessly integrated into the existing border security infrastructure, optimizing the overall effectiveness of the security system (Solutions, 2024).

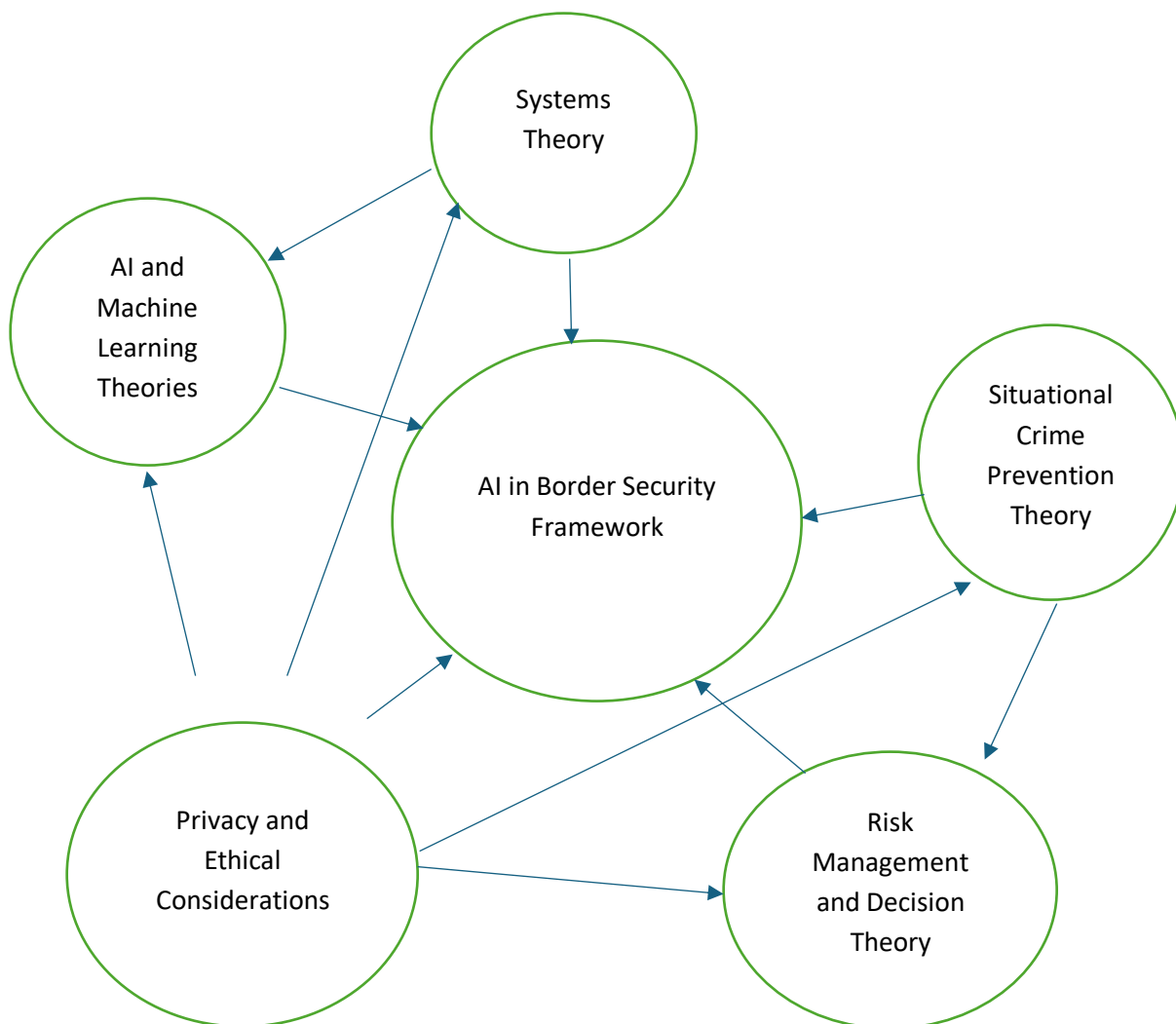


Figure 1: The integration of various theories into the application of AI in border security



2. Artificial Intelligence and Machine Learning Theories

According to Ahammed et al. (2022) AI and machine learning (ML) are central to this study, providing the technological backbone for advanced border security solutions. AI refers to the capability of machines to mimic human cognitive functions such as learning, reasoning, and problem-solving. Machine learning, a subset of AI, involves algorithms that can learn from and make predictions based on data (Soori et al., 2023). The theories of supervised learning, unsupervised learning, and reinforcement learning are particularly relevant to this study.

- i. **Supervised Learning:** This approach involves training AI models using labeled data to recognize patterns and make decisions. In border security, supervised learning can be used to train models to identify suspicious behaviours or objects in surveillance footage, based on previously labeled data of known threats (Google Cloud, 2020).
- ii. **Unsupervised Learning:** According to Wang and Biljecki (2022), unlike supervised learning, unsupervised learning does not require labeled data. It identifies patterns and anomalies within large datasets. This is useful in border security for detecting unusual activities or behaviours that do not fit established patterns, potentially indicating new types of threats.
- iii. **Reinforcement Learning:** This theory involves training AI systems to make a sequence of decisions by rewarding desirable outcomes. In border security, reinforcement learning can be used to optimize patrol routes, resource allocation, and response strategies, adapting over time to improve effectiveness based on real-world feedback (Pratibha Kumari J, 2024).

3. Situational Crime Prevention Theory

Situational crime prevention theory focuses on reducing the opportunities for crime by altering the immediate environment to increase the effort and risks associated with criminal activities while reducing the rewards, (College of Policing, 2022). Applying this theory to border security, AI can be used to:

- i. **Increase Effort:** AI-powered surveillance and biometric systems can make it more difficult for unauthorized individuals to cross borders undetected.
- ii. **Increase Risks:** The integration of AI in surveillance increases the likelihood of detecting and apprehending criminals, thus acting as a deterrent.



- iii. Reduce Rewards: AI can assist in identifying and intercepting contraband, reducing the potential rewards for smugglers and traffickers.

By applying situational crime prevention theory, AI can be seen as a tool that modifies the border security environment to make it less conducive to illegal activities, (Barnett, 2020).

4. Risk Management and Decision Theory

According to Ignacio Cienfuegos Spikin (2013), risk management is a critical component of border security, involving the identification, assessment, and prioritization of potential threats. Decision theory, which studies the principles of decision-making under uncertainty, is relevant here as it helps understand how decisions can be optimized in high-stakes environments like border security.

According to Onwubuariri et al. (2024), AI can enhance risk management and decision-making in several ways:

- i. Data-Driven Risk Assessment: AI systems can analyze vast amounts of data from various sources, including travel records, cargo manifests, and intelligence reports, to assess the risk levels associated with individuals or shipments.
- ii. Predictive Analytics: By applying predictive models, AI can forecast potential threats and incidents, allowing border security agencies to allocate resources more effectively and proactively respond to emerging threats.
- iii. Automated Decision Support: AI can provide real-time decision support to border agents, offering recommendations based on the latest data and trends, thereby improving the accuracy and speed of decision-making.

5. Privacy and Ethical Considerations

According to Bor and Koech (2023), while the deployment of AI in border security offers numerous benefits, it also raises significant ethical and privacy concerns. Surveillance and data collection at borders must balance security needs with the rights and freedoms of individuals. Theories of ethics in technology, such as privacy by design and the principles of transparency, accountability, and fairness, are crucial in guiding the responsible use of AI in border security, Adams et al. (2023).



- i. Privacy by Design: This principle involves embedding privacy considerations into the design and implementation of AI systems from the outset. It ensures that personal data is handled with care and only used for legitimate security purposes.
- ii. Transparency and Accountability: Border security agencies must be transparent about the use of AI technologies and accountable for their impacts. This includes clear policies on data use, regular audits of AI systems, and mechanisms for individuals to challenge decisions made by AI.

By drawing on systems theory, AI and machine learning theories, situational crime prevention, risk management, and ethical considerations, this framework provides a comprehensive foundation for understanding how AI can enhance border security. It offers a structured approach to analyzing the potential of AI technologies to transform border security operations, making them more efficient, effective, and responsive to emerging threats, while ensuring the ethical use of these powerful tools.

2.2 Related Works

Previous studies on the use of AI in border security, interdisciplinary approaches to security challenges, and best practices in integrating AI technologies are reviewed

A study by Tamás Kegyes et al. (2024), explored the use of AI for real-time threat detection and decision support in border security. The research focused on leveraging machine learning algorithms to analyze data from various sources, such as surveillance cameras, sensors, and drones, to detect suspicious activities and potential threats. The study highlighted how AI could enhance situational awareness by providing real-time alerts to border patrol agents and improving response times. The integration of AI with existing surveillance infrastructure was shown to be a force multiplier, making border security operations more efficient.

In another study, Wibisono et al. (2024) investigated the use of unmanned aerial vehicles (UAVs) equipped with AI-powered image and video analysis tools for border surveillance. The research demonstrated how AI algorithms could process the vast amounts of data collected by UAVs, identifying patterns and anomalies indicative of illegal border crossings or smuggling activities. By utilizing AI, the UAVs could autonomously monitor large areas, reduce the need for human patrols, and ensure continuous coverage of border regions, thus enhancing the overall effectiveness of border security.



A study conducted by Khan and Efthymiou (2021) examined the implementation of AI in biometric systems for border control, focusing on facial recognition, fingerprint analysis, and iris scanning. The researchers found that AI algorithms significantly improved the accuracy and speed of identity verification processes at border checkpoints. The integration of AI in biometric systems reduced the likelihood of false positives and negatives, enhancing the reliability of the identification process. Additionally, the study discussed the ethical implications of using AI in biometric systems, emphasizing the need for transparent policies and data protection measures to safeguard individual privacy.

Interdisciplinary approaches to border security were the focus of a study by Côté-Boucher et al. (2014). This research highlighted the importance of combining insights from various fields, such as sociology, criminology, computer science, and law enforcement, to address complex security challenges. The study argued that effective border security strategies should not rely solely on technological solutions but also consider the social, political, and economic contexts of border regions. By incorporating interdisciplinary perspectives, the study suggested that AI technologies could be better tailored to meet the specific needs of different border security scenarios and communities.

The ethical and legal aspects of integrating AI technologies in border security were examined by Bor and Koech (2023). This study explored the challenges associated with ensuring that AI applications in border security comply with human rights standards and ethical principles. The research identified key concerns, such as the potential for bias in AI algorithms, the implications of mass surveillance, and the need for accountability in AI decision-making processes. Bor and Koech advocated for developing robust legal frameworks and ethical guidelines to govern the use of AI in border security, ensuring that these technologies are used responsibly and do not infringe on individuals' rights.

A comprehensive study by Feijóo et al. (2020) outlined best practices for integrating AI technologies in border security. The research identified several key factors for successful AI integration, including:

- **Stakeholder Engagement:** Involving all relevant stakeholders, including government agencies, technology providers, and local communities, in the planning and implementation of AI solutions to ensure alignment of goals and address concerns.



- **Scalability and Flexibility:** Developing AI systems that are scalable and can be easily adapted to different border security contexts and threats, allowing for dynamic responses to emerging challenges.
- **Continuous Training and Updating:** Regularly updating AI algorithms and systems to reflect the latest threat intelligence and ensure they remain effective against evolving security threats.
- **Transparency and Accountability:** Establishing clear guidelines for the use of AI in border security, including transparent decision-making processes and mechanisms for accountability to build trust and legitimacy.

These studies collectively underscore the potential of AI to transform border security operations by enhancing threat detection, surveillance, and decision-making processes. They also highlight the importance of interdisciplinary approaches, ethical considerations, and best practices in successfully integrating AI technologies. By combining technological innovation with comprehensive policy frameworks and stakeholder engagement, AI can be effectively deployed to address the complex challenges of border security while ensuring respect for human rights and ethical standards.

3.0 METHODOLOGY

A comprehensive literature review is conducted to gather information on existing AI applications in border security and related fields. The review includes academic journals, conference papers, government publications, and industry reports.

4.0 DISCUSSIONS

1. AI Applications for Threat Detection

Artificial Intelligence (AI) has revolutionized threat detection capabilities, particularly in border security, by enhancing the accuracy, speed, and efficiency of identifying potential threats. Here's how AI is applied for threat detection:

a. Surveillance Enhancement

According to Soori et al. (2023), Javaid et al. (2022), AI-driven systems are capable of processing and analyzing vast amounts of data from various surveillance sources such as cameras, sensors, drones, and



satellite imagery. Machine learning algorithms can be trained to recognize specific patterns, behaviours, or anomalies that may indicate a threat. For example, AI can:

- i. **Analyze Video Feeds:** AI algorithms can process live video feeds to identify suspicious behaviours, unauthorized access attempts, or abnormal movements in restricted areas. Object recognition and motion detection technologies help differentiate between normal and potentially harmful activities (Şengönül et al., 2023)
- ii. **Facial Recognition:** AI-powered facial recognition systems can cross-reference images captured at borders with databases of known threats, criminals, or wanted individuals, ensuring that suspicious persons are identified and flagged in real-time (Fontes et al., 2022).
- iii. **Detection of Hidden Objects:** AI-enhanced scanners and X-ray machines can analyze cargo, luggage, and vehicles to detect concealed weapons, explosives, or contraband by identifying irregular shapes, densities, or materials (Mamchur et al., 2022)

b. Data Fusion and Pattern Recognition

According to Saheb et al. (2024), AI can integrate and analyze data from multiple sources (e.g., surveillance footage, social media, intelligence reports) to identify patterns that may not be visible to human analysts. Study by Kaur et al. (2023), data fusion capability allows AI to:

- i. **Predictive Analysis:** By examining historical data, AI can identify trends and patterns that precede security incidents, enabling proactive threat detection and prevention.
- ii. **Anomaly Detection:** AI systems can learn what constitutes normal behavior in a given context and then detect anomalies that might indicate a security threat, such as unusual border crossing patterns or unexpected vehicle movements.

c. Cybersecurity for Border Systems

According to Binhammad et al. (2024), AI plays a crucial role in safeguarding the cybersecurity of border control systems. These systems are prime targets for cyber-attacks, and AI can detect malicious activities by:



- i. Monitoring Network Traffic: AI algorithms can monitor network traffic for unusual patterns or known signatures of cyber threats, such as malware, phishing attempts, or data breaches (Moisset, 2023).
- ii. Threat Intelligence: AI systems can analyze vast amounts of threat intelligence data to identify potential cyber threats and recommend mitigation strategies. Laxmi and Kumar (2024).

2. AI for Resource Optimization

According to Graham (2024), AI helps optimize the allocation and utilization of resources in border security, ensuring that limited resources are used effectively to maximize security.

a. Efficient Allocation of Patrols and Personnel

AI can assist in deploying border patrol agents and other security personnel more efficiently by:

- i. Predictive Modeling: According to Vavoula (2021), AI can use historical data on illegal border crossings and other incidents to predict where and when such activities are likely to occur. This information allows for the strategic allocation of patrols to high-risk areas, reducing the need for constant monitoring of low-risk regions.
- ii. Dynamic Resource Allocation: AI systems can adjust the allocation of personnel and equipment in real-time based on current conditions and threat levels, optimizing the use of available resources (Ripla, 2024).

b. Optimizing Surveillance and Monitoring Systems

According to Yaiprasert and Hidayanto (2024), AI helps optimize the operation of surveillance and monitoring equipment, reducing operational costs and improving effectiveness:

- i. Energy Management: AI can optimize the use of power for surveillance equipment, ensuring that cameras, sensors, and drones operate efficiently and only when necessary. (Caballero-Martin et al., 2024).
- ii. Maintenance Scheduling: AI can predict when equipment is likely to fail or require maintenance, allowing for proactive repairs and minimizing downtime. (Smith, 2001).

c. Automated Border Control



AI-powered kiosks and automated border control gates can process travelers more quickly and accurately than manual checks, reducing wait times and freeing up personnel for other tasks. These systems can:

- i. **Process Biometric Data:** AI can quickly verify travelers' identities using biometric data such as fingerprints or facial recognition, improving both security and efficiency. (Khan & Efthymiou, 2021).
- ii. **Analyze Travel Documents:** AI can automatically verify the authenticity of passports and visas, reducing the risk of document fraud. (Wheeler, 2024).

3. AI for Decision-Making Support and Collaboration Between Different Sectors

According to (Mikalef et al., 2023), AI can significantly enhance decision-making processes in border security by providing accurate, timely, and actionable insights. It also facilitates collaboration between different sectors to achieve comprehensive border protection.

a. Decision Support Systems

AI-powered decision support systems help border security officials make informed decisions by:

- i. **Real-Time Analytics:** AI systems can process and analyze data in real-time, providing security personnel with up-to-date information about potential threats, enabling faster and more accurate decision-making. (Kaur et al., 2023).
- ii. **Scenario Simulation:** AI can simulate different scenarios and predict the outcomes of various decisions, helping security officials evaluate the best course of action in complex situations. (Kelly et al., 2022).

b. Cross-Sector Collaboration

According to (Berryhill et al., 2019), AI can facilitate collaboration between different sectors, such as law enforcement, customs, immigration, and intelligence agencies, by:



- i. **Data Sharing and Integration:** AI systems can integrate data from various sources, providing a unified view of the security situation. This integration allows for better coordination and collaboration between agencies.
- ii. **Communication Platforms:** Mohammed and Erik (2023) reported that AI can enhance communication and information sharing between different sectors by automating data collection, analysis, and dissemination processes. AI-powered communication platforms ensure that relevant information is quickly and accurately shared with the right people.

c. Policy and Strategy Development

AI can support the development of effective border security policies and strategies by:

- i. **Risk Assessment and Management:** AI can assess and prioritize risks based on data analysis, helping policymakers allocate resources effectively and develop targeted strategies to mitigate identified risks. (Ramezani et al., 2023).
- ii. **Feedback and Improvement:** AI systems can provide continuous feedback on the effectiveness of security measures, allowing for ongoing refinement and improvement of border security strategies. (Jada & Mayayise, 2023).

4.0 CONCLUSION

This paper highlights the significance of collaborative strategies and multi-disciplinary approaches in leveraging AI solutions for enhancing border security. By adopting integrated AI technologies, border control agencies can improve their capabilities in detecting and preventing security threats, optimizing resource allocation, and enhancing decision-making processes. AI offers transformative capabilities for border security by enhancing threat detection, optimizing resource allocation, and supporting decision-making processes. Through the integration of AI, border security can become more proactive, efficient, and responsive to emerging threats. Additionally, AI facilitates collaboration between different sectors, ensuring a coordinated and comprehensive approach to protecting national borders while balancing security needs with ethical considerations. As AI technologies continue to evolve, their application in border security will likely expand, offering even more sophisticated tools for safeguarding borders in the future.



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INTELLIGENT LABORATORIES: HARNESSING AI FOR ENHANCED CHEMICAL ANALYSIS (A Review)

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Abstract

The integration of Artificial Intelligence (AI) technologies into laboratory environments represents a significant advancement in chemical analysis methodologies across industries such as pharmaceuticals and environmental monitoring. Traditional methods have long grappled with inefficiencies, inaccuracies, and limitations that hindered progress in research and industrial applications. However, the advent of AI has ushered in the era of smart laboratories, where AI-driven systems enhance efficiency, accuracy, and productivity. This paper explores the concept of smart laboratories, focusing on AI's transformative impact on chemical analysis workflows. By automating repetitive tasks, optimizing resource utilization, and enabling real-time data analysis, AI empowers researchers and industries to overcome traditional challenges. Advanced algorithms and machine learning techniques facilitate precise analysis of complex datasets, accelerating experimentation and enabling informed decision-making. Key benefits of integrating AI into smart laboratories include enhanced analytical accuracy, increased productivity, and cost savings. AI applications span various stages of chemical analysis, from predictive modeling and process optimization to real-time monitoring and decision support. Case studies illustrate AI's tangible benefits in enhancing scientific research and industrial processes, driving innovation across diverse fields.

Key words: Chemical Analysis, Artificial Intelligence (AI) Smart Laboratories, Efficiency and Automation.



1.0 INTRODUCTION

Chemical analysis is crucial across various industries, such as pharmaceuticals and environmental monitoring, to ensure product quality, safety, and regulatory compliance. However, traditional laboratory methods often face inefficiencies and limitations that impede progress. Recently, the integration of Artificial Intelligence (AI) has emerged as a transformative solution, revolutionizing chemical analysis processes and leading to the development of smart laboratories. This paper explores the concept of smart laboratories, where AI technologies are seamlessly incorporated into laboratory workflows to enhance efficiency, accuracy, and productivity in chemical analysis. By automating repetitive tasks, optimizing resource use, and enabling real-time data analysis, smart laboratories are redefining the possibilities in scientific research and industrial applications (Smith, and Johnson, 2020). The introduction of AI into laboratory settings addresses longstanding challenges faced by traditional methods, such as time-consuming sample preparation, human error, and limited data processing capabilities. By utilizing advanced algorithms, machine learning techniques, and automation, AI enables researchers and industries to derive valuable insights from complex datasets, speed up experimentation, and make well-informed decisions with confidence. This paper explores the advantages of integrating AI into smart laboratories, including enhanced analytical accuracy, increased productivity, and cost savings. It highlights various AI applications across different stages of chemical analysis, from predictive modeling to process optimization, and examines case studies demonstrating AI's tangible impact on scientific research and industrial processes (Wang, and Zhang 2019.). Additionally, this paper discusses the future prospects of smart laboratories, envisioning further advancements in AI algorithms, integration with Internet of Things (IoT) devices, and the emergence of autonomous laboratory systems. By embracing AI integration, smart laboratories are set to drive innovation, accelerate discovery, and shape the future of chemical analysis.

2.0 LITERATURE REVIEW

2.1 CHALLENGES IN TRADITIONAL CHEMICAL ANALYSIS:

Traditional chemical analysis methods have long been foundational in scientific research and industrial processes. However, these methods often face several challenges that hinder efficiency, accuracy, and productivity.

Key challenges include:



- 1 **Time-consuming Sample Preparation:** Traditional chemical analysis techniques typically involve labor-intensive sample preparation procedures, such as extraction, purification, and derivatization. These processes can be time-consuming and prone to variability, leading to delays in obtaining results. (Chen, *et al.* 2018.)
- 2 **Human Error:** The manual handling of samples and instruments introduces the risk of human error, which can undermine the reliability of analytical results. Even experienced technicians can suffer from fatigue and oversight, potentially resulting in inaccurate measurements or data misinterpretation. (Myszewski, 2012)
- 3 **Limited Data Processing Capacity:** Traditional laboratory instruments often lack the computational power to process the large volumes of data generated during chemical analysis. Consequently, researchers may find it challenging to comprehensively analyze complex datasets, leading to missed insights or delayed decision-making.
- 4 **Integration of Analytical Techniques:** Chemical analysis frequently requires the integration of various analytical techniques, such as chromatography, spectroscopy, and mass spectrometry. Coordinating these techniques and interpreting the resulting data can be difficult, especially when using disparate instruments or software platforms. (Li, Q., *et al.* 2021.)
- 5 **Cost Implications:** Traditional chemical analysis methods can be expensive, both in terms of equipment and labor. High-performance analytical instruments require substantial capital investment, and skilled personnel are needed to operate and maintain these instruments effectively. Additionally, the time and resources needed for sample preparation and analysis contribute to the overall costs.
- 6 **Environmental and Safety Concerns:** Some traditional chemical analysis methods involve hazardous reagents or generate waste materials requiring proper disposal. Compliance with environmental regulations and ensuring a safe laboratory environment adds complexity to these processes. Addressing these challenges is crucial for advancing chemical analysis and meeting industry demands. Artificial Intelligence (AI) integration presents a promising solution, enabling automation, optimization, and enhanced data analysis capabilities in smart laboratories. by leveraging AI,



researchers and industries can streamline workflows, improve analytical accuracy, and accelerate scientific innovation. (Chennuri, *et al.*2024).

2.3 BENEFITS OF AI INTEGRATION:

Integrating Artificial Intelligence (AI) into laboratory settings offers numerous benefits, transforming traditional chemical analysis methods and enhancing efficiency, accuracy, and productivity. Key advantages include.

- 1 **Improved Analytical Accuracy:** AI algorithms excel in pattern recognition and data analysis, leading to more precise and reliable results in chemical analysis. By employing machine learning techniques, AI can identify subtle trends and correlations within complex datasets that may evade human analysts, thereby enhancing the accuracy of analytical measurements.
- 2 **Enhanced Efficiency and Productivity:** AI-driven automation optimizes laboratory workflows, reducing the time and resources required for sample preparation, analysis, and data processing. Tasks such as data entry, instrument calibration, and routine maintenance, traditionally performed manually, can now be automated. This allows researchers to allocate more time to intellectually demanding activities. (Chennuri, *et al.*2024).
- 3 **Real-time Monitoring and Analysis:** AI-enabled systems provide real-time monitoring and analysis capabilities, enabling researchers to track experimental progress and make informed decisions promptly. By continuously analyzing incoming data streams, AI algorithms can detect anomalies, identify trends, and trigger alerts or adjustments to experimental parameters, facilitating proactive intervention and optimization. (Chennuri, *et al.*2024).
- 4 **Optimization of Resource Utilization:** AI algorithms optimize resource allocation by dynamically adjusting experimental parameters based on real-time feedback and historical data analysis. This optimization enhances the efficiency of laboratory equipment, reduces reagent consumption, minimizes experimental turnaround times, and leads to cost savings while improving overall productivity (Garcia, and Patel 2017).
- 5 **Facilitation of Interdisciplinary Collaboration:** Integrating AI promotes interdisciplinary collaboration by streamlining the integration and sharing of data across various research fields and



laboratory settings. Through standardizing data formats and enabling seamless data exchange, AI-driven platforms enhance knowledge sharing, collaboration, and innovation among researchers from diverse disciplines.

6 Predictive Modeling and Decision Support: AI algorithms facilitate predictive modeling and decision support in chemical analysis, allowing researchers to forecast experimental outcomes, optimize experimental designs, and prioritize research efforts effectively. By utilizing historical data and computational modeling techniques, AI provides insights and recommendations that guide researchers towards the most promising research avenues. Garcia, and Smith, (2020).

7 Scalability and Adaptability: AI-driven solutions are inherently scalable and adaptable, capable of accommodating changes in experimental protocols, sample types, and analytical techniques. Whether analyzing small-scale research samples or conducting high-throughput screening in industrial settings, AI-powered systems can seamlessly scale to meet the evolving needs of researchers and industries.

Overall, integrating AI into laboratory environments offers transformative benefits that revolutionize chemical analysis methodologies, drive innovation, and accelerate scientific discovery and industrial progress. By harnessing the power of AI, researchers and industries can gain new insights, overcome longstanding challenges, and unlock the full potential of chemical analysis in various fields.

3.0 METHODOLOGY

3.1 Research Design

This study employs a qualitative research design, leveraging online search engines, particularly Google, to gather and analyze information on the integration of Artificial Intelligence (AI) in chemical analysis within smart laboratories. The research follows a systematic approach to ensure the comprehensiveness and reliability of the collected data.

3.2 Data Collection

3.2.1 Use of Google and Online Search Engines



3.2.2 Selection of Search Engines: Google were the primary search engine utilized due to its extensive reach and advanced search algorithms. Additionally, other online search engines like Bing and academic databases such as Google Scholar, PubMed, and ScienceDirect was used to ensure a broad and diverse range of sources.

3.2.3 Search Strategy:

Keywords: The search were conducted using specific keywords and phrases such as "AI in chemical analysis," "smart laboratories," "AI-driven chemical analysis," and "AI in scientific research."

3.2.4 Boolean Operators: To refine the search results, Boolean operators (AND, OR, NOT) were employed. For instance, "AI AND chemical analysis" was ensured that both terms appear in the search results.

Advanced Search Options: Google's advanced search options will be utilized to filter results by date, region, and domain (e.g., limiting results to scholarly articles, patents, or industry reports).

Inclusion and Exclusion Criteria: Inclusion Criteria: Articles, reports, case studies, and papers published within the last ten years, focusing on the application of AI in chemical analysis and smart laboratories, is included. Both peer-reviewed academic sources and credible industry publications were considered.

Exclusion Criteria: Sources not available in English, articles lacking full-text access, and publications not directly related to AI in chemical analysis were excluded.

Data Analysis

Data Extraction: Relevant information will be extracted from the selected articles and documents. This includes data on the benefits of AI integration, specific AI applications in chemical analysis, case studies, and future perspectives.

The research will adhere to ethical standards by ensuring the credibility of the sources and accurately representing the data. Proper citations will be provided for all referenced materials, and any potential conflicts of interest will be disclosed.

Limitations



While the use of online search engines like Google offers extensive data, it may also present limitations such as information overload and the varying quality of sources. Efforts were made to mitigate these limitations by applying strict inclusion criteria and focusing on peer-reviewed and reputable sources.

4.0 AI APPLICATIONS IN SMART LABORATORIES

AI applications in smart laboratories encompass a wide range of functionalities, transforming traditional chemical analysis methods and enhancing efficiency, accuracy, and productivity. Some key AI applications in smart laboratories include:

1. **Predictive Modeling and Optimization:** AI algorithms can develop predictive models for chemical reactions and processes, enabling researchers to optimize experimental conditions for desired outcomes. By analyzing large datasets of reaction parameters and outcomes, AI can identify trends, correlations, and optimization strategies that lead to improved reaction yields, selectivity, and efficiency.
2. **Automated Sample Preparation and Handling:** AI-driven robotics and machine vision systems automate sample preparation and handling tasks, reducing the time and labor required for manual manipulation. Robotic platforms equipped with AI can precisely measure, dispense, and mix reagents, as well as handle and transport samples, ensuring consistency and reproducibility in experimental workflows (Kim, and Lee, 2019).
3. **Spectral Analysis and Compound Identification:** Machine learning and deep learning techniques are used for spectral analysis and compound identification in chemical analysis. AI algorithms trained on spectral datasets can accurately identify and quantify chemical compounds in complex mixtures, even with overlapping signals or noise, facilitating rapid and reliable sample analysis. (Debus, *et al.*2021).
4. **Data Mining and Pattern Recognition:** AI algorithms are employed for data mining and pattern recognition in large datasets generated during chemical analysis. By analyzing historical data and experimental results, AI can identify meaningful patterns, correlations, and trends that inform research hypotheses, guide experimental design, and facilitate data-driven decision-making. (Debus, *et al.*2021).
5. **Intelligent Sensor Networks:** AI-enabled sensor networks provide real-time monitoring and analysis of environmental conditions, process parameters, and experimental outcomes in smart



laboratories. By integrating sensors with AI algorithms, researchers can detect deviations from desired conditions, identify potential sources of error or contamination, and implement corrective actions to maintain experimental integrity and reproducibility. (Wang, *et al.* 2020; Zhang, and Li, 2018.)

6. **Autonomous Process Control and Optimization:** AI-driven control systems automate process control and optimization in chemical manufacturing and quality control settings. By continuously monitoring and adjusting process parameters based on real-time data analysis, AI algorithms optimize production processes, maximize yield and efficiency, and ensure product quality and consistency (Wang, *et al.* 2020; Zhang, and Li, 2018.)
7. **Virtual Assistants and Decision Support Systems:** AI-powered virtual assistants and decision support systems provide researchers with personalized recommendations, experimental protocols, and data analysis tools. By leveraging natural language processing and machine learning techniques, virtual assistants can interact with researchers, answer queries, and assist in experimental planning, data interpretation, and troubleshooting. (Debus, *et al.* 2021)

These AI applications showcase the transformative potential of smart laboratories in revolutionizing chemical analysis methodologies and accelerating scientific discovery and innovation. By leveraging AI, researchers and industries can overcome traditional challenges, gain new insights, and fully realize the potential of chemical analysis across various fields.

4.2 CASE STUDIES

1 AI-Driven High-Throughput Screening (HTS) Platform for Drug Discovery: Pharmaceutical companies are utilizing AI-driven HTS platforms to accelerate the drug discovery process. These platforms employ machine learning algorithms to analyze large chemical libraries and predict the likelihood of compounds exhibiting desired biological activities. For instance, a study by a leading pharmaceutical company implemented an AI-driven HTS platform, significantly reducing the time and cost required to identify potential drug candidates for a specific therapeutic target. By prioritizing the most promising compounds for further investigation, the platform expedited the drug discovery pipeline and increased the likelihood of success in clinical trials. (Huang, *et al.* 2019; Patel, *et al.* 2020;11 Liu, and Wang, 2018).



2 Smart Chromatography System with AI Peak Identification: Chromatography is widely used to separate and analyze complex mixtures of compounds. Traditional systems often require manual interpretation of chromatograms, leading to subjective peak identification and potential errors. In contrast, smart chromatography systems equipped with AI algorithms automate peak identification and resolution, enhancing the accuracy and reproducibility of analytical results. A recent case study by a research institution demonstrated the effectiveness of an AI-powered chromatography system in accurately identifying and quantifying peaks in chromatograms, even with overlapping signals or noise. By eliminating the need for manual intervention, the system improved analytical efficiency and reduced the risk of human error, making it invaluable for chemical analysis in research and industry. (Prasad, and Diverkar, 2024.)

3 Automated NMR Spectroscopy Data Analysis for Structural Elucidation: Nuclear Magnetic Resonance (NMR) spectroscopy is a powerful technique for elucidating the structure of organic compounds. However, NMR data analysis can be time-consuming and labor-intensive, requiring expertise in spectral interpretation and chemical shift assignment. To address this challenge, researchers have developed AI-driven tools for automated NMR spectroscopy data analysis. These tools use machine learning algorithms trained on large databases of spectral data to predict chemical shifts, assign resonances, and deduce structural information from NMR spectra. A recent study by a university research group demonstrated the efficacy of an AI-based NMR data analysis tool, significantly streamlining the process and providing accurate structural elucidation.

4 Intelligent Process Monitoring System in Chemical Manufacturing: Chemical manufacturing plants rely on real-time process monitoring and control systems to ensure product quality, consistency, and safety. Traditional process monitoring systems often rely on predefined rules and heuristics, limiting their ability to adapt to changing conditions or detect subtle deviations from desired operating parameters. In contrast, intelligent process monitoring systems equipped with AI algorithms offer advanced analytics and predictive capabilities, enabling proactive detection of anomalies and optimization of manufacturing processes. A case study by a chemical manufacturing company implemented an AI-driven process monitoring system that continuously analyzed sensor data from various process variables, such as temperature, pressure, and flow rates. By applying machine learning algorithms to historical data, the system learned normal operating patterns and could identify



deviations indicative of process abnormalities or equipment malfunctions. By alerting operators to potential issues in real-time and recommending corrective actions, the system improved process efficiency, reduced downtime, and enhanced overall plant performance.

These case studies demonstrate the diverse applications of AI in smart laboratories, highlighting its potential to revolutionize chemical analysis methodologies and drive innovation across various industries. By leveraging AI technologies, researchers and industries can overcome traditional challenges, accelerate scientific discovery, and achieve new levels of efficiency and productivity in chemical analysis.

4.3 FUTURE PERSPECTIVES

The integration of Artificial Intelligence (AI) into smart laboratories has already catalyzed significant advancements in chemical analysis methodologies. Looking ahead, several emerging trends and future perspectives are poised to further transform the landscape of smart laboratories and shape the future of chemical analysis:

1 Advancements in AI Algorithms: The field of AI is continuously evolving, with ongoing research focused on developing more sophisticated algorithms capable of handling increasingly complex data analysis tasks. Future advancements may include the integration of deep learning techniques, reinforcement learning, and probabilistic reasoning models to enhance the accuracy, efficiency, and versatility of AI-driven systems in smart laboratories.

2 Integration with Internet of Things (IoT) Devices: The proliferation of IoT devices offers new opportunities for data collection, connectivity, and automation in smart laboratories. Future smart laboratory environments may leverage IoT sensors and devices to monitor experimental conditions, track equipment performance, and facilitate real-time data exchange and analysis, enabling seamless integration with AI-powered analytics platforms. (Zhao, *et al.* 2019; Garcia, and Smith, 2020).

3 Cloud-Based AI Platforms: Cloud computing technologies provide scalable and flexible infrastructure for deploying and managing AI-driven solutions in smart laboratories. Future developments may see the widespread adoption of cloud-based AI platforms, enabling researchers to access computational resources, collaborate on data analysis projects, and leverage advanced AI



algorithms through a centralized and user-friendly interface. (Zhao, *et al.* 2019; Garcia, and Smith, 2020; Wang, *et al.* 2017).

4 AI-Enabled Autonomous Laboratory Systems: The concept of autonomous laboratory systems, where AI-driven robots and instrumentation autonomously conduct experiments and analyze data, represents a futuristic vision for smart laboratories. Future advancements in robotics, automation, and AI may enable the development of fully autonomous laboratory workflows, where experiments are planned, executed, and analyzed without human intervention, leading to unprecedented levels of efficiency, productivity, and innovation. (Garcia, and Smith, 2020; Wang, *et al.* 2017).

5 Personalized and Adaptive Experimentation: AI algorithms have the potential to tailor experimental workflows and adapt conditions to suit individual research objectives and preferences. Future smart laboratory systems may incorporate AI-powered virtual assistants that interact with researchers, understand their goals, and suggest customized experimental designs, optimizing resources and maximizing research outcomes.

6 Ethical and Regulatory Considerations: As AI technologies become more integrated into smart laboratory environments, addressing ethical and regulatory considerations related to data privacy, algorithmic bias, and responsible AI use is essential. Future developments in AI governance frameworks and ethical guidelines will play a crucial role in ensuring the responsible and ethical deployment of AI-driven solutions in chemical analysis and research. (Chen, and Wang, 2019).

Overall, the future of smart laboratories promises exciting opportunities for innovation, collaboration, and discovery. By embracing emerging AI technologies and envisioning novel applications in chemical analysis, researchers and industries can unlock new insights, overcome longstanding challenges, and harness the full potential of AI to advance scientific knowledge and improve human well-being.

5.0 CONCLUSION

The integration of Artificial Intelligence (AI) into smart laboratories marks a transformative shift in chemical analysis methodologies, offering unprecedented opportunities to enhance efficiency, accuracy, and productivity. Throughout this paper, we have explored the challenges faced by traditional chemical analysis methods, the benefits of AI integration, and various applications of AI in smart laboratories.



By leveraging AI algorithms, machine learning techniques, and automation technologies, smart laboratories are revolutionizing every aspect of chemical analysis—from predictive modeling and automated sample preparation to real-time monitoring and decision support. These advancements enable researchers and industries to overcome traditional limitations, accelerate scientific discovery, and drive innovation across various fields, including pharmaceuticals, materials science, environmental monitoring, and beyond.

Looking ahead, the future of smart laboratories holds exciting prospects, with emerging trends such as advancements in AI algorithms, integration with Internet of Things (IoT) devices, and the development of AI-enabled autonomous laboratory systems poised to further revolutionize chemical analysis methodologies. However, as we embrace these advancements, it is essential to consider ethical and regulatory aspects and ensure the responsible and ethical deployment of AI-driven solutions in laboratory environments.

In conclusion, smart laboratories empowered by AI technologies hold immense promise for advancing scientific knowledge, solving complex challenges, and improving human well-being. By embracing innovation, collaboration, and responsible AI use, we can unlock new frontiers in chemical analysis and shape a future where smart laboratories play a central role in driving progress and innovation across various industries and disciplines.



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HARNESSING AI SOLUTIONS FOR ENHANCING FINANCIAL SECURITY AND STABILITY IN NIGERIA'S PUBLIC SECTOR: OPPORTUNITIES AND CHALLENGES

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Abstract

This paper examines the innovative changes an Artificial Intelligence (AI) solution is bringing to improve financial security and stability in Nigeria's public sector. Despite efforts to improve financial management practices, the public sector in Nigeria faces challenges such as inefficiency, corruption, and lack of transparency. The literature review reveals that AI tools such as: blockchain, machine learning, data analytics, etc offer promising solutions to address these challenges. AI can automate repetitive tasks, improve risk management practices, and enhance decision-making processes. However, for AI to be fully implemented in the public sector there is the need to address obstacles such as the quality of data to be utilized, technical expertise, and privacy issues. The paper recommends investing in data infrastructure, providing capacity-building initiatives, and developing a comprehensive AI strategy. Collaboration with the private sector and stakeholders is crucial to leveraging resources and capability/skill of personnel. Effectiveness of AI solution should be properly monitored and evaluated. The findings suggest that AI has the possibility to significantly improve the effectiveness, transparency, and accountability in Nigeria's public sector. Future research should focus on sector-specific impacts, ethical considerations, and comparative studies across countries.

Keywords: Artificial Intelligence, Financial Security, Financial Stability, Public Sector



1.0 INTRODUCTION

For any economy to be effectively and efficiently functional and also be self sustainable; financial security and stability are crucial and Nigeria economic system is not exempted. Lately, there has been an increasing recognition of the significance of leveraging Artificial Intelligence (AI) solutions to enhance financial security and stability, particularly in the public sector. Most governments of developed countries around the world today are increasingly turning to AI to enhance the transparency, accuracy and efficiency of their financial systems. AI tools including predictive analytics, natural language processing, and machine learning are being used to detect fraud, streamline processes, and optimize resource allocation (Ernst and Young, 2018). For example, countries like India, Germany, the United States, Singapore and the United Kingdom have implemented AI solutions in tax administration, budgeting, and public procurement to enhance financial security and efficiency.

India tax structure for example was struggling with lack of manpower, corruption, tax evasion, and tedious processes of tax assessment and tax returns and in 2019 the government introduced the use of AI and machine learning. The main goal was to remove complexity associated with the tax system in the country. Machine learning introduced was used for finding patterns of similarity and dissimilarity in between taxpayers, understanding tax payer's behavior, getting adequate data needed for decision making purpose (Ankit, Saurabh, Gaurav, and Manoj, 2021).

In Nigeria, the public sector is facing significant challenges related to financial security and stability, including issues such as revenue leakages, corruption, lack of adequate accountability and transparency and also inefficient resource allocation. These challenges not only undermine the government's ability to deliver essential services but also erode public trust in the system (Aguolu, 2014) and (Alake and Olatunji, 2012). Today, Nigerian government has recognized the potential of AI to address these challenges and has taken steps to integrate AI into its financial systems. For example, the Federal Inland Revenue Service (FIRS) has implemented AI-powered systems to improve issues associated with revenue collections and compliance with tax authorities. FIRS adopted the tax digitalization process in the year 2013, introducing an integrated tax administration system (ITAS). The scheme introduced consists of some sets of programs that will help to reduce the complexities of tax administration and also strengthen the compliance and participation of all stakeholders through the use of AI. The introduction of TaxPro-max is one of the most recent innovations which have made it very easy for companies and individual to be easily accessed and make tax payment promptly. TaxPro-max was introduced and became effective from 7th of June 2021, which is the means for filling of all Nigerian tax returns. The key features of this AI tools introduces includes; online submission of tax returns, electronic tax clearance, validation of tax identification number (TIN) and other online correspondence with the FIRS (PWC Nigeria, 2015). Similarly, the Nigerian Customs Service has deployed AI technologies to enhance its customs operations and reduce revenue leakages.

Despite these efforts, Nigeria still has a long way to go and so much to do to fully harness the benefits of AI for enhancing financial security and stability in the public sector (Okoye and Ezejiofor, 2014).



With the recent advancement in AI technology the African economy can harness digital tools and new technologies, generate new ideas, link individual businesses with global market and government systems and also roll out sustainable business model globally. The main objective of this paper to harness the opportunities and challenges involved with the utilization of AI, with a focus on identifying practical strategies for implementation and capacity building (Smith, 2020).

Amabali, (2019) opined that government should prioritize the digitalization of financial transaction that is completely shifting of cash movement in and out of government purse to a more digitalized system with the aid of AI to ensure close monitoring and evaluation, transparency and accountability.

2.0 LITERATURE REVIEW

EXPLANATION OF CONCEPTS AND THEORETICAL FRAMEWORK AND THEIR RELEVANCE

The literature on AI solutions for financial security and stability in the public sector provides resourceful insights into inherent benefits and challenges of implementing Artificial intelligence (AI) technologies. Overall, these concepts, theories and frameworks provide a rich theoretical foundation for understanding and implementing AI solutions for enhancing financial security and stability in the public sector. By incorporating these theories into their AI strategies, governments should develop effective and sustainable solutions to tackle the difficulties associated with the issues of financial security.

Artificial Intelligence

According to Merriam-Webster dictionary AI is an aspect of computer science that as to do with the simulation of human intelligent behavior into computers; thereby making computer to act and imitate the behavior of real human. Machines have been designed to think and act like real human being. Its application has cut across various industries and sectors such as medical care, security and defense, journalism, lecturing, finance, transportation, entertainment e.t.c.(Johnson, 2019).

AI is also defined as the study of agents that fully observes the entire environment and makes decisions that is perceived to be in the best interest of all that will help to achieve the overall goals (institute of electrical and electronic engineers (IEEE). AI have the unique ability to perceive the environment at any point in time and give the best judgment, this is one of the reasons why AI tools can be use for security and military defense of a country the closest example is the use of drones. The introduction of AI tools is making lives easier by engaging in automated repetitive tasks, reducing time to perform task, analysis of vast amounts of data, helping to make faster and better decisions and generally helping to improve many aspects of our daily lives.

Financial Security

It is the peace of mind you have when there is no need to worry about income at the point where money needs to be expended or utilized. It also means that nation, business or individual have enough money



saved to cover emergencies and meet up with future financial obligations (investopedia). It is a state of having income sufficiently saved and proper financial planning to cover expenses, manage risk and also achieve financial goals for present and future (Mohammed, 2015 and Martinez, 2015).

Federal Deposit Insurance Corporation (FDIC) further defines financial security as having enough funds at your disposal to meet your financial obligations as the need occurs, to manage your financial risks effectively, and to plan and save for the nearest future.

Financial Times Lexicon explains financial security as the peace of mind gotten from having a stable income or other resources of income to support a comfortable standard of living now and in the foreseeable future. Presently, one cannot truly assert to the statement that Nigeria is financial secured or that it can meet up with the present financial obligations with the continuous fluctuation in cost of living and the latest agitation for living wage by the civil servant. The case is still on the president Bola Ahmed Tinubu's table for his final verdict.

Financial Stability

According to International Monetary Fund (IMF) Financial stability is refers to the state or condition in which any financial system of a nation, financial institution, business entity, market are able to cope with shocks that is to say their ability to withstand vulnerabilities.

Bank for International Settlements (BIS) also explains that, financial stability is a state where the economy is running smoothly and the financial system is functional, which in turn allows economic to function maximally in achieving it objective of sustainable growth and development.

Most economy of the world cannot fully boast of been financially stable because financial stability is a situation where the financial system of any economy is capable of withstanding shocks internally and externally without compromising its ability to facilitate economic growth efficiently (European Central Bank (ECB)). The present debt state of Nigeria gotten from debt management office (2024) reflects the most current debt position of Nigeria.

MARCH 31, 2024 NIGERIAN TOTAL DEBT PORTFOLIO

Table 1

S/N	Debt Category	Amount Outstanding (US\$'M)	Amount Outstanding (₦'M)
A	Total External Debt	42,115.54	56,024,618.24
B	Total Domestic Debt	49,348.45	65,646,263.25



	FGN Only	46,290.28	61,578,106.70
	States & FCT	3,058.17	4,068,156.55
C	Total Public Debt(A+B)	91,463.99	121,670,881.49

Source: Debt management office, 2024

Public Sector

Public Sector refers to publicly owned and managed institution or establishment with the funds from the citizens ensuring provision of goods and services that will help to improve the living condition of the citizens of such country. It is also organizations owned and operated by the government, which provide essential goods and services to the general public and maintain essential infrastructure for economic, social growth and development (Idris, and Gidado, 2015).

Public sector in Nigeria encompasses government ministries, agencies, state-owned enterprises, and other entities responsible for public service delivery and governance. United Nations also said something similar that public sector is comprised of institutions and agencies established by governments to deliver services and implement national policies and programs for the betterment of her citizens (Cooper, 2003 and Bello, 2017).

According to World Bank, public sector is that part of any economy that is managed by national, regional, or local government of a nation. It should be noted that the resource used belong to the general public and should be used in their best interest. The introduction of AI will give the citizen confidence on the operations of the government, this is because there will be more openness, transparency, accountability and reduction in financial fraud and corruption (Bailey, 2004).

Complexity Theory

Complexity theory is a theory that seeks to explain the behavior and changes that occurs over a period of time within a system. This theory highlights that financial systems are complex in nature, adaptive, characterized by non-linear interactions and continuous changes in behaviors. AI tools, such as data analytics and machine learning, can help to understand and manage this complexity by identifying patterns and relationships in financial data. Turner and Baker,(2019) opined that every system is dynamic in its own way, that organizations are made up of smaller sub-set that are complex and must learn to integrate in other to get the best and achieve the overall objective. No matter the complexity of a system it must be able to interact within and also with the external environment (Holland, 1992).

Information Theory



Information theory is an aspect of applied mathematics and also electrical engineering which involves way information is obtained, quantified, analyzed, stored and also communicated. It clearly provides information on the flow of information within and outside the system regularly. AI technologies can improve information processing in financial systems by extracting insights from large datasets and facilitating decision-making. This theory seeks to identify the quantity of information availability and how much can be communicated between various component who needs it at any point in time (Stone, 2018).

Cybernetics

Cybernetics is the study of control and communication in systems. In the context of financial security, AI as been designed to ensure interaction between human and machine and obtain feedback on their interaction, this will to ensure continuous monitoring and adjustment of financial processes to maintain stability and security. As far as communication is intact, adequate control measures in place and continuous feedback is gotten it will be very easy to identify the interactions between human and machines within a given system (Mindell, 2000)

Risk Management Frameworks

Risk management frameworks, such as the COSO ERM framework (Committee of Sponsoring Organizations of the Treadway Commission Enterprise Risk Management). It's a structure that produces principles and guidelines useful for effectively managing of risks within the organizations. ISO 31000 (International Organization for Standardization's standard on risk management) outlines guidelines for identifying, assessing, and hedging against risks in organizations or sector. AI has the capacity to provide real-time risk analysis and prediction potentials.

Ethical Frameworks

Ethical frameworks, such as the principles of objectivity, fairness, confidentiality, transparency, and accountability, are crucial for ensuring that AI technologies are deployed responsibly in the public sector (Brown, 2018, Powell, 2001 and White, 2013). Concepts like algorithmic bias and fairness are particularly relevant in the context of AI in financial security.

Regulatory Frameworks

Regulatory frameworks, such as data protection laws and financial regulations, play a critical role in governing the use of AI in financial security. Compliance with these frameworks is essential to make certain that AI technologies are utilized legally and ethically.

Decision-making Theories: Theories of decision-making, such as bounded rationality and prospect theory, can inform the design of AI systems that support decision-making in financial security by taking into account human cognitive limitations and biases.



3.0 METHODOLOGY

This study employs a qualitative research design, utilizing secondary data to explore the opportunities and challenges associated with harnessing artificial intelligence (AI) for enhancing financial security and stability in Nigeria's public sector. The center of this research is on reviewing and synthesizing existing literature to provide a comprehensive analysis of the topic. Data collection from secondary data sources includes: Academic and professional books, academic journals, literature reviews, reputable online resources, government publications etc.

4.0 OPPORTUNITIES AND CHALLENGES

4.1 OPPORTUNITIES ASSOCIATED WITH THE ADOPTION OF ARTIFICIAL INTELLIGENCE INTO THE PUBLIC SECTOR

The paper identified that AI has the ability to considerably enhance financial security and stability in the public sector. However, realizing these benefits will require careful planning, human capital and investment in technology, and a commitment to addressing the challenges and barriers to implementation (Clark, 1994, Clark, 2010 and Williams, 2017). Some of these benefit associated with the utilization of AI in any government are identified and discussed in the paper.

Detection, Prevention and control of Fraud

AI technologies, particularly machine learning algorithms, have been effective in detecting and preventing fraud in the public sector. These algorithms can analyze large datasets to identify patterns indicative of fraudulent activities, helping government agencies to mitigate financial losses and improve accountability. AI algorithms can detect patterns indicative of fraudulent activities, helping to reduce fraud and corruption in the public sector.

Risk Management

AI can enhance risk management practices in the public sector by providing real-time analysis of financial data and identifying potential risks. This can help government agencies to make informed decisions and allocate resources more effectively.

Improving Efficiency

AI technologies can automatically repeat tasks and streamline financial processes, leading to cost savings and improved efficiency. For example, AI-powered chatbots is designed to handle everyday inquiries, freeing up human resources for more difficult and other time consuming but important tasks.



Enhancing Transparency and Accountability

AI solutions can improve transparency and accountability in the public sector by providing a clear audit trail of financial transactions. Blockchain technology, in particular, has been touted as a tool for enhancing transparency and reducing corruption (Abdullahi, 2016).

Enhanced Decision-Making: AI technologies can provide real-time analysis of financial data, enabling better decision-making and resource allocation.

Better Service Delivery: AI can help government agencies in Nigeria improve service delivery by providing more personalized and efficient services to citizens.

4.2 CHALLENGES AND BARRIERS

In spite of the potential benefits, implementing AI solutions in the public sector faced with series of challenges, including lack of technical expertise, resistance to change and data privacy issues (Clark, 1994 and Bailey, 1998). Addressing these challenges will be crucial for the successful implementation of AI in improving financial security and stability. The paper reviews few of such challenges which include:

1. **Data Quality and Data Availability:** The implementation of AI solutions in the public sector is hindered by the lack of high-quality and readily available data. Many government agencies in Nigeria still rely on paper-based or outdated systems, making it difficult to access and analyze data effectively.
2. **Lack of Technical Expertise:** There is a shortage of technical expertise in AI among public sector officials in Nigeria. Good training programs and capacity-building scheme are needed to equip them with the skills needed to put into operation and manage AI solutions.
3. **Security and Data Privacy Concerns:** AI technologies raise concerns about security and data privacy. Government agencies must ensure that sensitive information is protected and that AI systems comply with relevant data protection regulations.
4. **Resistance to Change:** There may be resistance to the adoption of AI solutions among public sector workers who has the fear that AI will replace their position at their work stations. It is important to educate the workers on the benefits of AI and also include them during the implementation process to mitigate this resistance.
5. **Cost of Implementation:** Implementing AI solutions can be costly, especially for cash-strapped government agencies in Nigeria. Finding sustainable funding sources and cost-effective solutions is crucial.

Role of AI in Enhancing Financial Security



AI technologies, such as, data analytics, machine learning and blockchain, have the potential to address these challenges and enhance financial security in Nigeria's public sector. A machine learning algorithm is able to detect and also to prevent fraud, improve risk management practices, and automate financial processes. Data analytics can provide real-time analysis of financial data, enabling better decision-making and resource allocation. Blockchain technology can help to ensure transparency and accountability by making available a secure and tamper-proof financial transactions records (Ibrahim, 2019, Adebayo, 2012, Adeleke, 2018 and Adewale, 2020).

5.0 CONCLUSION

While there are challenges relating with the implementation of AI solutions in Nigeria's public sector, there are also significant opportunities for improving financial security and stability. However, successful implementation will require addressing challenges such as lack of technical expertise, data privacy concerns and resistance to change. Furthermore, AI solutions offer a promising avenue for improving financial security and stability in Nigeria's public sector, with the potential to drive economic growth and development. Monitoring and evaluation mechanisms and regular feedback should be considered in order to be able to assess the effectiveness of AI solutions and identify areas for improvement.

AI technologies can address key challenges such as fraud, inefficiency, and lack of transparency and as such government should go ahead and adopt it into the system since the benefits outweighs the cost. The following were the recommendations suggested:

Investment in Data Infrastructure: Policymakers should invest in improving data infrastructure to ensure that high quality and readily available data is accessible for AI analysis. This includes digitizing records, improving data storage, data retrieval and good management systems, and ensuring data security.

Capacity Building: there is the need for good training programs and capacity building initiatives for public sector officials to enhance their technical skills in AI. This will help them effectively implement and manage AI solutions in their organizations.

Develop AI Strategy: Develop a robust AI strategy that list out the objectives, scope, and implementation plan for leveraging AI in enhancing financial security and stability. This strategy should also address ethical and privacy considerations.

Collaborate with Industry: work in partnership with the private sector and academic institutions to take advantage of their expertise and resources in implementing AI solutions. This can help reduce costs and improve the effectiveness of AI initiatives.

Promote Transparency: Ensure that AI systems are transparent and accountable by providing explanations for their decisions and ensuring that they comply with relevant regulations and standards.



Monitor and Evaluate: Establish monitoring and evaluation strategies to evaluate the effectiveness of AI solutions in ensuring financial security and stability. This will help identify areas for improvement and ensure that AI initiatives are achieving their anticipated outcomes.

Address Privacy Concerns: Implement measures to address privacy concerns related to the utilization of AI in the public sector. This includes ensuring that personal data is protected and that AI systems comply with relevant data protection regulations.

Encourage Innovation: Create a supportive environment for innovation in AI by providing incentives for research and development in this field. This can help spur the development of new and innovative AI solutions for enhancing financial security and stability

Engage Stakeholders: Engage with stakeholders, such as citizens, civil society organizations, and the private sector, to gather feedback and ensure that AI initiatives meet their needs and expectations

Pilot scheme: Start with small-scale pilot projects to test the feasibility and effectiveness of AI solutions before fully adopting it. This will help identify inherent potential drawbacks and mitigate risks associated with implementation.

Policymakers should prioritize investments in data infrastructure and capacity building to support the effective implementation of AI solutions.

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PREDICTING LEARNING STYLES OF STUDENT USING PYTHON PROGRAMMING LANGUAGE

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Abstract

This paper explores how students learn quickly and effectively in various ways, depending on their abilities and intellectual capacities. It emphasizes the importance of teachers and lecturers understanding the methods that enable most students to assimilate or comprehend information more efficiently during lectures. The aim is to determine how different learning styles manifest in learning environments influenced by existing factors. This study will help the lecturer determine the most effective method for improving the academic performance of students. To identify these learning styles, questionnaires were used to collect data from the students. Out of 300 questionnaires distributed, 250 were completed and returned by the students. This study highlights five major learning styles extracted from the data: Visual, Audio, Reading and Writing, Kinesthetic (Tactile), and Logical (Mathematical) learners. A Python Programming Language was used to develop a program to predict the learning styles of students at Kogi State Polytechnic, Lokoja campus. Results indicate that the audio learning style is most prevalent among students, as repeated exposure to content enhances their understanding and learning fast

Keywords: Prediction, Student Learning Styles, and Python Programming Language



1.0 INTRODUCTION

The understanding of different various diverse of student learning styles are importance crucial for effective teaching and learning outcomes in education. Learning styles is a set of factors, behaviours, and attitudes that facilitate learning for an individual in a given situation. Styles are the way how students learn, how teachers teach in the classroom, and how the students and Teachers or Lecturer interact in the school environment (Cash, Dawicki & Sevic,2013). People are born with different tenant and certain tendencies toward particular styles, but biological or inherited characteristics are influenced by culture, personal experiences, maturity level, and development by parent or guidance. Style can be considered a contextual variable or construct because what the learner brings to the learning experience is as much a part of the context as are the important features of the experience itself. Each learner has different ways and method of perception, organization and retention (Bay Atlantic,2024). These learning styles are characteristic cognitive, affective, and physiological behaviours that serve as pretty good indicators of how learners perceive, interact with, and respond to the learning environment (Manish, 2020). Students learn in a different way from each other and it has been studied that brain structure influences language structure acquisition. It has also been shown that different hemispheres of the brain contain different perception avenues. There are different cells present in some brains but not present in others (Gunathilaka,Fernando & Pasqual,2017). There are different method in which student can acquire new knowledge and skills. These preferences can vary widely among students and may include visual, auditory, kinesthetic, or tactile learning modalities, among others (Bay Atlantic ,2024). Recognizing and accommodating these styles of Learning can enhance student engagement, motivation, and comprehension, ultimately leading to improved academic performance and success (Natsu's, 2013).

Traditionally, the school management have relied on subjective observations, assessments, Test and feedback to identify students' learning styles. However, these methods are often limited in scope, prone to biases, and may not capture the full spectrum of learning preferences present in a diverse student population. Consequently, there is growing interest in leveraging data mining techniques to analyse a large datasets of student learning behaviours and characteristics to identify patterns and trends related to learning styles.



Python is a versatile, high-level programming language widely used across various domains, including web development, operating systems, artificial intelligence, machine learning, numerical computing, mobile applications, game development and Prediction model. Its recent surge in popularity is attributed to its straightforward syntax and user-friendly nature, making it accessible to beginners and non-programmers alike. In this paper, we will develop a system using Python to predict student learning styles for educational data, researchers and educators to uncover valuable insights into student learning behaviours, preferences, and performance. These insights can help in instructional strategies, curriculum development, and personalized learning approaches tailored to individual students' needs. Predicting student learning styles system was developed using python based language to represents a promising approach to understanding the complex interplay between student characteristics, learning behaviours, and academic outcomes. By analysing various data sources, such as student personal Information, assessment scores, learning activities, and engagement metrics, researchers can develop predictive models to classify students into different learning style categories. These models can then provide personalized recommendations, interventions, and support mechanisms to enhance student learning experiences.

Predicting student learning styles is important to enhance student education and improving their outcomes. Many researchers have investigated and study on different aspects of this problem using diverse methodologies. Meng & Meihui (2022) analyzed students' online learning behavior and psychological state using data mining techniques, highlighting the relationship between these factors. Shaimaa, Francois, & Ying (2019) proposed algorithms for dynamic student profile adaptation based on learning styles, demonstrating the effectiveness of personalized e-learning systems. Manish (2020) emphasized the importance of personalization in e-learning and developed mechanisms for delivering personalized content. Gunathilaka, Fernando, & Pasqual (2017) focused on identifying learning behaviours to personalize education, using multiple models for a comprehensive approach.

Despite these advancements, there is a gap in integrating these findings into a cohesive system that can predict student learning styles effectively. Specifically, there is a need to develop a system that can analyze various environmental factors influencing learning styles. In this work python programming language was used to develop the system. Additionally, while existing studies have used different models and algorithms, there is a lack of focus on a unified framework that can be easily implemented and adapted in educational institutions. This study aims to address these gaps by developing a system



using Python programming Language to predict student learning styles at Kogi State Polytechnic, Lokoja campus.

The objectives are:

- i. to identify and collect relevant data related to student learning preferences.
- ii. to pre-process and analyse the collected data using prediction algorithms.
- iii. to develop a model to effectively classify student learning styles based on the analysed data using python based programming

This study holds significant importance in the realm of education as it seeks to revolutionize the way students are taught and assessed. By prediction algorithms to evaluate student learning styles, educators can gain profound insights into individual preferences, strengths, and weaknesses. This, in turn, facilitates the customization of teaching methodologies, content delivery, and assessment strategies to optimize learning experiences and outcomes for students across diverse profiles. Visual learners find that looking at objects allows them to process knowledge more effectively. This includes photos, movies, diagrams, graphics, and charts. If the student finds that sketching diagrams or mind maps helps them revise, they may be a visual learner. The learner may also want to use aids such as films with charts and graphics to assist them retain material. After the lecture class, students may prefer to listen back to the lecturer's lectures using audio method, while some students use podcasts and discussions to be more beneficial than other ways of learning. Kinesthetic learning is the movement, hands-on experiments, and exercises. Those kinesthetic learners can choose hands-on, practical teaching above other learning approaches. Kinesthetic learner likes tutorials and understands more by practical. Furthermore, the findings of this research can inform the development of student learning platforms and tools, fostering a more inclusive and effective educational environment.

2.0 REVIEW OF RELATED WORK

Thilina, (2013) worked on prediction techniques to identify the Student Learning Styles. The Researcher said that the paper is focused on applying different data mining techniques to identify and discover valuable insights on how student learned, which can be used to evaluate overall performance in e-learning systems and recognize different learning patterns. Each data mining technique has its own advantages and disadvantages depending on its application to educational data, revealing various learning patterns with different accuracy levels. Based on these techniques, models can be developed to



evaluate student performance and predict their overall outcomes at the end of course modules. The results can guide teachers in providing the necessary support to students who need more attention, enhancing their teaching capabilities. This dynamic adjustment of knowledge flows within e-learning environments aims to make them more effective and efficient.

Esther, Vincent & Simon (2020) worked on predicting student learning styles. They focused on evaluating student learning styles at their universities using data mining approaches. This prediction determines how different learning styles are attained within learning contexts that are specifically influenced by existing circumstances. These learning styles have been influenced by a variety of elements, the majority of which may be found in the student's learning environment. A data mining technique was employed, which expressly included the use of pattern analysis to determine the underlying learning styles in the data collected from the learners. This research focuses on the five major learning styles that describe the patterns derived from the collected data.

Meng & Meihui (2022) proposed on evaluation of Students' Online Learning Behaviour and Perception of Psychological State. The research was on analysis model of OLB, a sequence mining model of OLB, and an interactive model of OLB. Finally, a psychological state perception model based on OLB analysis is constructed. Mean Absolute Error (MAE) and Mean Squared Error (MSE) are used as indices to compare the fitting effects of Gradient Boosting Regression Trees (GBRT), Ada-Boost Regression, Linear Support Vector Regression (Linear SVR), and Linear Regression algorithms on the model. The results on the work indicate a strong relationship between students' psychological state and OLB.

Alexander, Craig & Adam (2024) worked on the evaluation of student learning styles using data mining techniques. The Researchers aim was to find out how various learning styles were achieved. These various learning styles have been affected by different factors that are mainly engraved and found within the students learning environment. A data mining technique utilizing pattern analysis was employed. This approach identified the underlying learning styles within the data collected from learners.

Shaimaa, Francois & Ying (2019) proposed on a Novel Algorithm for Dynamic Student Profile Adaptation Based on Learning Styles. The researchers stated that E-learning recommendation systems enhance student performance and knowledge by offering different instruction tailored to students'



interests and learning styles (LSs), which are typically stored in student profiles. For these systems to be effective, the profiles must be adaptable and reflect students' changing behaviours. In this paper, we introduce new algorithms designed to track student learning behaviour patterns, identify their LSs, and maintain dynamic student profiles within a recommendation system (RS). We also propose a novel method for extracting features that characterize student behaviour to identify LSs according to the Felder-Silverman learning style model.

Based on **(Manish, 2020)** The researchers focused on learning styles for content delivery, highlighting the importance of personalization in e-services. Personalization is increasingly deemed essential, with many professionals incorporating it into web services. Recommender systems heavily rely on personalization to function effectively, a concept gaining traction in the service sector, including education. With advancements in "Teaching with Technology," the industry is moving toward providing personalized learning content on e-learning platforms. This personalization is achieved by analysing learners' behaviour, cognitive skills, and learning styles, with Adaptive Educational Hypermedia Systems (AEHS) being particularly effective in distance e-learning.

Gunathilaka, Fernando & Pasqual (2017) the researchers investigated student learning behaviours to personalize education, noting the global popularity of e-learning techniques. E-learning aims to automate pedagogical approaches for remote education, introduce interactivity, and keep students continuously engaged. Despite interactive mechanisms, modern e-learning solutions often lack individual attention for equal knowledge distribution. Students differ in knowledge, cognitive capacities, aptitudes, prior knowledge, learning styles, memory types, motivations, family backgrounds, and habits, influencing their learning patterns. Therefore, personalizing e-learning has become crucial for enhancing student knowledge by customizing the learning environment to their preferences. The research utilizes models such as Felder-Silverman's model, the VAK model, Kolb's model, and Howard Gardner's Multiple Intelligence model are used to extract learning styles and preferences. Analysis has shown how static and dynamic learning behaviours can be extracted through LMS login profiles and distributed questionnaires within the same student group.

3.0 METHODOLOGY

Data were collected via a questionnaire distributed to students on the Kogi State Polytechnic campus. Out of approximately 300 questionnaires distributed, 250 were returned. A program was developed using Python programming language and K- Nearest Neighbour to predict the learning styles of various

students at Kogi State Polytechnic, Lokoja campus. The input forms were systematically designed to collect this data from students. Once entered, the data is processed and stored in the system's database. The database is designed to efficiently handle and analyse the collected data to meet the requirements of the Learning style prediction system. The input database was designed to meet the requirements of the proposed system. The input forms are shown below.

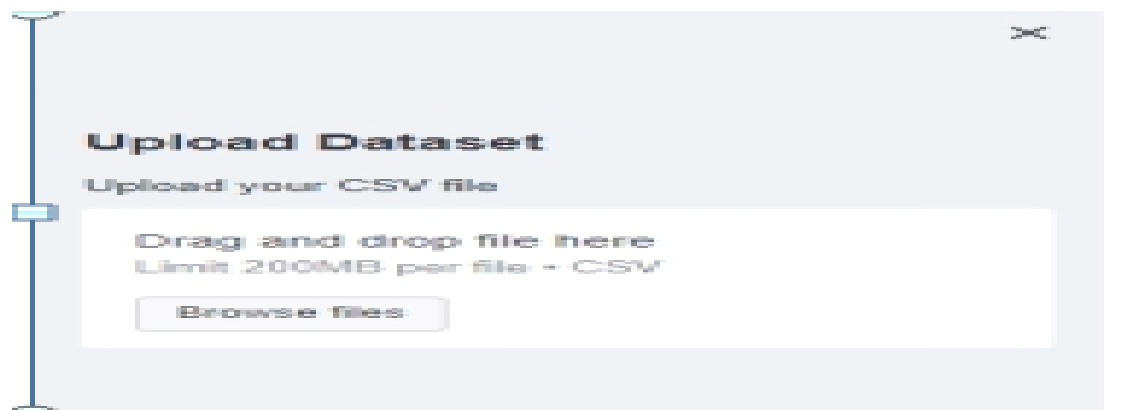


Fig 1: Main menu

Data collected from 250 students were saved in the folder and each of the data was drag and drop in the main menu shown above.

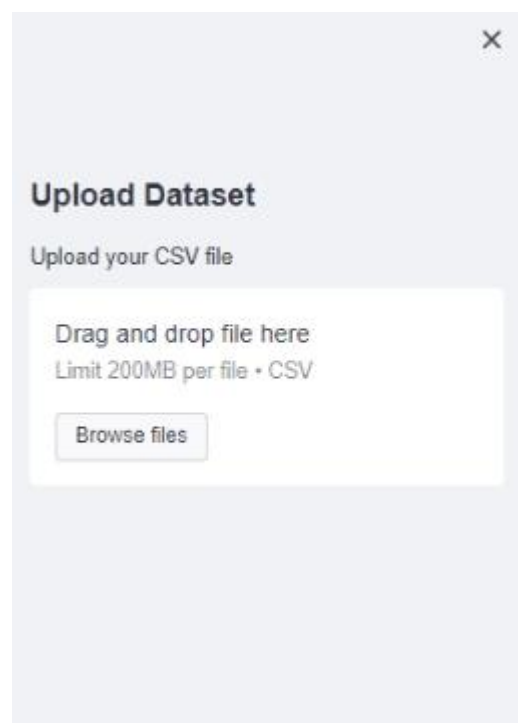
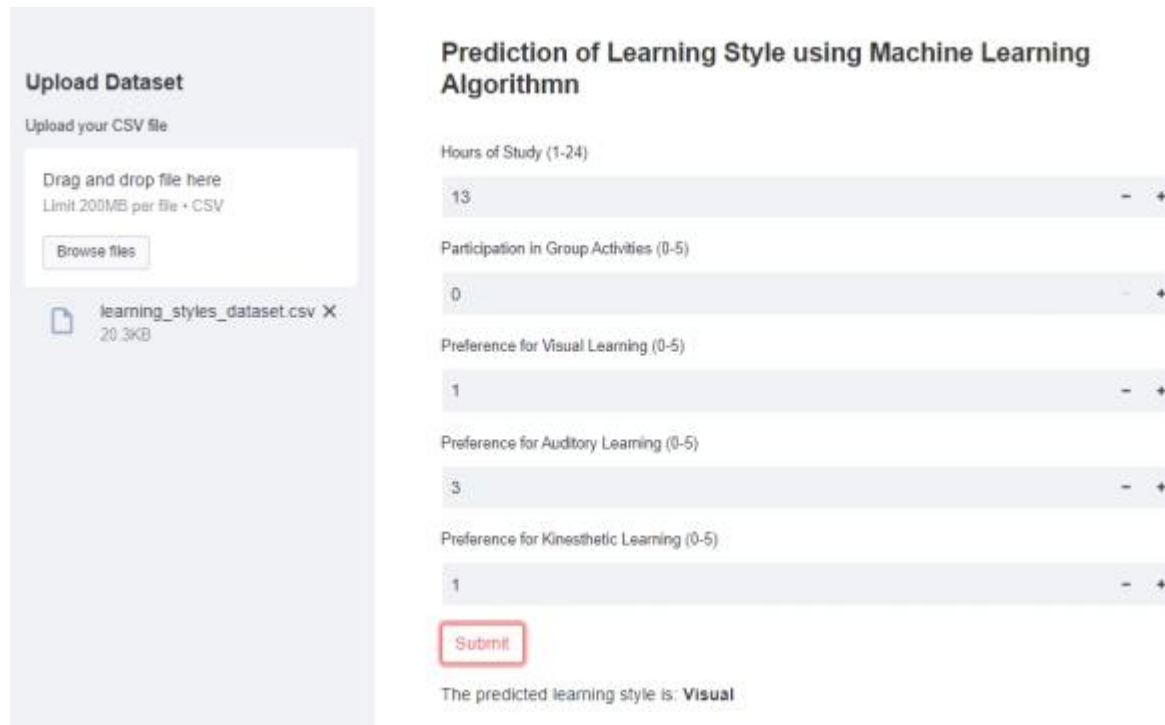


Fig 2: Dataset upload



Upload Dataset

Upload your CSV file

Drag and drop file here
Limit 200MB per file • CSV

Browse files

learning_styles_dataset.csv X
20.3KB

Prediction of Learning Style using Machine Learning Algorithm

Hours of Study (1-24)
13

Participation in Group Activities (0-5)
0

Preference for Visual Learning (0-5)
1

Preference for Auditory Learning (0-5)
3

Preference for Kinesthetic Learning (0-5)
1

Submit

The predicted learning style is: **Visual**

Fig 3: Processed results.

3.1 Algorithm

Algorithm is the procedure of solving problem and the order in which the problem must be solved. The pseudocode algorithm was used to solved the above methodology.

Step 1: Preparation of data

- Collect the questionnaire data from the 250 returned surveys.
- Arrange the data into a structured format, such as a CSV file, whereby row corresponds to a student and each column represents their responses and learning style.

Step 2: Feature Selection

- Choose the inputs features that will be used for prediction. These include survey responses .
- The variable are the learning style of each student (Visual, Kinesthetic, Audio, Read/Write, Logical).

Step 3: Data Pre-processing

- Normalize (standardize) the feature values if necessary to ensure all features contribute equally to the distance calculations.

Step 4: KNN Implementation



- i. Choose the number of neighbors (k). A common choice is 1 or 5, but this can be optimized based on the data.
- ii. Calculate the distance between a new data point (student) and all other points in the training set. Common distance metrics include Euclidean distance.

Step 5: Prediction

For each new student, find the k nearest neighbors in the training set based on the calculated distances.

- i. Determine the majority learning style among these k neighbors.

Step 6: Evaluation

Evaluate the model's performance using the test set. Metrics used is accuracy, precision.

3.2 Result and Analysis

Each of the 250 data sets was processed and analysed. The program uses specific data points from the questionnaire to make predictions about a student's preferred learning style. Here is an example of the kind of data collected for a student:

Hours of study per week: 13

Participation in group activities (times per week): 0

Preference for visual learning (on a scale of 0-5): 1

Preference for audio learning (on a scale of 0-5): 3

Preference for kinaesthetic learning (on a scale of 0-5): 1

Explanation per one questionnaire given:

Hours of Study

The student studies for 13 hours per week. This indicates the time commitment and consistency in their study habits.

Participation in Group Activities

The student does not participate in group activities. This could suggest a preference for solitary learning or a lack of interest in collaborative learning environments.

Preference for Visual Learning

The student rated their preference for visual learning as 1 out of 5. This suggests they do not favor learning through visual means such as diagrams, charts, or videos.

Preference for Audio Learning



The student rated their preference for audio learning as 3 out of 5. This indicates a moderate preference for learning through auditory means such as lectures, discussions, or audio recordings. Most of the Students learn very fast by Audio Learning.

Preference for Kinesthetic Learning

The student rated their preference for kinaesthetic learning as 1 out of 5. This suggests they do not prefer learning through physical activities, hands-on experiences, or experiments.

Predicting Learning Styles

Using the above data, the program developed in Python can analyze these preferences and predict the student's dominant learning style. In this case:

The student's low preference for visual (1/5) and kinesthetic (1/5) learning suggests these are not effective methods for them.

The moderate preference for audio learning (3/5) indicates they may benefit more from auditory learning methods.

Thus, the program might predict that the student is an auditory learner and would benefit most from lectures, discussions, and listening to explanations.

4.0 CONCLUSION

Evaluating learning styles involves analysing various factors like study hours, participation in group activities, and preferences for visual, auditory, and kinesthetic learning. By examining these variables, educators can identify an individual's dominant learning style—whether visual, auditory, Reading/Writing Learners or kinesthetic. From the result given audio Learning style is most adopt by the student because repetition of work again and again bring understanding. This Evaluation helps tailor educational approaches to enhance learning efficiency and effectiveness. Prediction models can automate this process by finding patterns in the data, providing personalized insights for students. This customized learning strategy can significantly improve academic performance and student engagement by aligning teaching methods with individual learning preferences. For future work the researcher can work on other student learning style like Logical/analytical learner, Social/linguistic learners, Solitary learners and Nature learners.



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A REVIEW ON PHYSICS OF CLIMATE CHANGE: UNDERSTANDING THE DYNAMICS OF A GLOBAL THREAT TO ENVIRONMENTAL SECURITY IN NIGERIA

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ABSTRACT

Climate change poses significant threats to environmental security, affecting global stability, human health, and economic prosperity. This study is a review to explore the fundamental physical principles driving climate change and the relationships between the greenhouse effect, energy balance, and feedback mechanisms. We analyze how the physical processes impact climate change dynamics and contribute to rising temperatures, extreme weather events and altered ecosystems. We also discuss the effects on environmental security in Nigeria, resource depletion, food insecurity including strategies for reducing and adapting to climate change. Our review highlights the importance of understanding the physics of climate change to address environmental security concerns and promote sustainable development in Nigeria. We recommend further research in advanced climate change impacts on biodiversity, environmental security and conflict, climate change mitigation technologies, and vulnerability and adaptation assessments. International cooperation, policy frameworks, and individual actions are essential for addressing this global challenge.

Keywords: climate change, physics, environmental security, sustainability, greenhouse effect, energy balance, feedback mechanisms.



1.0 INTRODUCTION

Climate change is no longer a distant threat; it is a harsh reality we face daily, from devastating wildfires to catastrophic hurricanes, and from melting glaciers to drought-stricken landscapes. The scientific consensus is clear; human activities are significantly contributing to the Earth's warming, and the consequences are already being felt.

Understanding the physics of climate change is crucial for developing effective strategies to mitigate its impacts and ensure environmental security. By grasping the underlying principles and processes, we can better address the challenges ahead, from reducing greenhouse gas emissions to adapting to the changing climate, (Santos et al.,2022)

Duchenne-Moutien and Neetoo (2021) reported that climate change poses a significant threat to environmental security, with rising temperatures, extreme weather events, and altered ecosystems compromising access to resources, threatening food systems, displacing vulnerable populations and affecting global stability, human health, and economic prosperity. Despite the critical importance of understanding the physical mechanisms driving climate change, there remains a knowledge gap which is needed to inform effective solutions in the following areas like quantifying the dynamics of greenhouse gas emissions and their impact on global temperature rise, trying to understanding the complex interactions between atmospheric, oceanic, and terrestrial systems that influence climate variability and change, developing accurate predictive models to forecast climate-related extreme events and their consequences, assessing the vulnerability and resilience of ecosystems and human societies to climate change, identifying effective plans for reducing and adapting to climate change, while ensuring environmental security and sustainable development. The knowledge of the physical mechanisms driving climate change supports the development of effective policies, strategies for mitigation and adaptation which also allow for the identification of vulnerable ecosystems and the implementation of targeted conservation efforts. By recognizing the physical implications of climate change promotes sustainable development practices, reducing the risk of environmental degradation. The study of physics of climate change will foster collaboration among scientists, policymakers, and stakeholders, ensuring a comprehensive approach to environmental security. National Research Council (2010).

Understanding the physics of climate change enables more accurate predictions of climate-related events, helping to enhance environmental security and inform decision-making. The complex physics



of climate change can lead to uncertainty and difficulty in predicting exact outcomes while researching and modeling climate change requires significant computational and financial resources. The stark realities of climate change can evoke feelings of anxiety, hopelessness, and despair among individuals and communities.

Also addressing climate change may face political and social resistance, hindering implementation of effective solution.

This paper is aimed to review the physical fundamentals of climate change and its effect on environmental security, finding ways of reducing it in Nigeria

Specific objectives include:

1. To review the study of the dynamics of the Earth's system which includes energy balance, greenhouse gases and the response mechanism, to how human activities impact the climate.
2. Also to review how to apply physical understanding to predict and find solution to climate change on ecosystems, resources and human community to ensure a reliable and better future by analyzing the intricate relationships between the atmosphere, oceans, land, and living organisms, and how human activities disrupt these delicate balances.

2.0. LITERATURE REVIEW

Wikipedia Contributors (2019) narrated the study of physics of climate change and environmental security has its roots in the early 19th century when scientists first began to understand the Earth's climate system. Here are some key milestones in the historical background of this study:

In 1824 Joseph Fourier, discovers the greenhouse effect by recognizing that the Earth's atmosphere traps heat. This continued in 1896 when Svante Arrhenius calculated the relationship between CO₂ levels and global temperatures.

Between 1950s-1960s Scientists like Gilbert Plass and Charles David Keeling continue to study the greenhouse effect and CO₂ levels. while in 1970s, the concept of climate change emerged, with scientists like Wallace Broecker and Stephen Schneider warning of potential dangers. In 1980s, the Intergovernmental Panel on Climate Change (IPCC) was established to assess climate change science



and impacts. The concept of climate change has been studied for over a century, with early scientists like Svante Arrhenius and Guy Callendar recognizing the potential for human activities to influence the Earth's climate, (Howe, 2010).

However, it was not until the 1980s that climate change emerged as a major environmental concern, with the discovery of the Antarctic ozone hole and the realization that human activities were contributing to the depletion of the ozone layer. Also in 1990s, the Kyoto Protocol was adopted, aiming to reduce greenhouse gas emissions. In the 1990s and early 2000s, the Intergovernmental Panel on Climate Change (IPCC) was established to provide a scientific basis for climate policy, and the Kyoto Protocol was signed to limit greenhouse gas emissions. However, despite these efforts, global emissions continued to rise, and the urgency of the climate crisis became increasingly apparent Whereas in 2000s, Climate change became a mainstream concern, with the IPCC's Fourth Assessment Report (2007) and the Copenhagen Summit (2009). In 2010s, the Paris Agreement (2015) sets global goals for mitigating climate change.

In recent years, the focus has shifted from mitigating climate change to adapting to its impacts, with a growing recognition of the need for sustainable solutions and environmental security. The Paris Agreement, signed in 2015, set a goal of limiting warming to well below 2°C and pursuing efforts to limit it to 1.5°C, but current country pledges fall short of achieving this goal (Abbass et al., 2022).

This paper builds on this historical reviewed context, providing an updated analysis of the physics of climate change and its impacts on environmental security, and proposing sustainable solutions and policy recommendations to address this critical global challenge.

2.1 RELATED WORKS

Here are some related works reviewed:

National Research Council (2010) conducted a study on "Advancing the Science of Climate Change". According to the results, Hypotheses about climate change are supported by multiple lines of evidence, and human activities are the main cause of climate change.

Nurita Apridiana et al. (2024) conducted another study on Climate Change Education in Sustainable Physics Learning, from the findings, it reveals that Climate change education integrated into physics



learning has a positive impact on students' understanding and increases their environmental awareness and care.

Also, a study on "Climate Change: A Review of the Impact on the Physical Environment" Ifeanyi-Obi et al (2020). Findings revealed that climate change significantly impacts the physical environment, including rising sea levels, changes in precipitation patterns, and increased extreme weather events.

Stephens et al. (2019): study on the Physics of Climate Change: A Review of the Fundamental Processes: The authors reviewed the fundamental physical processes driving climate change, including the greenhouse effect, heat transfer, and the role of feedback mechanisms.

Adger et al. (2018) carried out a study on Environmental Security and Climate Change: A Review of the Literature" and according to the findings; Climate change poses significant threats to environmental security, including increased risk of conflict, displacement, and human rights violations.

Monroe et al. (2019) conducted a research on Climate Change Education: A Review of the Literature the findings revealed that Climate change education is essential for building public awareness and promoting behavior change, but current educational efforts are often insufficient.

2.3 Physics Principles of climate change: These are the principles responsible in driving climate change as reported in United Nations Institute for Training and Research (UNITAR) (2015), USGCRP (2010):

1. Conservation of energy involved in energy balance and Earth's energy budget
2. Thermodynamics(heat transfer and energy conversion) a process that occurs in thermal radiation and the greenhouse effect
3. Phase transitions involving Feedback mechanisms (ice-albedo, water vapor, cloud)
4. Fluid dynamics, a process in ocean heat transport and circulation
5. Atmospheric circulation and jet stream dynamics
6. Radiation transfer, the process is concerned with absorption and emission of radiation heat and light waves. (Stevens, B., & Feingold, G. (2016))

3.0 METHODOLOGY

This study employed a comprehensive literature review methodology to explore the physics of climate change and its implications for environmental security in Nigeria. The aim is to synthesize existing



research, identify gaps, and understand the dynamics of climate change within the Nigerian context. Academic journals, books, conference proceedings, and reports from reputable organizations. The study will utilize academic databases such as Google Scholar, PubMed, Scopus, and Web of Science. Keywords will include climate change, physics, environmental security, sustainability, greenhouse effect, energy balance, feedback mechanisms and related terms. Studies published in peer-reviewed journals and authoritative sources from the last decade to ensure relevance and accuracy was included. Priority was given to research with focus on Nigeria or comparable regions with similar climatic conditions.

4.0. DISCUSSION AND RESULT

4.1 Dynamics of a Global Threat to Environmental Security in Nigeria

Environmental security is a critical component of national and global stability, encompassing the protection of ecosystems, natural resources, and the overall health of the environment. In Nigeria, environmental security faces multifaceted threats that are influenced by both local and global factors. These threats impact not only the ecological balance but also socio-economic stability and public health. Understanding these dynamics is crucial for formulating effective policies and strategies to mitigate risks and ensure sustainable development. (Ugwuanyi , 2014)

Kumar et al. (2022) reported that climate change represents one of the most significant global threats to environmental security. Rising global temperatures lead to extreme weather events such as heatwaves, droughts, and heavy rainfall. In Nigeria, these changes exacerbate problems like desertification in the northern regions, increased flooding in the southern areas, and altered agricultural productivity. The country's vulnerability is heightened due to its reliance on rain-fed agriculture and its extensive coastline.

Evelyn et al. (2012) said Pollution, driven by industrial activities and urbanization, affects air, water, and soil quality. While Nigeria contributes to global pollution through its industrial activities, it is also a recipient of pollutants from international sources. The transboundary movement of pollutants through atmospheric and water systems affects local ecosystems and human health. Contaminants like plastics and chemicals find their way into Nigerian rivers and coastal areas, impacting biodiversity and community health.



Adikwu et al. (2023) reported that global biodiversity loss impacts Nigeria's rich natural heritage, including its rainforests, savannas, and wetlands. Deforestation driven by logging and agriculture, along with habitat destruction, threatens species unique to the region. This loss reduces ecological resilience, affecting ecosystem services such as water purification and soil fertility.

Onyena and Sam (2020) noted that the unsustainable extraction of natural resources, driven by global demand, affects Nigeria's mineral and energy resources. Oil and gas exploitation, while economically significant, leads to environmental degradation through oil spills, gas flaring, and habitat destruction. The depletion of freshwater resources due to overuse and pollution further exacerbates environmental challenges.

4.2 General Impact of Physics of Climate Change on environmental security

The physics of climate change has significant impacts on environmental security,(Field, C.B etal 2014) including:

1. Rising sea levels: Coastal erosion, flooding, and saltwater intrusion into freshwater sources.
2. Extreme weather events: Increased frequency and intensity of heat waves, droughts, and storms.
3. Water scarcity: Changes in precipitation patterns and increased evaporation due to warmer temperatures.
4. Loss of biodiversity: Disruption of ecosystems and extinction of species.
5. Food insecurity: Impacts on agricultural productivity and food distribution.
6. Human migration and displacement: Forced migration due to rising sea levels, drought, and extreme weather events.
7. Conflict and instability: Competition for resources and mass migration can lead to social and political instability.
8. Health impacts: Increased spread of disease, heat stress, and pollution leading to increased respiratory problems, cancer, and other health issues.



9. Economic impacts: Damage to infrastructure, increased costs for healthcare and emergency response, and loss of productivity.

10. Social and cultural impacts: Loss of traditional ways of life, cultural heritage, and community identity.

The physics of climate change has far-reaching consequences for environmental security, affecting not only the natural environment but also human societies and economies.

4.3 Strategies of environmental security in Nigeria

1. Promote renewable energy: Transition to solar, wind, and hydroelectric power to reduce dependence on fossil fuels.

2. Improve energy efficiency: Encourage energy-saving practices in buildings, transportation, and industry.

3. Sustainable agriculture: Implement climate-resilient agricultural practices, such as agro forestry and conservation agriculture.

4. Reforestation and afforestation: Plant more trees to reduce deforestation and promote carbon sequestration.

5. Flood control measures: Implement floodplain management and drainage systems to reduce flood risk.

6. Drought management: Implement water harvesting and conservation strategies to reduce drought impact.

7. Climate-resilient infrastructure: Build roads, bridges, and buildings that can withstand extreme weather events.

8. Early warning systems: Establish systems to alert communities of impending extreme weather events.

9. Environmental education: Educate the public on climate change causes, impacts, and solutions.



10. Policy and governance reforms: Strengthen policies and governance frameworks to support climate change mitigation and adaptation efforts.

These methods can help reduce the impacts of climate change and enhance environmental security in Nigeria, and require a collaborative effort from government, industries, and individuals to implement and maintain. (Intergovernmental Panel on Climate Change (IPCC) 2020)

4.3 The Relationship between The physical principles driving climate change: Greenhouse effect, Energy balance, and Feedback mechanisms.

The greenhouse effect is the warming of the Earth's surface due to the absorption and re-emission of infrared radiation by atmospheric gases (greenhouse gases, GHGs). GHGs, such as CO₂, CH₄, and H₂O, trap heat and maintain the Earth's temperature. Energy balance refers to the equilibrium between the energy received from the sun and the energy lost to space. The Earth's energy balance is maintained through the balance between incoming solar radiation and outgoing infrared radiation while the Feedback mechanisms respond to changes in the climate system, amplifying or dampening the initial change, (NASA, 2023)

Positive feedback loops amplify warming (e.g., melting Arctic ice reduces Earth's albedo, increasing solar absorption) as Negative feedback loops dampen warming (e.g., increased CO₂ fertilization enhances plant growth, absorbing CO₂).

4.4 Relationships between these concepts:

The greenhouse effect is driven by the absorption of infrared radiation by GHGs, which maintains the Earth's energy balance. Human activities, such as burning fossil fuels, increase GHG concentrations, enhancing the greenhouse effect and disrupting the energy balance, (British Geological Survey, 2022). This disruption triggers feedback mechanisms, which can amplify or dampen the initial warming which can in turn, affect the energy balance, either reinforcing or counteracting the initial change. (Adger, W. N., Arnell, N. W., & Tompkins, E. L. 2018).

5.0 CONCLUSION

The physics of climate change is a pressing global issue, and understanding its principles is crucial for addressing environmental security concerns. We must adopt a multi-faceted approach, combining



mitigation and adaptation strategies to ensure a sustainable future. International cooperation, policy frameworks, and individual actions are essential for addressing this global challenge. Overall, the study emphasizes the importance of understanding the physics of climate change to address environmental security concerns and promote sustainable development. It is therefore recommended that a comprehensive national climate change policy must be build. Also, much investment in renewable energy and energy efficiency should be carried out. By promoting sustainable land use, forest reservation, enhanced climate resilience and adaptation in vulnerable communities.



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COMPARATIVE PREVALENCE OF INTESTINAL HELMINTHES OF FREE ROAMING MALE AND FEMALE CHICKENS SOLD IN LOKOJA KOGI STATE

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ABSTRACT

Gastrointestinal Helminthes are parasites found in the intestine of animals. They are mostly helminths, which include cestodes, trematodes, and nematodes. These are flatworms and round worms. Their mode of transmission is generally through ingestion of their eggs from the soil and so they are referred to as geohelminths. Chickens are a major source of protein worldwide and the preference of Lokoja residence for free ranged chickens as organic source of protein necessitated this study to provide adequate source of comparative prevalence on the male and female chickens for effective control of these helminths, some of which have zoonotic effects on man. 20males and 20female chickens were purchased from different locations in Lokoja; Felele, Karara; Adankolo and New Market. The chickens were slaughtered and the gastrointestinal organ harvested and separately preserved in containers containing saline water and transported to the laboratory of Kogi State Polytechnic Lokoja for examination. Intestinal scrapping and flotation method was used for the examination of adult parasites. Results revealed all free ranged chickens examined were found to be infected with parasites. The following prevalence was recorded. The highest prevalence of 99.15%, 89.19%, 86.67%, 75.86% cestode infection recorded in Old market, New market, Felele and Adankolo respectively and highest nematode infection 24.14%, 13.33%, 10.81% and 0.86% from Adankolo, Felele, New market and Old market respectively. No single trematode was recorded in this study. It is therefore recommended that a clean environment devoid of refuse dump and fenced environment be provided for free ranged chickens to prevent contact with contaminated soil and water which are the major source of infection. Total male helminth infection 76.50% compared to female infection 26.50% in Old market chickens was higher. Similarly in Adankolo which recorded male infection of 75.86% while female infection was 24.14% whereas this was different from what was recorded from Felele, where male infection totaled 33.33% which was lower than female infection of 66.67%. Same result as in Felele was observed with chickens purchased in New Market, Karara with total



male prevalence of 5.41% and female prevalence of 94.60%. It is recommended that sellers of poultry livestock should maintain a clean and hygienic caging as well as deworming the birds before sales. Buyers should also avoid consumption of poultry intestine to prevent zoonotic infections of cestodes.

KEYWORDS: Prevalence, Intestinal parasites, Free ranged Chickens



1.0 INTRODUCTION

Majority of people inhabiting Lokoja rear chicken on free range especially those defined over the years in rural communities. chicken, guinea fowls, pigeons, turkeys, and ducks are village poultry produce, form an integral part of rural agricultural investments (Adedeji, *et al* 2014). *Gallus domesticus* play an important role to the people in Lokoja with and also provide them with very rich protein food (eggs and meat).

Biosecurity mitigation, management and husbandry of poultry bird population in Africa rural communities can be broadly classified into an captive and free range systems (Ogbaje, *et al* 2019). In captive system, birds are raised in large quantities in an enclosure, controlled environment with proper sanitation and routine treatment when they become sick; In free range systems, birds are allowed to scavenge for their food, which can them susceptible to disease causing agents, with poor or no medication when sick (Oyelami *et al* 2022).

Parasitic diseases are mostly significant threats to poultry production system in African countries including Nigeria,. The adverse effects of endoparasites in avian species, they cause parasitic diseases and economic loss to the farmers and pose serious health challenges to the consumers. Avian haemoparasites are pathogenic to domesticated and wild birds, It has been reported that it cause high rate of mortality, reproductive failure, growth retardation, reduced productivity of poultry bird (Hasan, *et al.* 2017). Lokoja is one of the major market where free-range chickens are been sold, The study area are predominantly occupied by kogites. Women are a major part of the community practicing free range chicken rearing system. Free-range chickens are more exposed to contaminated soil, water, and forage and so are more susceptible to gastrointestinal helminth infections.

Endoparasitic infections in free-range chickens results in anaemia, diarrhoea, slow metabolism, which gives rise to decreased egg production, and increased mortality rates. These gastrointestinal helminths are able to transmit endoparasites to humans via contaminated meat, eggs, direct contact and is a concern to public health and environment. Raillietina infection is caused by spp. The definitive hosts where adults develop are mainly birds which include *Gallus domesticus*. They shed proglottides containing egg capsules which are shed in the faeces. Arthropods which are



the intermediate hosts ingest the proglottides or free eggs and within the intermediate host, the cysticercooids of these parasites are released. The chickens get infested when they ingest these intermediate host containing the cysticercooids (larva). Humans can also be infected when these intermediate arthropods are ingested by humans.

Ascariidiasis in chickens occurs by ingestion of eggs of *Ascaridia spp* contaminated food or water and exposure to contaminated faeces from infected chickens..

The increased needs for *Gallus domesticus* products has led to a raise in poultry practice production in almost all African countries. . The largest group of this domesticated livestock consist of free range *Gallus domesticus* (Inuwa, et al., 2021). Due to the action of parasite on birds, lead to infection by diseases, the sector has been stated to have recorded a fall in production (Philip *et al.*,2019). In Kenya, Sabuni et al (2010; 2011; 2013) and Waruiru *et al* (2017) have reported that haemoparasites are common in free range chickens. Among the high factors that serve as a threat to *Gallus gallus domesticus*, the occurrence of parasites. . When they are few, they do not usually cause health problem but when they occur in large numbers can lead to devastating effect on growth; replacement birds that take long to reach maturity, egg production and over-all health (Junaidu *et al.*, 2014).

3.0 MATERIALS AND METHOD

STUDY SITE

This study was carried out in Felele market, New market, s in lokoja metropolise.

Lokoja is the capital city of Kogi State Nigeria.It is situated at the confluence of the rivers Benue and Niger. It lies about 7.8023 degrees North of the Equator and 6.7333degrees East of the Meridian. It is about 165km Southwest of Abuja, Federal Capital Territory of Nigeria, as the crow flies, and 390km Northeast of Lagos by same measure. Adetunji,et al (2015).The total area of Lokoja is 1,230sq m with a total population of 692,050.

SAMPLE COLLECTION

A total of 40 free ranged adult chickens were randomly purchased from farms in Felele (n = 10), New Market,(n = 10), Adankolo (n = 10) and Old market (n = 10) . The birds were slaughtered, and individual intestinal contents were immediately collected and placed into well-labeled sterile



sample plastic containers and put in a cool box. The samples were immediately be transported to the Laboratory of the Kogi State Polytechnic Lokoja, Nigeria, for further processing.

Parasitology Examination

Floation method was used for this experiment. Thegastrointestinal tracts were separated intoeosophagus, crop, the proventriculus, gizzard,small intestine, and caecum. Each part was dissected and content washed into petri dishes for the parasitic examination. Each section was slit longitudinally with the addition of 10ml of normal saline into the dissecting tray and parasites were picked with forceps and cestodes, nematodes were placed into different petri- dishes for identification and counting according to the method of Tania, *et al* 2016. All helminths were identified using helminthological keys(Taylor, *et al* 2015)

RESULTS AND DISCUSSION

▪ **Table 1:** Comparison of the prevalence of helminths in the intestinal tract of both male and female Free range Chicken (*Gallus domesticus*) that were bought in Old market, Lokoja Kogi state

▪ <i>Helminths Species</i>	<i>No of Male chicken prevalence (n=5)</i>	<i>No of Female chicken prevalence (n=5)</i>	<i>Total No of male and female chicken prevalence (n=10)</i>	<i>% Prevalence</i>
Cestodes				
<i>Raillietina sp</i>	85(71.55%)	31(26.72%)	116	99.15%
Nematodes				
<i>Ascaridia galli</i>	1(100%)	0(0%)	1	0.86%.
Total	86(76.50%)	31(26.50%)	117	100%



In the ten chickens from the Old market (TABLE 1), Cestodes were 85(71.55%) *Raillietina* sp in the male and 31(26.72%) in the females. Total prevalent cestode infection was 99.15% Nematodes *Ascaridia galli* 1(100%) in the male chickens and no nematodes found in the female chickens.

Table 2: Comparison of the prevalence of helminths in the intestinal tract of both male and female Free range Chicken (*Gallus domesticus*) that were bought in Felele market, Lokoja Kogi state

<i>Helminths Species</i>	<i>No of Male chicken %prevalence (n=5)</i>	<i>No of Female chicken %prevalence (n=5)</i>	<i>Total No of male and female chicken prevalence (n=10)</i>	<i>% Prevalence</i>
Cestodes				
<i>Raillietina</i> sp	3(23.08%)	10(76.92%)	13	86.67%
Nematodes				
<i>Ascaridia galli</i>	2(100%)	0(0%)	2	13.33%
Total	5(33.33%)	10(66.67%)	15	100%

From Felele market (TABLE 2) cestode sp for male chickens *Raillietina* 3(23.08%) and in females 10(76.92%) prevalence. The total prevalence nematode infection was 0.86% . The total prevalence cestode infection was 86.67% while total nematode infection was 13.33%.. which was a lower prevalence than the cestode infection. From the New Market, Karara, Lokoja



Table 3: Comparison of the prevalence of helminths in the intestinal tract of both male and female Free range Chicken (*Gallus domesticus*) that were bought in New market, Karara, Lokoja Kogi state

<i>Helminths Species</i>	<i>No of Male chicken prevalence (n=5)</i>	<i>No of Female chicken prevalence (n=5)</i>	<i>Total No of male and female chicken prevalence (n=10)</i>	<i>% Prevalence</i>
Cestodes				
<i>Raillietina sp</i>	2(6.06%)	31(93.94%)	33	89.19%
Nematodes				
<i>Ascaridia galli</i>	0	4(100%)	4	10.81%
Total	2((5.41%)	35(94.60%)	37	100%

,(TABLE 3) the male prevalence cestode infection was 2(6.06%) while the female prevalence was 31(93.94%.) Total % prevalence Cestode infection was .89.19% while nematode was 10.81%. From Adankolo market

Table4: Comparison of the prevalence of helminths in the intestinal tract of both male and female Free range Chicken (*Gallus domesticus*) that were bought in Adankolo market, Lokoja Kogi state

<i>▪ Helminths Species</i>	<i>No of Male chicken prevalence (n=5)</i>	<i>No of Female chicken prevalence (n=5)</i>	<i>Total No of male and female chicken prevalence (n=10)</i>	<i>% Prevalence</i>
Cestodes				
<i>Raillietina sp</i>	22(100%)	0(0%)	22	75.86%
Nematodes				



<i>Ascaridia galli</i>	0(0%)	7(100%)	7	24.14%
Total	22(75.86%)	7(24.14%)	29	100%

(TABLE 4) % prevalence cestode infection was 22(100%) for male chickens and no cestodes for female chickens. while nematode infection was 0(0%) for male chickens and 7(100%) for female chickens. Total prevalence cestode infection was 75.86% while Nematode infection was 24.14%.

Out of the 40 free range chickens of male and female were examined, all 40 (100%) were infected.

The highest prevalence of 99.15%, 89.19%, 86.67%, 75.86% cestode infection recorded in Old market, New market, Felele and Adankolo respectively and highest nematode infection 24.14%, 13.33%, 10.81% and 0.86% from Adankolo, Felele, New market and Old market respectively.

The comparative prevalence of cestodes among the male chickens were 100%, 71.55%, 23.08%, 6.06%, from Adankolo, Old market, felele and new market respectively while the female highest cestode prevalence were 93.94%, 76.92%, 26.72% from New market, Felele, old market and no cestode infection from female chickens from Adankolo respectively. In the male result showed higher infection of nematodes among male chickens. 100%, 100%, 5.41%, from Old market, Felele, New market and no nematode infection in those from male chickens from Adankolo. All chickens examined showed multiple helminth infections in agreement with the findings of Phiri et al (2007) except those gotten from Adankolo which maybe attributed to lower human activity and population compared to the other markets where the samples were collected

Total male helminth infection **76.50%** compared to female infection **26.50%** in Old market chickens was higher. Similarly in Adankolo which recorded male infection of **75.86%** while female infection was **24.14%** which agrees with the findings of Negbenebor and Ali (2018), Suhaila, et al(2015) whereas this was different from what was recorded from Felele, where male infection totaled **33.33%** which was lower than female infection of **66.67%**. Same result as in Felele was observed with chickens purchased in New Market, Karara with total male prevalence of **5.41%** and female prevalence of **94.60%**



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PREVALENCE AND RISK FACTORS OF HIV AMONG PREGNANT WOMEN ACCESSING CARE OF AT FEDERAL MEDICAL CENTER KEFFI NASARAWA STATE NIGERIAN

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ABSTRACT

HIV, a sexually transmitted infection can be spread through contract with infected blood or from mother to child during pregnancy childbirth or breastfeeding. This study was carried out to determine the prevalence and risk factors of human immunodeficiency virus (HIV) among pregnant women accessing care at federal medical centre Keffi, Nasarawa state Nigeria. A total of 200 blood samples were collected from pregnant women attending antenatal Clinic FMC Keffi Nasarawa State. The blood sample was collected in sample bottles containing EDTA. The blood samples were centrifuged, a drop of serum was added to the test strip and allowed for 15minutes after which it was observed for reactions either positive or negative. Out of the 200 samples collected only 19 (19.0%) were positive for HIV infection. Based on age group, age group 16-25 years a total of 78 samples were collected and tested and 8(23.0) % samples were positive, age group 26-35years 88 samples were collected and 7(16%%) samples were tested positive. In age group 36-45 years, 28 samples were collected and 3(21.4%) were tested positive while in age group 46-55 years a total of 6 samples were collected and tested out of which 1(33.3%) was positive. This study showed a high burden of HIV (1(1 9.0%) among pregnant women, there is need to always screen pregnant women for HIV infection during their antenatal clinics.

Keywords: Human immunodeficiency virus (HIV), test strip, blood sample, pregnant women, Hospital (FMC), Keffi.



1.0 INTRODUCTION

HIV is a sexual transmitted infection (STI). It can also be spread by contact with infected blood or from mother to child during pregnancy, childbirth or breast-feeding. Without medication it may take a year before HIV weakens immune system to the point of AID. (Mayo, 2020). HIV continues to be a major global public health issue, having claimed more than 32 million lives so far. However, with increasing access to effective HIV prevention, diagnosis treatment and care, including for opportunistic infection, HIV infection has become a manageable chronic health condition, enabling people living with HIV to lead long and healthy lives (WHO, 2019).

HIV attacks the body immune system, especially the CD4 cell (t-cells) which help the immune system fight off infection. If left untreated, it reduces the number of CD4 (t-cells) in the body making the number of the person more likely to get infection related to the virus (WHO, 2019)

HIV gradually attacks the immune system, which is our body's natural defense against illness. The virus destroys a type of white blood cell called a T-helper cell and makes the copies of itself inside them. HIV destroys CD4 cell, which damages the immune system. A damaged immune system makes it hard for the body to fight off infection. Antiretroviral therapy (ART) prevents HIV from destroying CD4 cells (WHO, 2019).

At the end of 2013 there were approximately 35 million people with HIV (PLHIV) worldwide. This number is rising as more people are living longer because of anti-retroviral therapy (ART). The number of new HIV infections, although declining is still very high. An estimated 0.8% of adults age 15-49 years worldwide live with HIV, although the burden of the epidemic continues to vary considerably between regions and countries. Of the 35 million PLHIV, approximately 24.7 million live in sub-Saharan Africa, the region hardest hit by the epidemic (UNAIDS, 2014)

The 24.7 million PLHIV in sub-Saharan Africa account for nearly 71% of the global total. Ten countries Ethiopia, Kenya, Malawi, Mozambique, Nigeria, South Africa, Uganda, the United Republic of Tanzania, Zambia and Zimbabwe account for 81% of all PLHIV in the region (UNAIDS, 2014).

Several reasons have been put forward to explain rising prevalence, such as the increasing number of individuals on ART who are living longer, an increase in risky sexual behavior and possibly less focus on HIV/AIDS prevention programs (Ministry of Health, 2012). The Joint United Nations Programme



on HIV/AIDS (UNIADS) estimated the number of the new infection at 150,000 in 2011 up from 120,000 in 2004 (PEPFAR, 2014). UNAIDS provides guidance for dealing with key population at risk, while acknowledging sub-population that may also be vulnerable to HIV and in some setting, should be the focus of HIV prevention intervention. The sub-population vary by country and context and should be considered for potential monitoring when developing a nation or sub-national monitoring and evaluation (M&E) plan (UNIADS, 2008).

Nigeria has the second largest HIV epidemic in the world (NACA, 2017). Although HIV prevalence among adults is much less (1.3%) than other sub-saharan Africa countries such as south Africa (19%) and Zambia (11.5%), size of Nigeria population means 1.8million people were living with HIV in 2019 (UNAIDS, 2020). Recent drops in prevalence estimates for the country has been attributed to better surveillance (PEPFAR, 2019).

The aim of this study is to determine the prevalence and risk factors of Human immunodeficiency virus among pregnant women accessing care at the Federal Medical Center Keffi Nasarawa State, Nigeria.

The specific objectives are to;

- i. Determine the prevalence and risk factors of HIV among pregnant women accessing care at the Federal Medical Center Keffi.
- ii. Determine the possible solution to the population of study

2.0 LITERATURE REVIEW

2.1 History of HIV

In the early days of the HIV epidemic, knowledge about the natural history of HIV accrued rapidly. However, the widespread use of effective antiretroviral therapy (ART) brought a shift in focus of the research community away from studies of natural history to those treated infection. Nevertheless, recent years have seen many advances in our knowledge about natural history (poropatich K and Sullivan DJ, 2011).



2.1.1 Long-Term Nonprogressors and Elite Controllers

The natural course of untreated HIV infection varies widely. The past decade has seen considerable interest in the identification of subgroup of HIV-positive persons who exhibit distinct patterns of disease progression. It is hoped that the information obtained through the identification of such individual might provide insight for the development of vaccine and novel treatment approaches (Poropatich K and Sullivan DJ, 2011).

Long-term Nonprogressors (LTNP) are individual who remain asymptomatic for a prolonged period of time off ART with a high CD4 cell count (Gaardbo *et al*, 2012). Although it is widely reported that 1-5% of the HIV-positive population are LTNP, these estimates are complicated by the fact that there is no standardized definition of LTNP, and thus definitions used (and the way in which they are applied, particularly in the presence of varying follow-up and irregularly measured CD4 cell counts) differ widely (Madec *et al*, 2009). For example, identified asymptomatic individuals who remained off ART for more than 8 years with a CD4 cell count more than 500 cells/ μ l using this definition, 9% of their clinic population were identified as LTNP, using a similar definition but with only 7 years of follow-up (Okulicz *et al*, 2009) reported a prevalence of 5.02% in a military cohort. In contrast, only 0.4% of patient in the French hospital's Database on HIV were identified as LTNP (Grabar *et al*, 2009).

2.1 Dynamics of HIV transmission

Heterosexual intercourse is the major route for HIV transmission in Nigeria accounting for over 80% of the infections with the majority of remaining HIV infections among key affected populations (Nigeria National Agency for the Control of AIDS, 2014, 2010). Other modes of transmission such as intravenous drug use and same-sex intercourse are now growing in importance (Nigeria National Agency for the Control of AIDS, 2010). In fact, it has recently been modelled that the high-risk groups which constitute about 1% of the general population in Nigeria and involving men that have sex with men (MSM), female sex workers (FSWs) and injecting drug users (IDUs) will significantly contribute to new HIV infections in the coming years (Nigeria National Agency for the Control of AIDS, 2012). These groups and their partners will contribute to 40% of new infections while people practicing low-



risk sex (heterosexual) in the general population will contribute to 42% of the infections due to low condom use and high sexual networking (Nigeria National Agency for the Control of AIDS, 2012).

2.1.1 Sex Worker

Transport workers and sex workers, both considered MARPs, have long been associated with risky sexual behavior and the spread of HIV in East Africa, in Africa and in other parts of the world. Transport workers spend prolonged periods of time away from home and, due to a combination of loneliness, peer pressure, alcohol use and to satisfy their sexual needs, may resort to casual sex or develop regular non-marital sexual relationships while in transit (Ntozi *et al.*, 2003). Some studies (Gysels *et al.*, 2002); (Ntozi *et al.*, 2003); (Pickering *et al.*, 1997) have also reported that long distance truck drivers often comprise approximately 28- 30% of the clientele of sex workers (International Organization for Migration, 2008).

Great numbers of sex workers, many of whom lack other livelihood options, frequent stopping points along transport corridors. This situation creates an environment where individuals engage in sexual acts with multiple concurrent partners, thereby increasing their chance of contracting HIV and other STIs. Through sexual networks, people with multiple concurrent partners have the potential to spread HIV infection from high-risk groups to the general population. Because long distance truck drivers normally spend nights away from home they may engage in sex with many casual and semi-regular partners along their transport routes, sometimes without using condoms (Morris & Ferguson, 2006), exposing themselves to the risk of acquiring or transmitting HIV.

Commercial and casual sex can be easily available in the many bars around towns, from high-class sex workers, women selling food on the street or in markets, and the many women with no reliable income who are willing to provide sex very cheaply. High-class prostitution generally takes place in lodges, where overnight clients pay for a room in which they sleep with a woman with whom they had earlier made an appointment. Cheaper sex is extremely casual and can take place with little or no negotiation in a banana plantation, the man or woman's home or any other convenient place (Pickering *et al.*, 1997).

Sex work can be difficult to distinguish from other sexual relationships. Money may not always be exchanged. Commodities, favours or other goods may substitute for money. Long distance truck drivers are attractive clients to commercial sex workers; however, many other women may also have



casual or regular sexual relationships with long distance truck drivers. Besides commercial sex workers, transport workers also tend to develop sexual networks with other local young girls and women who provide services along transport corridors, as bar attendants and street traders. The economic opportunities offered in truck stops and along transport routes often attract girls and women from rural areas. Some studies show that such women may offer sex to transport workers in exchange for free transport or other favours (Anarfi, 1997).

2.1.2 Multiple Sexual Partners

One of the risk factors for HIV transmission is engaging with multiple concurrent and casual sexual partners. Long distance truck drivers move from place to place as part of their jobs. This mobility increases the number of potential sexual contacts that long distance truck drivers may engage in. Transport hubs are also associated with the influx and interaction of people from different backgrounds and with different sexual histories and networks. Long distance truck drivers may make new sexual contacts and, in the process, may facilitate the transmission of HIV (Ministry of Works and Transport, 2011).

Documented evidence indicates that long distance truck drivers have many partners along transport routes, many of whom may be sex workers. The finding that long distance truck drivers engage in sex with multiple sexual partners suggests that they can act as a bridge to transmit HIV and other STIs to the general population (Matovu & Ssebadduka, 2012).

Ntozi et al. found that long distance truck drivers attributed having multiple sexual partners to the nature of their job (travel), to excessive alcohol consumption and to money, which they normally carry. They travel a lot, live in different lodges and meet many women along the way. Women believe that trucks belong to the long distance truck drivers, therefore that they have a lot of money. Long distance truck drivers reported, *–When a vehicle breakdown on safari we drink and sleep with women...we have sexual partners scattered all along the routes we follow on safari.*

Sexual patterning has advantages over more traditional methods of recall, which are influenced by social desirability and recall biases. In another study, long distance truck drivers were asked to recall all their sexual partners over the 12 months prior to being interviewed by name, nickname or description, as well as by frequency of contact, type of partner and consistency of condom use. A total of 210 different sexual partners were recorded by the 101 men reporting. A range of 1 to 4 partners



and no abstentions were recorded. Around 72% of the men reported having had more than one sexual partner over the period. Currently-married men reported an average of 2.16 partners compared with 1.96 partners for all other men (International Organization for Migration, 2008).

2.1.3 Condom use

According to Matovu and Ssebadduka (2013), knowledge of condom use as an HIV prevention strategy is generally high. Attitudes towards condom use were generally favourable as well, with 91% of sex workers and 82% of long-distance truck drivers agreeing with the statement, *–Condom use is the best method for HIV prevention*. However, one-third of long-distance truck drivers and 28% of sex workers agreed with the statement, *–Condoms kill the mood for sex*. In addition, 18.4% of long-distance truck drivers agreed with the statement, *–I don't like to use condoms myself*. Long distance truck drivers cited the need to *–please the lower part of the body* as one of the reasons why they normally do not like to use condoms (Matovu & Ssebadduka, 2013).

The findings of Matovu & Ssebadduka (2012) highlight the trade-off between degree of intimacy and condom use. Condom use with close partners is very low. Consistent condom use is highest for liaisons with sex workers and lowest with spouses. Although condom use is high initially for *‘other regular’* partners, use at last liaison and consistent use are only around 40% (International Organization for Migration, 2008). The reasons advanced for this pattern include protection against possible contraction of HIV from casual partners, and a desire to have children with wives and other regular partners. Some long distance truck drivers also reported that they did not use condoms with regular partners or spouses in order to build trust. Respondents reported *–We do not think any of us can use condoms with a wife, how then could one get children*, *–it is not wise to use condoms with a regular partner, she can think you do not trust her and she can also lose trust in you, which is not good* (Ntozi et al., 2003).

2.2 Mode of Transmission of Hepatitis B Virus

Transmission of HIV results from exposure to infectious blood or body fluids containing blood (CDC, 2015). Possible forms of transmission include sexual contact (Fairley and Read, 2012) blood transfusions and transfusion with other human blood products (Buddeberg et al., 2008) re-use of contaminated needles and syringes (Hughes, 2000) and vertical transmission from mother to child (MTCT) during childbirth. Breastfeeding after proper immunoprophylaxis does not appear to contribute to mother-to-child-transmission (MTCT) of HIV (Shi et al., 2011). There is no convincing



evidence that airborne infections occur and feces are not a source of infection, since the virus is inactivated by enzymes of the intestinal mucosa or derived from the bacterial flora. HIV is not transmitted by contaminated food or water, insects or other vectors. HIV has been found in all body secretions and excretions. However, only blood, vaginal and menstrual fluids, and semen has been shown to be infectious (WHO, 2014). The virus may be detected within 30 to 60 days after infection and can persist and develop. The incubation period of the HIV is 30 to 180 days (WHO, 2013).

2.2.1 Risk Factors for HIV

Main factors that predispose people to HIV infection include:

- a. history of Blood transfusion
- b. Surgery
- c. Hemodialysis
- d. Intranasal cocaine use
- e. Sexual Transmitted Disease (STDs)
- f. Multiple sexual partners
- g. Tattooing
- h. Homosexuality (WHO, 2000; UNAIDS/WHO, 2007).

2.2.2 Risk Groups for HIV

Here is a list of groups of people who are at risk of contracting HIV

- a. infants born to infected mothers
- b. sexual/household contacts of infected persons
- c. health care workers



- d. patients and employees in hemodialysis centers
- e. injection drug users sharing unsterile needles
- f. people sharing unsterile medical or dental equipment
- g. people providing or receiving acupuncture and/or tattooing with unsterile medical devices
- h. sexually active heterosexuals
- i. men who have sex with men

Frequent and routine exposure to blood or serum is the common denominator of healthcare occupational exposure. Surgeons, dentists, oral surgeons, pathologists, operating room and emergency room staff, and clinical laboratory workers who handle blood are at the highest risk (WHO, 2000).

3.0 MATERIALS AND METHOD

3.1 Study Area

This research was carried out at Federal Medical Centre, Keffi. It is located in Nasarawa State North-central of Nigeria. Keffi has an area of 138 km² and a population of 92,664 at the 2016 census. It is between the latitude of 8.85° N and longitude 7.87° E. The annual rainfall ranges from 1100 mm to 2000 mm, and the mean temperature in Keffi range between 20°C and 34°C with the hottest months being March/April and coolest months being December/January (Ibrahim Omale 2013).

3.2 Study Population

The sample size of the study was determined using the prevalent rate of 12.5% for HIV study conducted in Abuja (NNCA, 2011) and the Kish Leisle formula (Mshana *et al.*, 2009).

$$N = Z^2 P(1-P) / d^2$$

Where N=Sample size

P= Prevalence of HIV



Z= Confidence interval (1.96)

d= Allowable error (5%)

$$N = 1.96^2 \times 0.125(1 - 0.125) / (0.05)^2$$
$$= 168.07$$

A total of 200 samples were collected to increase statistical precision and to minimize error.

3.2 Ethical Clearance

The ethical approval was then obtain from the ethical committee of the Federal Medical Center Keffi with Ref:FMC/KF/HREC/020/21 and the Reg. No NHREC/21/12/2012

3.3 Subject Selection

All pregnant women attending antenatal clinic FMC Keffi were eligible for this study. Participation was voluntary and each subject involved in the study gave a written consent. The demographic data of the participants that includes; age group, marital status, occupation, educational level, religion, blood transfusion, and gestation age, were obtained using a structured questionnaire. Two hundred (200) subjects aged from 16 – 55 years were involved in this research.

3.4 Inclusion Criteria

3.4.1 Pregnant women who attended Antenatal clinic Federal Medical Centre Keffi during the course of the study, after given a verbal consent to participate in the study were included.

3.4.2 Those who signed their informed consent form to participate in the study were also included.

3.5 Exclusion Criteria

Pregnant women who were not willing to participate in the study or who received medical treatment



against HIV infection at the time of the study were excluded from the study.

3.6 Materials

Syringe and needle, Stopwatch, Gloves, Cotton wool, EDTA bottle, Centrifuge machine and Pasture pipette.

3.7 Procedure

1. Using EDTA, blood sample was collected from the pregnant women
2. The EDTA bottle containing the blood was placed in the centrifuge another corresponding sample was placed in the opposite direction
3. After the spinning, the EDTA bottle was removed from the centrifuge
4. With the aid of pasture pipette a drop of serum was added into the test strip, it was allowed for 15 minutes
5. The strip was observed for reaction

3.8 Interpretation of Test Results

Positive: Two distinct red lines appeared. One line in the control region (C) and another line in the test region (T).

It was noted that the intensity of the red color in the test line region (T) varied, depending on the concentration of HIV present in the specimen. Therefore, any shade of red in the test region (T) was considered positive.

Negative: One red line appears in the control region (C). No apparent red or pink line appeared in the test region (T).

Invalid: Control line fails to appear. Insufficient specimen volume or incorrect procedural techniques are the most likely reasons for control line failure. In such case, the procedures were repeated with a new test device.

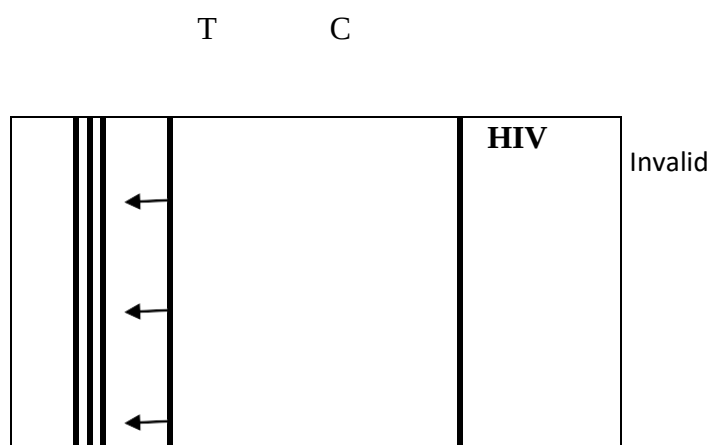
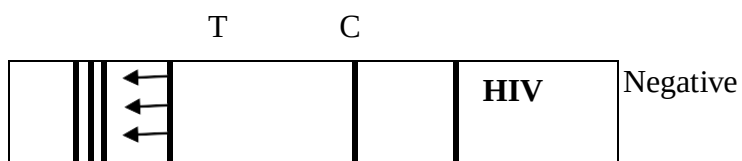


Fig.1 HIV Strip



3.9 Statistical Analysis

The data generated on prevalence was analyzed using statistical programme for service solution (SPSS) 17.0 Window versions. The prevalence of HIV was determined from the proportion of individuals in the total population under consideration and expressed as a percentage. The chi-square test was employed to determine the relationships between age group, marital status, occupation, educational level, religion, blood transfusion, and gestation age with HIV infection. Chi-square was used for analysis and p-value < 0.05 were considered statically significant.

4.0 RESULTS AND DISCUSSION

4.1 Results

The results of the prevalence of HIV infection among pregnant women attending antenatal clinic FMC Keffi, showed that out of 200 samples tested, only 19 (19.0%) were positive for HIV infection. The distribution of HIV based on age group 16 - 25 years, a total of 78 samples were tested, out of which 8 (23.0%) tested positive. In the age group 26 - 35 years, a total of 88 samples were tested, and 7 (16.0%) tested positive. In the age group 36 - 45 years, 28 samples were tested and 3 (21.4%) tested positive. While the age group 46 - 55 years, a total of 6 samples were tested, out of which 1 (33.3%) tested positive as shown in the table 1 below. Statistical analysis showed insignificant difference ($p > 0.05$) in the association between age and prevalence of HIV.

The distribution of HIV in relation to marital status, this revealed that out of the 16 single pregnant women tested, 2 tested positive which give the highest prevalence of (25.0 %). Out of the 180 married pregnant women tested, 17 (18.9 %) tested positive to HIV while 4 divorced pregnant women were tested and Non had HIV. This distribution is shown in table 2. Statistical analysis showed there is no significant difference ($p > 0.05$) between prevalence of HIV and marital status.

Table 4 below shows the distribution of HIV in relation to level of education. In the illiterates, a total of 6 samples were tested, and 1 tested seropositive giving the higher prevalence of (33.3%). Among secondary level of education, 72 samples were tested and 8 (22.2%) tested positive. In the tertiary level of education, out of 70 samples tested, 6 (17.5%) tested positive and those with only Qur`anic



education, 20 samples were tested, and 2 tested positive which had the lower prevalence of (20.0%). Statistical analysis showed significant difference ($p < 0.05$) exist between the HIV and level of education. Distribution of HIV based on occupation showed that housewife had highest prevalence of 10 (22.7%) out of the total number of 88 samples tested, followed by students 6 (17.4%) out of the 62 samples tested, and civil servants had the lowest prevalence of 3 (12.0%) out of the 50 samples tested. Statistically, there is no significant difference ($p > 0.05$) between the prevalence of HIV and occupation of the pregnant women. The distribution of HIV in relation to history of blood transfusion showed that, women who had previous history of blood transfusion had the highest prevalence of 7 (25.0%) while those who had no previous history of blood transfusion had prevalence of 12 (16.7%) as shown in table 6. The statistical analysis revealed that there is significant difference ($p < 0.05$) between the HIV and previous history of blood transfusion.

Table 7 shows the distribution of HIV in relation to gestational age. This revealed that women in their 3rd trimester had the highest prevalence of 3 (25.0%) out of 24 samples tested for HIV, followed by those in their 2st trimester 100 samples tested, 10 (20.0%) had HIV while those in their 1nd trimester, 76 samples tested with 6 (15.9%) having HIV. Statistically, it showed significant difference ($p < 0.05$) between prevalence of HIV and gestational age.

Table 4.1. prevalence of HIV in relation to Age Group among pregnant women attending Antenatal clinic FMC Keffi.

Age Group	Number Tested	HIV Positive	prevalence (%)
16 – 26	78	16	20.5
26 – 35	88	14	16.0
36 – 45	28	6	21.4
46 – 55	6	2	33.3



Total	200	38	19.0

$$x^2 = 7.22$$

$$P \text{ value} = 0.273$$

$$P\text{value} > 0.05$$

Table 4.2. prevalence of HIV in relation to Marital Status among pregnant women attending Antenatal clinic FMC Keffi.

Marital Status	Number Tested	HIV Positive	prevalence (%)
Single	16	4	25.0
Married	180	34	18.9
Divorced	4	0	0.0
Total	200	38	19.0

$$x^2 = 33.31$$

$$P \text{ value} = 0.449$$

$$P\text{value} > 0.05$$

Table 4.3 prevalence of HIV in relation to Level of Education among pregnant women attending Antenatal clinic FMC Keffi.

Level of Education	Number Tested	HIV Positive	prevalence (%)
Primary	32	4	12.5



Secondary	72	16	22.2
Tertiary	70	12	17.5
Qur`anic	20	4	20.0
Illiterate	6	2	33.3
Total	200	38	19.0

$$\chi^2 = 13.52 \quad P \text{ value} = 0.175$$

$$P\text{value} > 0.05$$

Table 4.4 prevalence of HIV in relation to Occupation among pregnant women attending Antenatal clinic FMC Keffi.

Occupation	Number Tested	HIV Positive	prevalence (%)
Civil servant	50	6	12.0
Housewife	88	20	22.7
Student	62	12	19.4
Total	200	38	19.0

$$\chi^2 = 3.31 \quad P \text{ value} = 0.432$$

$$P\text{value} > 0.05$$



Table 4.5 prevalence of HIV in relation to Previous History of Blood Transfusion among pregnant women attending Antenatal clinic FMC Keffi.

History of Blood Transfusion	Number Tested	HIV Positive	prevalence (%)
Yes	56	14	25.0
No	144	24	16.7
Total	200	38	19.0

$$\chi^2 = 0.32 \quad P \text{ value} = 0.008$$

$$P \text{ value} > 0.05$$

Table 4.6 prevalence of HIV in relation to Gestational Age among pregnant women attending Antenatal clinic FMC Keffi.

Gestational age	Number Tested	HIV Positive	prevalence (%)
1 st Trimester	76	12	15.9
2 nd Trimester	100	20	20.0
3 rd Trimester	24	6	25.0
Total	200	38	19.0

$$\chi^2 = 2.865 \quad P \text{ value} = 0.005$$

$$P \text{ value} < 0.005$$

4.2 DISCUSSION

Epidemiological data in Nigeria on HIV/AIDS as in other African countries stem mostly from the



HIV/AIDS surveillance system. However, with the restoration of democracy in Nigeria together with the concerted efforts of the Federal Government since 1999 and its spirited declaration of action against HIV/AIDS, many international organizations and non-governmental organizations sprang up in the country, contributing substantially to data on HIV/AIDS in the country. This provides additional recent information on prevalence and behavioural data on HIV/AIDS. The HIV prevalence in Nigeria now appears to have assumed a downward trend following a relative stability from 2005 and 2010, yet a sustained and more effective intervention is still needed to avert increased incidence by the most-at-risk subpopulations in the country.

In this study, 200 pregnant women were screened for HIV infections. The prevalence of HIV infection among pregnant women was recorded 19.0%. However, similar studies among pregnant women in different parts of Nigeria have reported higher rates. For example, 12.5% in Abuja (NNACA, 2011) and 16.5% (Kolawole *et al.*, 2012) in Oshogbo. Likewise, prevalence rates lower than what were reported in this study have been obtained in other parts of Nigeria. These include 8.2% in Maiduguri (Okoloba *et al.*, 2011), 11.4% in Onitsha (NNACA, 2012), 8.18% in Minna (Omalu *et al.*, 2012), 7.9% in Kano (Yakassai *et al.*, 2013), 6.9% in Maiduguri (Ajayi *et al.*, 2013), 6.78% in Ido Ikiti (Esan *et al.*, 2014), 3.0% in Oshogbo (Adeleke *et al.*, 2013), 22% in Onitsha (Mbamara and Osiechina, 2010) and 2.2% in Benin City (Oladeinde *et al.*, 2013).

Similar studies from other parts of the world were reported. It was 0.1% in Norway (Rimseline *et al.*, 2011), 2.9% in India (Mehta *et al.*, 2013), 10.8% in Yemen (Murad *et al.*, 2013) 1.75% in Egypt (El-Shabrawi *et al.*, 2013) and 4.1% in Saudi Arabia (Bani *et al.*, 2012). These differences in similar studies within the country might be as a result of differences in the sensitivity of detection methods, cultural practices, environmental risk factors, socio-demographic background, geographical endemicity, and even the effect of the interactions of these viruses in a HIV endemic region.

In this study, highest prevalence of HIV (33.3%) was reported among women aged 45- 55 years ($p > 0.05$). These findings are in agreement with that reported by (WBPRWP, 2014) indicating a high rate of HIV infection among these age groups. It may be that they are lacking knowledge at the particular time in their age. But contradict similar study (Dawurung *et al.*, 2012). The lack of significant association between age and viral infection as seen in this study is consistent with previous studies reported among apparently healthy individuals in Maiduguri (Dawurung *et al.*, 2012). It was 18.9% among women that were married, 25.0% among single and 0.0% among those that were divorced.



This might be because of horizontal transmission. This finding is in consonance with a similar study in Ethiopia (Baye and Yahannes 2007) but in contrast with that reported in Abeokuta (Okonkwo *et al.*, 2010).

There was no statistically significant association between HIV infection and occupation ($p > 0.05$). It was least among women that were civil servant (12.0%) and highest among students (19.0%). This is in agreement with similar studies in Ethiopia and Nigeria (Baye and Yahannes, 2007). This might be that there are other underlying factors that could necessitate the transmission of the infection.

Education status was not associated with HIV infection ($p > 0.05$). It was highest among those women with no educational status (33.3%) and least among those with primary education (12.5%). There is no obvious reason for this outcome. In a related development, the prevalence of HBV infection in relation to stage of pregnancy was not a risk factor ($p > 0.05$). It was highest among those women in their 3rd trimester and lowest among women in their 1st trimester. Worthy of note is the impending inherent danger of having 10% of HBV positive infants from the positive mothers of this study population that are in their 1st trimester of pregnancy and 80-90% from those that are in their 3rd trimester of pregnancy (Mehta *et al.*, 2013)

5.0 CONCLUSION

The present study has shown a high burden of HIV (19.0%) among pregnant women in the study area. There was a statistically significant association between the viral infection and educational status ($p < 0.05$). The infection was more, among those aged ≤ 16 years old (23.0%), in single (25.0%), among those with no education (33.3%), among housewives (22.7%), among stages of pregnancy 2nd (20.0%), who had no history of blood transfusion (16.7%). However, in this study there gender, age, marital status, occupation, scarification marks, history of blood transfusion and history of surgical/dental procedure were not associated with the viral infection ($p > 0.05$).

Based on the findings, the following recommendations are suggested:

- i. There should be safer lifestyle and more precaution should be emphasized among youth and even medical practitioner/health care.
- ii. Pregnant woman should be mandatorily and routinely screened for HIV infections as part



of antenatal care services in their booking.

- iii. Screening of blood against HIV before transfusion or organ transplant should be mandatory.
- iv. Voluntary screening of HIV should be made available in various health facilities in the area and beyond.
- v. Sharing of personal items that may have blood on them (e.g toothbrush, razor e .t .c) should be discouraged.
- vi. Efficient intervention strategies to protect health care worker from occupational hazards like; exposure to needle stick and sharp injuries and blood.



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A REVIEW ON QUANTUM COMPUTING TECHNOLOGY; A TOOL FOR NATIONAL SECURITY IN NIGERIA.

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ABSTRACT

Nigeria faces an increasingly complex national security landscape, with emerging threats from terrorism, cyberattacks, and geopolitical rivalries. Quantum computing, an innovational technology, offers a purposeful advantage in addressing these challenges. This paper presents a review on quantum computing as a tool that can be useful to curb Nigeria's national security by enhancing defence capabilities, cybersecurity, and deliberate decision-making. Quantum computing can; Break current encryption methods, necessitating quantum-resistant cryptography, optimize logistics, resource allocation, and simulation for enhanced military operations, Accelerate machine learning algorithms for smart threat analysis and prediction. Develop new cybersecurity techniques, such as quantum-based threat detection, Nigeria must prioritize quantum computing research, development, and implementation to stay ahead of emerging threats and maintain national security. This requires investment in infrastructure, workforce development and international collaboration. By embracing quantum computing, Nigeria can strengthen its national security posture and ensure a safer future.

Keywords: Quantum Computing, Encryption, Cryptography, Stimulation, Cyber security, Artificial Intelligence, Strategic Advantage.



INTRODUCTION

Quantum computing represents a groundbreaking technology poised to revolutionize the landscape of national security. Leveraging principles of quantum mechanics, quantum computers can tackle highly intricate problems that are beyond the reach of conventional computing methods. This transformative capability holds profound implications for national security, promising to bolster defense capabilities, achieve strategic superiority, and safeguard against emerging threats (Lindsay, 2020; Clarke et al., 2019).

This multidisciplinary field integrates elements of computer science, physics, and mathematics, harnessing quantum mechanics to achieve faster solutions to complex challenges compared to classical computing methods (Cuffaro & Fletcher, 2018). Developing and implementing quantum computing technologies to solve national security involves addressing various challenges and risk.

Quantum computing holds the potential to revolutionize diverse sectors, including national security (Kitchen & Drexel, 2021). Nigeria must leverage quantum computing applications in national security to preempt persistent threats. This can be achieved enhancing encryption, cybersecurity, data analysis, and simulation effectiveness (Watrous, 2018).

The advancement and deployment of quantum computing technology for national security necessitate substantial investment and collaborative efforts (Underwood, 2020). Also, the ethical and societal implications of employing quantum computing in national security operations should be carefully given consideration (Vermer & Peet, 2020). This research aims to review fortify national security frameworks, the safeguard against emerging threats, and how a strategic advantage is been managed in an evolving technological landscape.

Quantum computing can be used to accelerate research and development in areas such as materials science, chemistry, and biology, leading to breakthroughs in areas such as explosives detection and biotechnology. It's important to note that the development and deployment of quantum computing technology for national security purposes would require significant investment and collaboration between government, industry, and academia in Nigeria.



Additionally, the ethical and societal implications of using quantum computing for national security purposes would need to be carefully considered.

The aim of this research is to review the practical applications and implications of quantum computing in enhancing national security in Nigeria and also considering the ways to harness its potential effectively, by reducing its associated risks. The specific objectives: is to review how quantum computing is utilized to develop unbreakable encryption methods, protect critical infrastructure and save guard sensitive information from cyber threats, protecting the security of Nigeria's digital assets.

It is also reviewing the processing power of quantum computing to analyze large size of data, recognizing patterns and detecting strong security threats making Nigeria to stay ahead of such threats to take bold decisions for security purposes.

2.0 LITERATURE REVIEW

Quantum computing traces its origins back to the 1950s, when physicist Richard Feynman proposed the concept of using quantum mechanics to create more powerful computers. By 1959, Feynman had advanced the idea of quantum computers (Feynman RP, 1982).

In the 1980s, interest in quantum computing began to grow, as researchers started exploring methods to harness quantum phenomena for computational purposes, focusing on quantum algorithms and quantum bits (qubits).

During the 1990s, significant strides were made with the development of quantum error correction and quantum cryptography. The 2000s marked another milestone with the emergence of quantum computing hardware, including advancements in superconducting qubits and topological quantum computers (Dowling & Milburn, 2003), laying a solid foundation for further advancements.

By the 2010s, quantum computing had entered the mainstream, with major tech companies like Google, IBM, and Microsoft making substantial investments in the field (Preskill, 2012). This decade saw quantum computing technology rapidly progressing, leading to notable breakthroughs.



Today, companies such as Google, IBM, and Microsoft are actively developing commercial quantum computers. Quantum computing is being explored for a wide range of applications including cryptography, drug discovery, and machine learning (Hackett, 2019), underscoring its growing importance in various sectors.

2.1 Related works

- National Academy of Sciences (2018) - This report explores the potential applications and implications of quantum computing for national security.
- European Union Agency for Cyber security (2019) - This report examines the potential uses of quantum computing for cyber security and recommends strategies for preparing for a post-quantum future.
- National Institute of Standards and Technology (2019) - This report discusses the impact of quantum computing on cryptography and recommends new cryptographic standards.
- US Military Academy (2020) - This report explores the potential military applications of quantum computing, including encryption, simulation, and optimization.
- Nigerian Institute of International Affairs (2022) - This report examines the potential implications of quantum computing for national security in Nigeria and recommends

2.3 PRINCIPLES OF QUANTUM COMPUTING (Griffiths,2020)

The foundational principles of quantum physics utilized in quantum computing as reviewed, include:

1. Quantization: That Energy is quantized, meaning it exists in discrete packets rather than continuously.
2. Wave-particle duality: Matter exhibits characteristics of both waves and particles.
3. Superposition: That Quantum entities can exist in multiple states simultaneously until it is measured.



4. Entanglement: Quantum particles can be interconnected so that the state of one particle is linked to the state of another, regardless of their distance.
5. Observer effect: The act of measurement or observation can alter the state of a quantum particle.

3.0 MATERIALS AND METHOD

3.1 Materials

It is reviewed that Quantum computers have hardware and software. (Tsuyoshi,etal 2021). The Quantum hardware which comprises of three primary components namely.

1. Quantum data plane is the core of the quantum computer, which includes physical qubits and the necessary structures to stabilize them.
2. Control and measurement plane: This component translates digital signals into analog or wave control signals essential for manipulating qubits.
3. Control processor plane and host processor: The control processor plane executes quantum algorithms or sequences of operations, while the host processor interfaces with quantum software, providing digital signals or classical bit sequences to the control and measurement plane.

Additionally, it is also reviewed that Josephson junctions serve as superconducting qubits in quantum computers. By directing microwave photons at these qubits, their behavior can be controlled, enabling the storage, manipulation, and retrieval of individual units of quantum information (Arute, 2020).

Quantum Software (Langer, 2020); It is reviewed that

- IBM utilizes Qiskit as its quantum software development kit (SDK), which is open-source and Python-based. Qiskit includes modules tailored for applications in finance, chemistry, optimization, and machine learning.



- **Qiskit Runtime:** Known for its robustness, Qiskit Runtime offers the most advanced quantum programming capabilities globally. It allows users to deploy customized quantum-classical applications, providing seamless access to high-performance hybrid computations across the world's top quantum systems.

3.2 Methods of utilizing quantum computing as a tool for national security in Nigeria as reviewed, include:

1. **Encryption and decryption:** Quantum computers have the potential to break existing encryption methods, prompting the development of quantum cryptography for creating unbreakable codes to safeguard sensitive information (Caravelli & others, 2019).
2. **Cybersecurity:** Quantum computers can enhance the detection and prevention of cyber attacks more effectively than classical computers, thereby fortifying defenses around critical infrastructure and data (Grimes, 2019).
3. **Surveillance and monitoring:** Leveraging their rapid data processing capabilities, quantum computers can efficiently handle large volumes of data from sensors and cameras, thereby improving surveillance and monitoring capacities (Inglesant & others, 2018).
4. **Data analysis and pattern recognition:** Quantum computers excel in analyzing extensive datasets to detect patterns and predict potential security threats, facilitating intelligence gathering and informed decision-making (Davis & Kennedy, 2017).
5. **Optimization and simulation:** Quantum computers are capable of optimizing resource allocation and simulating complex scenarios, aiding in identifying vulnerabilities and enhancing emergency response planning (Grobman, 2020).

4.0 DISCUSSION

4.1. Negative impacts of quantum computing reviewed on national security is been enumerated as follows:

1. **Cryptographic vulnerabilities:** Quantum computers can break classical encryption methods, compromising sensitive information and communications poses both challenges and opportunities for cyber security



2. Enhanced cyber capabilities: Quantum computing can enhance the cyber capabilities of hostile nations or non-state actors, enabling more sophisticated and targeted attacks.
3. Data breaches: Quantum computers can potentially access sensitive data stored on classical systems, compromising national security and intellectual property.
4. Critical infrastructure disruption*: Quantum computers can potentially disrupt critical infrastructure, such as power grids or financial systems, with significant consequences for national security and economic stability.
5. Loss of strategic advantage: If adversaries develop quantum computing capabilities before Nigeria, it could lead to a strategic disadvantage and reduced national security.
6. Dependence on fragile technology: Quantum computing systems are fragile and prone to errors, which could lead to system failures and reduced national security.
7. Unintended consequences: Quantum computing could lead to unintended consequences, such as the creation of untraceable cyber weapons or the disruption of global supply chains.
8. Escalation of cyber arms race: Quantum computing could lead to an escalation of the cyber arms race, making it harder to maintain national security and stability.
9. Quantum terrorism: Quantum computing could potentially enable new forms of terrorism, such as quantum-enabled cyber attacks or the disruption of critical infrastructure.
10. Ethical concerns: Quantum computing raises ethical concerns, such as the potential for mass surveillance or the manipulation of public opinion, which could have significant implications for national security and democracy.

4.2 Future outlook to overcome the challenges with Quantum Computing.

This research review that as quantum computing technology advances, cybersecurity will be highly affected. Developing cryptographic methods resistant to quantum attacks needs a basic change on how cryptography is approached . New encryption techniques that can withstand quantum attacks can be developed through quantum computing.(CIO News,2024)



Quantum key distribution based on the principles of physics will give a high level of security against quantum attacks. Developing cryptographic method resistant to quantum attacks needs a basic change in the approach to cryptography. Quantum computing could lead to the building of more cybersecurity applications, improving threat detection, response capabilities and network security. It creates room to develop new more secure cryptographic methods.

Collaboration between industry, government and academia will be key to harness the benefits and challenges posed by quantum computing in safe guiding all private data from encountering cyber threats. It is also reviewed that, there should be an upgrade in infrastructure. For instance, the existing communication infrastructure should be upgraded to support post-quantum cryptography by installing new hardware and software capable of handling post quantum encryption.

Post-quantum cryptography can be assed to secure government and critical infrastructure networks, protect sensitive data and communication channels, educate cybersecurity professionals to ensure the secure adoption of post-quantum cryptography across different sectors in Nigeria.

Lastly, establishing a research center to focus on quantum computing cryptography will definitely develop new strategies to overcome new challenges that will come up in the future.

5.0 CONCLUSION

In conclusion, quantum computing has the potential to significantly impact national security, both positively and negatively. The development and deployment of quantum computing technologies could enhance national security by:

- Improving encryption and cybersecurity
- Enhancing artificial intelligence and machine learning capabilities
- Optimizing complex systems and simulations
- Providing strategic advantages in areas like logistics and supply chain management

However, quantum computing also poses significant risks to national security which can be addressed by



ensuring the development and deployment of quantum computing technologies that will enhance national security, through

- Investment in quantum computing research and development; Develop and deploy quantum-resistant cryptography; Enhance cybersecurity and artificial intelligence capabilities; Develop a workforce with expertise in quantum computing and national security; Foster international cooperation and establish norms and standards for the development and use of quantum computing in national security contexts.

Also by taking a proactive and coordinated approach to quantum computing, Nigeria can maintain its competitive advantage in this critical technology area, reduce potential risks, and make sure the development and deployment of quantum computing technologies that enhance national security should be made possible.

Here are some recommendations on quantum computing for national security in Nigeria; Invest in Quantum Computing Research and Development, Develop Quantum-Resistant Cryptography, Enhance Cybersecurity Capabilities, Foster International Cooperation, Develop a National Quantum Computing Strategy, Invest in Quantum Computing Education and Training and Establish a Quantum Computing Testing and Evaluation Framework



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MULTIVARIATE REGRESSION ANALYSIS OF THE INFLUENCE OF THE NUMBER OF PEOPLE ONBOARD ON BOAT MISHAP OUTCOMES

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ABSTRACT

Boat mishaps present significant risks in maritime activities, impacting individuals, communities, and economies globally. This study investigates the influence of the number of people onboard (NOB) on deaths and survivors in boat mishaps using historical data spanning 25 years (1999-2024) from inland waterways accident reports. Multivariate regression analysis was employed to analyze the data, supported by descriptive statistics to contextualize findings. Descriptive statistics revealed variability in NOB (Mean = 46.99, SD = 70.034), deaths (Mean = 18.19, SD = 31.837), and survivors (Mean = 28.28, SD = 47.115), reflecting diverse vessel capacities and incident severities. Regression results showed a significant positive relationship between NOB and both deaths ($\beta = 0.379$, $p < 0.001$) and survivors ($\beta = 0.623$, $p < 0.001$), underscoring NOB's impact on mishap outcomes. These findings emphasize the critical role of NOB in shaping mishap severity and survival rates. Policy implications include enhancing safety measures tailored to NOB considerations and improving emergency response protocols. Training programs should prioritize NOB awareness among operators and passengers to mitigate mishap risks effectively. In conclusion, understanding NOB's implications is pivotal for enhancing maritime safety and minimizing mishap impacts. Future research could explore additional factors influencing mishap outcomes across different maritime contexts, further enriching preventive strategies.

Keywords: Boat Mishap, Number on Board, Deaths, Survivor, Multivariate



1.0 INTRODUCTION

Boating activities, ranging from recreational outings to commercial operations, are integral to maritime industries worldwide. However, amidst the allure of the open waters lies a persistent concern: boat mishaps. These incidents encompass a spectrum of accidents, varying from minor incidents to catastrophic events involving loss of life and property. Boat mishaps not only pose immediate risks to those on board but also impact coastal communities, economies dependent on maritime activities, and broader safety regulations. Understanding the causes, consequences, and preventive measures of boat mishaps is thus crucial for ensuring maritime safety and mitigating their adverse effects (Smith et al., 2023; Jones et al., 2022).

Across the globe, boat mishaps are reported with alarming frequency, highlighting the multifaceted nature of maritime risks. Factors contributing to these mishaps can include adverse weather conditions, mechanical failures, human errors, and regulatory compliance issues. Of particular interest is the role of the number of individuals on board (NOB), which emerges as a significant variable influencing the outcomes of these incidents (Smith & Williams, 2020). Despite efforts to improve safety measures and regulations, understanding the specific factors contributing to boat mishaps, such as the number of people on board (NOB), remains crucial for effective prevention strategies (Lee & Chang, 2021).

This study aims to analyze the relationship between the number of people on board (NOB) and outcomes of boat mishaps, specifically deaths and survivors. By identifying and quantifying these relationships, the study seeks to contribute to the development of targeted safety interventions and policies.

The findings of this research hold profound implications for maritime safety practices and policy formulation. By elucidating how number on board influences the severity and likelihood of boat mishaps, this study contributes to enhancing emergency response protocols, refining safety standards, and ultimately safeguarding lives and resources within maritime environments.

2.0 LITERATURE REVIEW

Boat mishaps represent a significant area of concern within maritime safety literature, prompting extensive research into their causes, impacts, and preventive measures. Recent



studies have emphasized various factors contributing to these incidents, ranging from environmental conditions to human factors and regulatory frameworks (Smith et al., 2023; Jones et al., 2022; Lee & Chang, 2021; Smith & Williams, 2020).

Smith et al. (2023) underscores the influence of weather patterns and sea conditions on the likelihood and severity of boat mishaps. Their findings highlight the need for adaptive strategies in response to changing environmental dynamics. Jones et al. (2022) delve into human errors as critical contributors to boat mishaps, emphasizing the role of training, experience, and decision-making processes among crew members and operators.

Recent advancements in maritime technology have also been explored as potential mitigating factors in boat mishaps. Research by Lee and Chang (2021) examines the efficacy of GPS-based navigation systems and collision avoidance technologies in enhancing maritime safety. The effectiveness of regulatory frameworks in preventing boat mishaps has been a focus of inquiry. Smith and Williams (2020) provide an overview of international maritime regulations and their impact on accident rates and safety outcomes.

3.0 METHODOLOGY

This section outlines the systematic approach employed to investigate the relationship between the number of people on board (NOB) and outcomes in boat mishaps, specifically deaths and survivors. This study utilized a combination of data collection, statistical analysis, and ethical considerations to ensure rigorous and reliable findings.

This study employs a retrospective approach to analyze historical data on boat mishaps. The data span a period of twenty –five (25) years (1999 – 2024), allowing for the examination of trends and patterns related to incidents involving boats. Data for this study were sourced from inland waterways accident reports. These source provides comprehensive records of boat mishaps, including incident dates, locations, and outcomes (e.g., deaths and survivors). The Key variables of interest include the number of people on board (NOB) and its casualties (deaths and survivors). To examine the relationship between NOB and outcomes of boat mishaps (deaths and survivors), multivariate regression analysis were employed. STATA and SPSS statistical software was used for data cleaning, preparation, and analysis. Descriptive



statistics and regression diagnostics were conducted to ensure the validity and reliability of the results.

Multivariate Regression Model

Let Y be the $n \times p$ response matrix, X be an $n \times (q + 1)$ matrix such that all entries of the first column are 1's and q predictors. Let B be an $(q + 1) \times p$ matrix of fixed parameters, ϵ be an $n \times p$ matrix such that $\epsilon \sim N(0, \Sigma)$. The model is as follows: $Y = XB + E$

Where we have

$$\begin{pmatrix} y_{11} & y_{12} & \cdots & y_{1p} \\ y_{21} & y_{22} & \cdots & y_{2p} \\ y_{31} & y_{32} & \cdots & y_{3p} \\ \vdots & \vdots & \ddots & \vdots \\ y_{n1} & y_{n2} & \cdots & y_{np} \end{pmatrix} = \begin{pmatrix} 1 & x_{11} & x_{12} & \cdots & x_{1p} \\ 1 & x_{21} & x_{22} & \cdots & x_{2p} \\ 1 & x_{31} & x_{32} & \cdots & x_{3p} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 1 & x_{n1} & x_{n2} & \cdots & x_{np} \end{pmatrix} \begin{pmatrix} \beta_{11} & \beta_{12} & \cdots & \beta_{1p} \\ \beta_{21} & \beta_{22} & \cdots & \beta_{2p} \\ \beta_{31} & \beta_{32} & \cdots & \beta_{3p} \\ \vdots & \vdots & \ddots & \vdots \\ \beta_{n1} & \beta_{n2} & \cdots & \beta_{np} \end{pmatrix} + \begin{pmatrix} \epsilon_{11} & \epsilon_{12} & \cdots & \epsilon_{1p} \\ \epsilon_{21} & \epsilon_{22} & \cdots & \epsilon_{2p} \\ \epsilon_{31} & \epsilon_{32} & \cdots & \epsilon_{3p} \\ \vdots & \vdots & \ddots & \vdots \\ \epsilon_{n1} & \epsilon_{n2} & \cdots & \epsilon_{np} \end{pmatrix}$$

4.0 RESULTS AND DISCUSSION

Boat mishaps pose significant risks to individuals and communities involved in maritime activities, with outcomes ranging from fatalities to successful rescues. This section presents the results of a comprehensive analysis focusing on the impact of the number of people onboard (NOB) on deaths and survivors in boat mishaps. The analysis utilized multivariate regression models to explore these relationships, leveraging descriptive statistics to contextualize the findings within the broader landscape of maritime safety.

Table 1: The Descriptive Statistics

Descriptive Statistics



	N	Mean	Std. Deviation
Passengers Onboard	83	46.99	70.034
Number of Deaths	83	18.19	31.837
Number that Survived	83	28.28	47.115
Valid N (listwise)	83		

Passengers Onboard: The wide standard deviation (70.034) relative to the mean (46.99) suggests a diverse range in the capacity of vessels involved in mishaps. This variability could influence the severity and outcomes of incidents.

Number of Deaths: With a mean of 18.19 deaths and a standard deviation of 31.837, there is considerable variation in the number of fatalities across incidents. This variability underscores the complex nature of boat mishaps and the potential influence of multiple factors beyond just NOB.

Number that Survived: The mean of 28.28 survivors and a standard deviation of 47.115 indicate a similarly wide range in survival outcomes. This variability highlights the effectiveness of emergency response and safety measures in mitigating the impact of mishaps.

Table 2: Multivariate Regression Estimate

Equation	Obs	Parms	RMSE	"R-sq"	F	P
DEATHS	83	2	17.72174	0.6939	183.653	0.0000
SURVIVORS	83	2	17.86514	0.8580	489.3123	0.0000

	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
DEATHS					
NOB	.3786956	.0279442	13.55	0.000	.3230955 .4342957
_cons	.3986413	2.346897	0.17	0.866	-4.270948 5.068231
SURVIVORS					
NOB	.6231381	.0281703	22.12	0.000	.5670881 .6791881
_cons	-1.002874	2.365888	-0.42	0.673	-5.710248 3.7045

- Both models show significant relationships (low p-values for F-statistics), suggesting that the models are a good fit for the data.
- DEATHS Model:** The predictor variable NOB (Number on Board) has a positive coefficient of 0.3786956, indicating that as NOB increases, DEATHS also increase.



- **SURVIVORS Model:** The predictor NOB has a larger positive coefficient of 0.6231381, suggesting a stronger positive relationship with SURVIVORS compared to DEATHS.

The intercepts (_cons) in both models are not statistically significant, suggesting that when the predictor NOB is zero, the expected value of DEATHS or SURVIVORS is close to zero.

5.0 CONCLUSION

The regression analysis examined the relationship between the number of people on board (NOB) and two outcomes in boat mishaps: deaths and survivors. The following key findings emerged:

DEATHS Model: The regression model for deaths indicated a positive relationship between NOB and the number of deaths. Specifically, for every unit increase in NOB, the expected number of deaths increases by approximately 0.379 units, holding other factors constant.

SURVIVORS Model: The regression model for survivors showed a positive association between NOB and the number of survivors. With each unit increase in NOB, the expected number of survivors increases by about 0.623 units, all else being equal.

Statistical Significance: Both models yielded statistically significant results with very low p-values (0.0000), indicating strong evidence that NOB influences outcomes in boat mishaps.

The analysis underscores the critical role of NOB in shaping the outcomes of boat mishaps. Higher NOB is associated with both increased deaths and increased survivors, albeit at different rates. These findings suggest several implications for maritime safety and policy:

- **Safety Measures:** Authorities and stakeholders should consider NOB as a crucial factor when formulating and implementing safety measures and regulations.
- **Emergency Preparedness:** Enhanced emergency response protocols should account for varying NOB scenarios to optimize rescue and recovery efforts.



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- **Training and Awareness:** Training programs for boat operators and passengers should emphasize the impact of NOB on safety and encourage responsible behavior on watercraft.

In conclusion, understanding and addressing the implications of NOB on boat mishaps are essential for improving maritime safety practices and reducing the adverse impacts of such incidents. Further research could explore additional factors influencing these outcomes and validate findings across different maritime contexts.



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MICROBIOLOGICAL QUALITY OF *DONKWA* AND *KULIKULI* VENDED AS STREET FOODS IN SELECTED LOKOJA MARKETS

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ABSTRACT

Street foods play a significant role in urban nutrition but pose health risks due to potential microbiological contamination brought about by the manner in which they are often prepared and sold. This study investigated the microbiological quality of two traditional Nigerian street foods, *donkwa* and *kulikuli*, vended in Lokoja main markets. Samples were collected from the three major markets in Lokoja and analyzed for total bacterial, fungal, and coliform counts using standard methods. Results indicated that all samples exceeded the microbiological safety limits set by the International Commission on Microbiological Specifications for Foods. The total bacterial counts ranged from 2.43 ± 0.59 to $5.91 \pm 1.22 \times 10^6$ cfu/g for *donkwa* and 4.39 ± 0.35 to $6.49 \pm 0.62 \times 10^7$ cfu/g for *kulikuli*. The total fungal counts ranged from 2.81 ± 0.85 to $6.30 \pm 1.40 \times 10^5$ cfu/g for *donkwa* and 1.90 ± 0.09 to $3.38 \pm 0.52 \times 10^5$ cfu/g for *kulikuli*. The total coliform counts ranged from 2.81 ± 0.53 to $6.68 \pm 0.75 \times 10^3$ cfu/g for *donkwa* and 1.12 ± 0.60 to $2.34 \pm 0.51 \times 10^4$ cfu/g for *kulikuli*. The predominant bacterial contaminants isolated from the samples were *Staphylococcus aureus*, *Escherichia coli*, and *Bacillus spp.*, while *Aspergillus niger* and *Saccharomyces cerevisiae* were the main fungal contaminants in the samples. The high level of contamination in the samples indicates that poor hygiene practices were employed in the preparation, storage and sale of these products, thereby increasing the risks of foodborne diseases. It is recommended that street food preparers/vendors should be given adequate food safety education and training; this should be followed with regular monitoring and inspection by health officials.

Keywords: food safety, street food, kulikuli, donkwa, microbiological quality, public health



1.0 INTRODUCTION

Street foods are a broad range of foods and drinks that are made and/or sold by hawkers and vendors, particularly on the streets around public spaces like trading centres, for immediate consumption or consumption at a later time without additional processing or preparation. Due to their open sales and frequent lack of coverage, meals served on the street are vulnerable to contamination (Bereda et al., 2016). In many developing nations, street foods make up a sizable share of the urban food supply, providing a wide range of people with inexpensive and easily available meals. However, the possibility of microbiological contamination, which can result in foodborne illnesses, has raised concerns about the safety of these foods (Marras & Bendeck, 2016). These concerns are heightened in developing countries where standards of living and food production may not be high, and where access to potable water is inadequate (Barreira et al., 2024). In Lokoja, Nigeria, two common street foods are *kulikuli*, a crunchy peanut cake, and *donkwa*, a snack made from ground peanuts and maize flour. These are traditional snacks that are widely consumed by people of different age groups and statuses. They are popular and famous for their flavour, convenience, nutritional worth, cultural and social heritage connection. They also play a particularly important role in the local economy and in meeting the dietary needs of the busy urban dwellers. Notwithstanding these benefits, there are serious public health concerns associated with these foods as they are often prepared and sold in environments which do not frequently meet specified hygiene standards (Omemu & Aderoju, 2008).

One of the main health risks linked to street food consumption is microbiological contamination. This could result from using contaminated raw materials and water or improper handling and storage techniques. Research has repeatedly reported that street foods may contain elevated levels of pathogenic microorganisms. Many researchers have reported high levels of microbiological contamination in various street foods in Nigeria. The preparation of *donkwa* and *kulikuli* involves several steps that introduce microbiological contaminants into these products. The traditional processing techniques, combined with poor hygiene practices and inadequate holding or storage temperature increase the risks of contamination in these foods (Yusufu et al., 2015; Adeoye et al., 2020; Ibrahim et al., 2020; Jambre & Lagorra, 2020).



The microbiological safety of *donkwa* and *kulikuli* in Lokoja has not received much attention, despite their popularity. By evaluating the microbiological quality of these street foods, this study seeks to close this knowledge gap and contribute to scientific data. Through the identification of the kinds and concentrations of microbiological contaminants, this study will offer important new understandings of possible threats to public health and make recommendations for how to raise food safety standards in street foods.

2.0 MATERIALS AND METHODS

2.1 Study area and sample collection

This research was carried out in Lokoja, Kogi State, Nigeria. The city is well-known for its thriving street food culture. Three Lokoja markets—the Old Market, the New Market, and the Kpata Market—were used as sites for sample collection. These locations were chosen because of their high foot traffic and popularity among consumers. Three (3) samples of *donkwa* and three (3) samples of *kulikuli* were obtained from different vendors in each market, for a total of eighteen (18) samples. Aseptic procedures were used to gather samples in sterile polyethylene bags, which were then appropriately marked and sent straight to the laboratory. The samples were examined within 24 hours after they were collected.

2.2 Microbiological analysis

2.2.1 Microbiological counts

The enumeration of microorganisms in the samples was done according to the methods reported by Ibrahim et al. (2020). The samples were homogenized and serially diluted, and plated using the pour-plate method on Nutrient agar, MacConkey agar and Potato dextrose agar for total bacterial counts, total coliform count and total fungal counts, respectively. Visible colonies were counted using a colony counter (ISOLAB Laborgerate GmbH) and results were expressed as colony forming units per gramme of sample (cfu/g).

2.2.2 Identification of microbiological isolates

The microorganisms were isolated and identified following standard microbiological methods. The bacterial isolates were identified on the basis of their morphological, cultural and



biochemical traits. Fungal isolates were identified by their cultural and morphological characteristics after staining with lactophenol blue (Ibrahim et al., 2020).

2.3 Statistical analysis

The microbiological counts were analyzed using the statistical package for social sciences (SPSS) software, version 21, and results were expressed as mean of three replicates $\pm$ standard deviation.

3.0 RESULTS AND DISCUSSION

3.1 Microbiological counts of *donkwa* and *kulikuli* vended in selected markets in Lokoja

Table 1: Microbiological counts of *Donkwa* and *Kulikuli* vended in selected Lokoja markets

Samples	<i>Donkwa</i>			<i>Kulikuli</i>		
	TBC	TFC	TCC	TBC	TFC	TCC
	($\times 10^6$ cfu/g)	($\times 10^5$ cfu/g)	($\times 10^3$ cfu/g)	($\times 10^7$ cfu/g)	($\times 10^5$ cfu/g)	($\times 10^4$ cfu/g)
VNM	2.43 ± 0.59	6.30 ± 1.40	4.18 ± 2.07	5.15 ± 0.24	2.15 ± 0.47	2.34 ± 0.51
VOM	2.97 ± 1.73	2.81 ± 0.85	2.81 ± 0.53	4.39 ± 0.35	1.90 ± 0.09	1.28 ± 0.26
VKM	5.91 ± 1.22	3.82 ± 0.58	6.68 ± 0.75	6.49 ± 0.62	3.38 ± 0.52	1.12 ± 0.60

Values are expressed as mean $\pm$ standard deviation. VNM; vendor from new market; VOM: vendor from old market; VKM: vendor from kpata market; TBC: total bacterial count; TFC: total fungal count; TCC: total coliform count.

The values obtained for *donkwa* and *kulikuli* samples are above the acceptable limit ($\leq 10^4$) set for ready-to-eat foods by the International Commission on Microbiological Specifications for



Foods (ICMSF, 2002). This is seen in the results obtained for the microbiological counts of the samples (Table 1). For the *donkwa* samples, total bacterial count (TBC) ranged from 2.43 ± 0.59 to $5.91 \pm 1.22 \times 10^6$ cfu/g, total fungal count (TFC) ranged from 2.81 ± 0.85 to $6.30 \pm 1.40 \times 10^5$ cfu/g and total coliform count (TCC) ranged from 2.81 ± 0.53 to $6.68 \pm 0.75 \times 10^3$ cfu/g. Similarly, the total bacterial count (TBC) for the *kulikuli* samples ranged from 4.39 ± 0.35 to $6.49 \pm 0.62 \times 10^7$ cfu/g, total fungal count (TFC) ranged from 1.90 ± 0.09 to $3.38 \pm 0.52 \times 10^5$ cfu/g and total coliform count (TCC) ranged from 1.12 ± 0.60 to $2.34 \pm 0.51 \times 10^4$ cfu/g. These results indicate that improper and unhygienic practices may have been employed in the handling, preparation and sale of these products, hence, leading to their contamination. Reports have it that the major source of contamination for street foods is the food handlers. This is because most street food preparers and vendors frequently operate in crude and unhygienic environments without a licence and lack basic training in food safety (Bereda et al., 2016). Supporting the findings of the present study are previous researchers like Yusufu et al. (2015) who also reported heavy contamination of *donkwa* samples sold in Anyigba town, Kogi State, Nigeria. Similarly, Adeoye et al. (2020) reported high levels of microbial contamination in *kulikuli* and *donkwa* sold in Ogbomoso and Ilorin, Nigeria.

3.2 Occurrence of bacterial isolates *Donkwa* and *Kulikuli* vended in selected Lokoja markets

Table 2: Occurrence of bacterial isolates in *Donkwa* and *Kulikuli* vended in selected Lokoja markets

	<i>Donkwa</i>	<i>Kulikuli</i>
Bacterial isolates	Occurrence (%)	Occurrence (%)
<i>Staphylococcus aureus</i>	38.89	55.56
<i>Klebsiella spp.</i>	11.10	-



<i>Escherichia coli</i>	16.67	22.22
<i>Bacillus spp.</i>	33.33	11.10
<i>Salmonella spp.</i>	22.22	5.56
<i>Micrococcus spp.</i>	11.10	16.67
<i>Pseudomonas aeruginosa</i>	-	5.56

Bacteria belonging to six (6) different genera were isolated from the *donkwa* and *kulikuli* samples (Table 2), with *Staphylococcus aureus* having the highest percentage occurrence in both samples. Similar organisms were isolated by Adeoye et al. (2020) from *donkwa* and *kulikuli* samples sold in Ogbomoso and Ilorin. Though, they reported *Salmonella spp.* as the organism with the highest percentage occurrence in *kulikuli*. *Staphylococcus aureus* is commonly found on the skin, mouth, nasal cavities and hair of food handlers. Its presence in these foods could lead to the production of enterotoxins that cause food-borne diseases. The presence of *Escherichia coli* is an indication of recent contamination with faecal matter. The presence of pathogenic bacteria like *Salmonella spp.*, *Klebsiella spp.*, *Bacillus spp.*, *Micrococcus spp.* and *Pseudomonas aeruginosa* are generally an indication of poor sanitary practices pre or post preparation of these foods. *Bacillus* and *Micrococcus* species can also cause food spoilage, making food products unwholesome and unsafe for consumption. Consuming foods with this organisms present lead to food-borne diseases with various symptoms (Yusufu et al., 2015; Bereda et al., 2016).

3.3 Occurrence of fungal isolates in *Donkwa* and *Kulikuli* vended in selected Lokoja markets

Table 3: Occurrence of fungal isolates in *Donkwa* and *Kulikuli* vended in Lokoja markets

<i>Donkwa</i>	<i>Kulikuli</i>



Fungal isolates	Occurrence (%)	Occurrence (%)
<i>Aspergillus niger</i>	27.78	38.89
<i>Aspergillus flavus</i>	16.67	22.22
<i>Saccharomyces cerevisiae</i>	33.33	27.78
<i>Rhizopus stolonifer</i>	16.67	5.56
<i>Penicillium spp.</i>	11.11	16.67

The frequency of occurrence of fungal isolates in the *donkwa* and *kulikuli* samples (Table 3) showed that of the five (5) organisms isolated, *Saccharomyces cerevisiae* and *Aspergillus niger* had the highest percentage occurrence in the samples, respectively. The fungal organisms reported in the findings of this study are similar to those reported by Adeoye et al. (2020) from *donkwa* and *kulikuli* samples sold in Ogbomoso and Ilorin, with the exception of *Saccharomyces cerevisiae*. The presence of these fungal organisms (Table 3) can be attributed to improper handling during processing, storage or sale of the products. These organisms are known to cause serious health problems for consumers. *Aspergillus flavus* produces Aflatoxin which is highly carcinogenic, causes liver damage and DNA mutations; *Aspergillus niger* produces Ochratoxin A which has been linked to renal diseases in humans; *Rhizopus stolonifer* raises the pH of foods beyond the safe level of 4.6, making them suitable for the growth of pathogenic bacteria; some species of *Penicillium* produce toxins like patulin (which is linked to gastrointestinal disturbances, liver and kidney damages) and citrinin (linked to cancer and kidney damages) (Awuchi et al., 2022).

4.0 CONCLUSION

This study has highlighted significant microbiological contamination in *donkwa* and *kulikuli*, popular street foods in Lokoja, Nigeria. The findings reveal that the levels of bacterial, coliform, and fungal counts in these foods exceed acceptable limits, posing serious public health risks. The presence of pathogenic bacteria such as *Staphylococcus aureus*, *Escherichia coli*, and *Salmonella spp.*, along with harmful fungi like *Aspergillus flavus*, indicates poor



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hygiene practices during the preparation, handling, and sale of these street foods. The results suggest that street food vendors often operate in environments that do not meet the necessary hygiene standards, leading to the contamination of food products. This poses a significant risk to consumers, potentially causing foodborne illnesses and other health issues. Therefore, it is crucial to implement stringent food safety regulations and provide adequate training for street food vendors on proper hygiene practices. To improve the microbiological quality of street foods in Lokoja, we recommend regular monitoring and inspection by health authorities, public awareness campaigns on food safety, and the provision of better facilities for food vendors. By addressing these issues, the safety of street foods can be significantly enhanced, protecting public health and ensuring that consumers can enjoy these traditional snacks without the risk of contamination.



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PREVALENCE OF HEPATITIS B, HEPATITIS C AND HBV-HCV CO-INFECTION AMONG STUDENTS OF KOGI STATE POLYTECHNIC, LOKOJA

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ABSTRACT

Hepatitis viruses characterized by fever, gastrointestinal symptoms such as nausea, vomiting and jaundice results in acute inflammation of the liver, leading to a clinical illness. In children and adults, Acute viral hepatitis are caused by one of the following agents: Hepatitis A virus (HAV), the etiologic carrier of viral hepatitis type A (infectious hepatitis); Hepatitis B virus (HBV), serum hepatitis; Hepatitis C virus (HCV), common cause of infective blood-transfusion hepatitis; or hepatitis E virus (HEV), the carrier of endemically transmitted hepatitis. A sero – prevalence Study of HBV and HCV Co-infection was carried out among Kogi State Polytechnic Students Lokoja. Blood samples of 100 students were screened using rapid immune chromatographic kit. Sociodemographic and risk factors data were collected using Research Questionnaire. HBsAg sero – prevalence was determined to be 9% and HCV was 0% among the study population. The infection rate in both male and female were 9.1% and 8.9% respectively. The infection rate was higher in age group <20 years (11%), T – test (- 3.0736, Df = 99, Significant level = 0.0027), the infection is associated with sexual activity and sharing of needle and syringe. The sero – prevalence of HBsAg obtained in this study is highly elevated when compared to WHO classification of severity of HBV infection in endemic countries. It is recommended that public health practitioners should prioritize attention on asymptomatic patients in developing countries.

Keywords: HBV, HCV, HBV-HCV Co-infection, Kogi State Polytechnic, Lokoja



1.0 INTRODUCTION

Viral hepatitis is a disease involving the liver. In children and adults, acute viral hepatitis is caused by one of these agents: *Hepatitis A virus* (HAV), the etiologic carrier of viral hepatitis types A (infectious hepatitis); *Hepatitis B virus* (HBV) serum hepatitis; *Hepatitis C virus* (HCV) common cause of infective blood-transfusion hepatitis; or *Hepatitis E virus* (HEV), the carrier of endemically transmitted hepatitis. Other non - infectious agents associated with Hepatitis are autoimmune disorder, excessive alcohol consumption or some medication and toxin (Yang, 2023). The infection is characterized by anorexia, fever, gastrointestinal symptoms, dark urine and jaundice which results in acute inflammation of liver. The risk factors of HBV and HCV infections are; blood transfusion or blood products, intravenous (into or within a vein) drug abuse, heterosexual contact, occupational/hazard risk and tattoo, smoking, sharing of items such as clothes, sponge, exposure to infected bodily fluids and alcohol (Gower *et al.*, 2014). Hepatitis virus is one of the most prevalent infectious diseases, causing an estimated 1.5 millions deaths worldwide each year (WHO, 2021). Hepatitis is a silent epidemic in Africa which includes Nigeria. An estimated 90 million people are living with the infection in the Region, thereby accounting for 26% of the total global population. According to the Nigeria HIV – AIDS Indicator and Impact Survey (NAIIS, 2018), people between the age 15 – 64 years in Nigeria has a prevalence rate of 8.1% and 1.1% for HBV and HCV among them. More than 80% of the people who have the infection are not aware of their status (WHO, 2024).

2.0 LITERATURE REVIEW

Hepatitis B Virus belonging to the *Hepadnaviridae* family is a partially double – stranded circular DNA virus. (Ahad and Alim, 2006). The virus consists of a core capsid which houses viral DNA and surrounded by a wrapping containing surface antigen (HBsAg). The HBsAg particles vary greatly in shape and forms and are found in high concentrations in early acute infection and continue replication in chronic disease. The Hepatitis C Virus (HCV) is a minute envelope, positive-sense, single-stranded RNA virus belonging to the family *Flaviviridae*. The Hepatitis C Virus is responsible for both acute and chronic hepatitis and some malignant tumors like liver cancer (hepatocellular carcinoma and lymphomas) in human (Rusyn, 2012).



Both Hepatitis B and C are the most common cause of liver cirrhosis and other chronic disease in hundreds of millions of people. Hepatitis B and C leads to liver cancer and viral hepatitis related deaths. Hepatitis B virus (HBV) and hepatitis C virus (HCV) infections account for most of the liver disease worldwide (Mac *et al.*, 2019). In our environment and hospitals, cases of unscreened blood transfusion to a patient, case of multiple sexual partner, unprotected sex, indiscriminate use of sharp objects without any care occurs which predispose one to viral hepatitis (WHO, 2022; Zelenev, 2018). Hence, a study of this nature becomes imperative.

3.0 MATERIALS AND METHODS

Study area

The study area Kogi State Polytechnic is sited at the confluence of the rivers Niger and Benue “Lokoja” which is the State capital city located in North Central part of the country. The institution was established in December 1992 by Abubakar Audu the first and second executive Governor of the State. The School took off in January 1993 at the Government Secondary School, Lokoja and Osara campus. Presently the Polytechnic population is twenty-three thousand.

Study Design

A cross – sectional study was adopted in determining the prevalence of Hepatitis B and C infection among students of Kogi State Polytechnic, Lokoja, Kogi State.

Study Population and Sample Size Determination

The study population consist of students of Kogi State Polytechnic, Lokoja, Kogi State who gave their consent. The sample size was determined at 0.05 level of precision by adopting the method of Naing *et al.* (2006) for sample size calculation.

Therefore, a total of 100 samples was collected.

Sample Collection and Screening for HBV and HCV

One Step Hepatitis B surface Antigen (HBsAg) and Hepatitis C surface Antigen (HcAg) test Strip was performed using whole blood. After the specimens were collected, assay was swiftly performed.

Assay Procedure



The pouch was brought to room temperature before opening. The test strip was removed from the sealed pouch and used timely. Finger stick whole blood specimen was used for the assay; the capillary tube was filled from the finger stick blood and approximately 50µl of blood specimen was transferred to the specimen area of the cassette and one drop of buffer (approximately 40µl) was added and timed for the appearance of coloured lines. Result was read at 15-30 minutes. (Accubiotech, 2024). This procedure was repeated for all the samples.

Interpretation of Result

Positive: the appearance of two-colored bands on both the test line region of the membrane and the control line region of the test membrane.

Negative: A purplish red colored band appears only on the control region.

Invalid: If neither purplish red control band nor purplish red test band were not observed. Using a new strip, the specimen has to be tested again.

Statistical Analysis

Data gotten from the questionnaires was analyzed using statistical software for social sciences version 21. Results were presented using percentages, mean, mode and T-test to get the prevalence and association of risk factors.

4.0 RESULTS AND DISCUSSION

4.1 RESULTS

Sero-prevalence of HBV and HCV infection among students of Kogi State Polytechnic, Lokoja, Kogi State.

The overall prevalence of HBV infection among the students was 9% and the prevalence of HCV was 0% (Table1).

Table 1: Sero-prevalence of HBV and HCV Infection Among Kogi State Polytechnic Students

Hepatitis	No. Examined	No. Positive	(%) Positive
HBV	100	9	9



HCV	100	0	0
Total	100	9	9

Descriptive Analysis of Demographic Factors and HBV

Infection among Students of Kogi State Polytechnic Lokoja, Kogi State, subjects in the age group less than twenty (20) years had a prevalence of 11% while those in the age group greater than twenty had prevalence of 8%. Over all prevalence of HBV infection among male subjects was 9.1%, and that of female subjects was 8.9% Table 2.

Table 2: Descriptive Analysis of the Sociodemographic Factors and HBV Infection Among Students of Kogi State Polytechnic Lokoja.

Demographic Factor	No. Examined	No. Positive	(%) Positive
Age (Years)			
<20	28	3	11
>20	72	6	08
Total	100	9	09
Education			
Tertiary	100	9	09
Total	100	9	09
Sex			
Male	22	2	9.1
Female	78	7	8.9
Total	100	9	9



Descriptive Analysis of HBV Infection in Association with Risk Factors Among Students of Kogi State Polytechnic Lokoja, Kogi State.

Those who responded to be married has a 0% of HBV and those who responded to be single had 10% prevalence of HBV infection. Those who responded to having one sexual partner had prevalence of 9.7%, those who responded to having multiple sexual partners had prevalence of 12.5% while those who had no sexual partner had prevalence of 6.6% (Table 3).

Table 3: Descriptive Analysis of HBV Infection in Association with Risk Factors Among Students of Kogi State Polytechnic Lokoja.

Risk Factors	No. Examined	No. Positive	(%) Positive
Marital Status			
Married	10	0	0
Single	90	9	10
Total	100	9	9
Number of Sexual Partner			
One	62	6	9.7
More than one	8	1	12.5
None	30	2	6.6
Total	100	9	9
Sharing of Needle and Syringe			
Yes	6	1	16.7



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No	94	8	8.5
Total	100	9	9
Sharing of Razor			
Yes	14	2	14.3
No	86	7	8.1
Total	100	9	9
Sharing of Items like Clothes and Sponge			
Yes	18	2	11.1
No	82	7	8.5
Total	100	9	9
Use of Drugs			
Yes	4	1	25
No	96	8	8.3
Total	100	9	9



Table 3.1: Descriptive Analysis of HBV Infection in Association with Risk Factors Among Students of Kogi State Polytechnic Lokoja.

Exposure to Infected Bodily Fluids	No. Examined	No. Positive	% Positive
Yes	4	1	25
No	96	8	8.3
Total	100	9	9
Blood Transfusion			
Yes	2	0	0
No	98	9	9.2
Total	100	9	9
Awareness of HBV/HCV Infection			
Yes	24	2	8.3
No	76	7	9.2
Total	100	9	9
Vaccination			
Yes	6	0	0
No	94	9	9.6
Total	100	9	9

Table 4: Association of HBV infection relationship to number to awareness and Vaccination

Variables	No. Examined	Mean	Standard error	Standard deviation	95% CI	
Awareness of HBV/HCV	100	1.78	0.416333	0.4163332	1.69739	1.86261



Vaccination against HBV/HCV	100	1.94	0.238683	0.238633	1.89264	1.98736
Difference	100	-0.16	0.368453	0.3684529	-.2331091	-.0868909

T – test = -4.3425, Df = 99, Significant level = 0.000

Table 5 Association of HBV infection in relationship to number of sexual partner and use of needle

Variables	No. Examined	Mean	Standard error	Standard deviation	95% CI	
No. of sexual partner	100	1.66	0.0901402	0.9014018	1.481142	1.838858
Sharing of needle and syringe	100	1.94	0.238683	0.238633	1.89264	1.98736
Difference	100	-0.28	0.0910988	0.9109879	-.4607598	-.0992402

T – test = - 3.0736, Df = 99, Significant level = 0.0027

4.2 Discussion

This study was utilized data on the intensity of infection with Hepatitis. The study found an overall prevalence of 9%. Findings observed in this study is regarded as high sero-prevalence level of HBV infection in accordance with the World Health Organization classification of estimating the severity of HBV infection in prevalent countries. In 2010, WHO ascribe low prevalence to be <2%, moderate prevalence as 2 – 8% and high prevalence as >8% HBsAg positivity. Hepatitis is a serious public health problem in developing countries with high rate of morbidity and mortality from acute and chronic infections.

The sero-prevalence (9%) recorded is comparable with 8.2 – 8.3% reported among pregnant women in Nnewi, Yola and Zaria. Also, 11%, 9.5% and 19.8% were reported in Makurdi,



western Niger and Keffi. This prevalence is higher than that reported among adolescents in Abakaliki, South eastern Nigeria 4.1%, 6.02% among children on antiretroviral treatment programme in Uyo, South – Southern Nigeria. The differences in population selection may account for this difference. Our research deals with students of tertiary institution who are mostly adults; other factors like socio – economic, socio – cultural and sexual practices can also be considered as factors for the difference in the study rates. Hence, the need for urgent implementation and support of a national program for universal testing of HBV infection in an intermediate and high endemic region is highly suggested. For the socio – demographic factors, the infection rate was higher in adult less than 20 years of age (11%) than in those above 20 years (8%). This rate maybe as a result of this age group being an exploring age group. According to sex or gender, the infection rate was the same (9.1 and 8.9%). This means that infection rate is not associated with sex or gender.

Single respondents had the prevalence 10%, those with multiple sexual partner had prevalence of 12.5%, likewise sharing of needle and sharing of razor had 16.7% and 14.3%. The prevalence according to risk factors are high, this could be what account for the high prevalence rate in this study. HBV is higher in age group which are active in sexual activity. T – test (-3.0736, Df = 99, Significant level = 0.0027), the infection is associated with sexual activity and sharing of needle and syringe. There was 0% prevalence of HCV infection among the students. This 0% prevalence could be as result of the infection been contracted through blood transmission and blood products.

5.0 Conclusion

The prevalence of HBV infection is (9%) in accordance with WHO classification. HCV infection was 0%. The prevalence is highest within the age group <20 years, the prevalence rate was almost the same among male and female students of Kogi State Polytechnic Lokoja, Kogi State. Attention and focus of Public health practitioners should be on asymptomatic patients in developing countries. HBsAg and Anti – HCV screening with immune chromatographic kit should be followed with confirmatory test using highly sensitive and specific ELISA in order to eliminate false positive tests.



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NUTRITIONAL EVALUATION OF DATE FRUITS (*Phoenix dactylifera* L.) AND TIGERNUT (*Cyperus esculentus*) SOLD IN INTERNATIONAL MARKET, LOKOJA, KOGI STATE

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Abstract

The date palm (*Phoenix dactylifera* L.) is one of the most precious tamed fruit trees because of ritual significance in mortal societies, health benefits, productive capacity in harsh semiarid and thirsty surroundings, and the range of subsistence products from its fruits and other corridor of the large palm. Tigernut (*Cyperus esculentus*) is an unde seed crop belonging to the Cyperaceae family that has been set up to be a imperishable broad crop of the same rubric as the papyrus plant. The sweet value was calculated from crude protein, crude fat, crude fibre, carbohydrate, moisture and ash content. The results showed that date fruits (*Phoenix dactylifera*) contained ash (10.00) and Tigernut (9.50), crude protein (4.00) and (9.50), crude lipid (4.60) and tigernut (10.65), crude fibre (4.50) and tigernut (22.00), moisture (3.00) and (3.50) and carbohydrate (73.90) and (44.85) for date fruit and tigernut singly. This study concluded that the anatomized date fruits (*Phoenix dactylifera* L.) and tigernut contained topmost amount of Crude lipid and carbohydrate and lowest amount of crude protein.

Keywords: *Phoenix dactylifera* L., *Cyperus esculentus*, Cyperaceae crude protein, crude fat, crude fibre, carbohydrate, moisture and ash content



1.0 INTRODUCTION

Human beings bear food to grow, reproduce and maintain good health. Without it, our bodies can't stay warm, make or repair apkins or maintain the eyeblink. Eating the right foods helps us avoid certain conditions or recover hastily when illness occurs. These and other important functions are fueled by chemical substances in our foods called nutrients (Worthington – Robberts, 2018). Malnutrition is a major health problem in Africa, despite governments' sweats to promote food product. In this wise, protein- energy malnutrition in babies and children is one of the most common nutritional problems (Achu, 2017). The connection of fruits and the need to introduce farther shops as foods in order to bridge the gap of adding food deficiency in mortal nutrition have drawn the attention of various researchers all over the world (Anhwange *et al.*, 2017; Hassan *et al.*, 2017; Umar *et al.*, 2017). This is because it has been asserted that several mortal health problems are related to diets from which micronutrients involved in numerous biochemical processes used for the prevention of several conditions are derived (Kumari *et al.*, 2017; Özcan, 2017; Leterme *et al.*, 2016). Some conditions analogous as diabetes, obesity, cancer and cardiovascular conditions are adding in developing countries than ever ahead as a result of shy consumption of fruits and vegetables. These nations are devastated by hunger and conditions despite the fact that they have abundant fruits and other natural resources which if properly employed, could break these problems (Vainio-Maltla, 2019). The continuity of this trend as projected by world Health association (WHO) will lead to a rise in the chance of people living with diabetes alone in developing countries by 170 by the time 2025 (Ganry, 2018). The date palm (*Phoenix dactylifera* L.) is one of the most precious tamed fruit trees because of ritual significance in mortal societies, health benefits, productive capacity in harsh semiarid and thirsty surroundings, and the range of subsistence products from its fruits and other corridor of the large palm (Jain *et al.*, 2019). *Phoenix dactylifera*, generally known as date or date fruit, is a flowering plant species in the palm family, Arecaceae, cultivated for its eatable sweet fruit. Although its exact place of origin is uncertain because of long civilization, it presumably began from the Fertile Crescent region straddling between Egypt and Mesopotamia (Belewu and Belewu, 2017). The species is considerably cultivated across Northern Africa, the Middle East, The Horn of Africa and South Asia, and is naturalized in multitudinous tropical and tropical regions worldwide. *P. dactylifera* is a specie of rubric Phoenix, which contains 12–19 species of wild date fruits, and is the major source of



marketable product (Belewu and Belewu, 2017). Date trees generally reach about 21 – 23 metres (69–75ft) in height, growing singly or forming a clump with several stems from a single root system. Date fruits(dates) are round- globular, 3 to 7 centimetres (1.2 to2.8 in) long, and about 2.5 centimetres (0.98 in) in fringe, ranging from bright red to bright pusillanimous in colour, depending on variety. They are truly sweet, containing about 75 percent of sugar when dried (Ekeanyanwu *et al.*, 2010). Tigernut (*Cyperus esculentus*) is an under seed crop belonging to the Cyperaceae family that has been set up to be a imperishable broad crop of the same rubric as the papyrus plant (Belewu and Belewu, 2017; Odoemelan, 2013) Among carbohydrate polymers, due to its mileage in various food products, brio is presently given considerable attention and plays an important part as a thickener, shaping agent and water spongy. The brio in a result attained from Tigernut forms a strong paste as consistence, translucence and remarkable strength of cement in the cosmetics sedulity, the characteristics of brio derived from tigernut tubers are useful (Bamishaiye and Bamishaiye 2019). The physical parcels of native sap constantly circumscribe their artificial use. Native sap warrant solubility at low temperatures, tend to lose viscosity during low pH baking, and tend to retrograde (Shi *et al.*, 2019) as a result, sweats are predicated on modifying native sap to expand their compass of use. Sap from different sources have parcels which translate into their functional characteristics and operations which alter their physio- chemical and functional parcels when modified (Moorthy *et al.*, 2002; Korhonen *et al.*, 2020). brio modification can be adapted for specific operations and has been achieved using various physical procedures, chemical processes and enzyme treatment (Ojinnaka *et al.*, 2019; Kim *et al.*, 2020) Enzymatic variations have been introduced in recent decades, which partly replace the physical and chemical styles of brio modification, because enzymes are safer and healthier for both the terrain and food uses than chemical styles. Not only are enzymatic responses mild and truly specific to brio substrates in complex food systems, they also contribute to high yields and lower by-products (Buttler *et al.*, 2014; Kennedy *et al.*, 2020) though multitudinous researchers have worked on Tigernut (Bamishaiye, 2019; Belewu, 2017; Bamgbose *et al.*, 2013 Odoemelan, 2013), there is little information on the effect of malt extract on the solubility of Tigernut bounce this design therefore aimed at probing the impact of malt extract on the solubility of Tigernut brio. The aim of this study is to assess the nutritive and medicinal implicit



contents set up in date fruit (*Phoenix dactylifera L.*) and tigernut (*Cyperus esculentus*) sold in international market Lokoja, Kogi State.

2.0 MATERIALS AND METHOD

2.1 Materials

All the material used were of analytical standard, which includes; Desiccator, Beakers, Retort stand, Conical flask, Volumetric flask, Filter paper (Whatman's), Crucible, Burette, Spatula, Measuring cylinder, Stirring rod, Funnel, Heating mantle, Cotton wool, Plain sample bottles, Soxhlet extraction and reflux unit, Extraction thimbles, Flat bottom flask, Mortar and pestle, Water bath, Muffle furnace, Oven and Grinding machine (blender).

2.2 Reagents

0.1M hydrochloric acid, 1.25% sulphuric acid solution, Petroleum ether, Phenolphthalein indicator, 0.1M sodium hydroxide, 40% formaldehyde solution, Saturated potassium oxalate, Concentrated (H_2SO_4) sulphuric acid solution, 1.25% sodium hydroxide solution, Distilled water and Raw nitric acid solution (HNO_3).

2.3 Sample Preparations

The sample was washed with distilled water and air dried and weighed. The fruits were then sun dried for 2 days after which they were halved, oven dried and pulverized into a coarse powder using mortar and pestle. This was safely kept in an air tight container (desiccators) at room temperature prior to the commencement of the analysis.

2.4 Proximate Analysis

After the preparation process, the sample was analyzed for moisture, ash, crude fiber, fat/lipid, crude protein and carbohydrate content and these were conducted in the chemistry laboratory of Kogi state polytechnic Lokoja, Kogi state. The proximate analysis was carried out in trinity according to the AOAC (2019) methodology. The energy content of the samples was estimated by multiplying the crude protein, crude lipids and carbohydrate with the recommended factors of 2.

2.4.1 Moisture Content Determination

Humidity content of food is of great important to every food processor as a number of biochemical and physiological changes in food which depend veritably much on the humidity content. Thus humidity content determination is one of the vital factors of food determination



in the laboratory. This analysis is carried out to determine the quantum of humidity content contained in the sample using the styles described by AOAC (2019).

Procedure

A clean gauntlet (crucible) was dried to a constant weigh in an air roaster at 105⁰c for 30minutes, cooled in a desiccator and counted (W₁). 2 gram of the sample flour date fruit (*Phoenix dactylifera L.*) and tigernut (*Cyperus esculentus*) was directly counted into the clean, preweighed gauntlet (W₂) and place into a hot roaster at 1050c for 6- 8 hours until a constant weight was attained. The gauntlet was also removed and placed in a desiccators for 30minutes to cool after which it was weigh again (W₃). The percentage humidity content was calculated for the sample using the expression below;

$$\text{Moisture content} = \frac{W_2 - W_3}{W_2 - W_1} \times 100 \%$$

Where, W₁ = weight of empty crucible.

W₂ = weight of empty crucible + sample before oven drying.

W₃ = weight of empty crucible + sample after oven drying.

2.4.2 Ash Content Determination

Ash in food constitute the residue remaining after all humidity has been removed as well as organic accoutrements (carbohydrates, protein, fats, vitamins, organic acid etc.) this analysis is carried out in order to determine the inorganic matter of sample after burning (incinerating) in muffle furnace. The ash content was determined using the sanctioned system of AOAC (2010).

Procedure

A clean gauntlet (crucible) was dried to a constant temperature, counted and enkindle to a muffle furnace of 550⁰c for 1 hour and cooled in the desiccator. 2g of the sample flour was counted into the gauntlet and counted again (W₂). The gauntlet and its content was transfer into the muffle furnace and the temperature was gradationally increased until it reaches 550⁰c. The temperature was maintained for 8 hrs. The appearance of the argentine white indicates complete oxidation of all organic matter in the sample. After ashing, the gauntlet was removed cooled in a desiccator and counted (W₃). The ash content present in the sample was attained using the formula;

$$\text{Ash content} = \frac{\text{Loss of Weight}}{\text{Weight of Sample}} \times 100 \%$$

$$\text{Ash content} = \frac{W_3 - W_1}{W_2 - W_1} \times 100 \%$$



W_2 = weight of sample in crucible before incineration

W_3 = weight of sample in the curable after incineration.

2.4.3 Crude Fibre Determination

Crude fibre represent the organic residue after the accoutrements have been treated under standard condition with boiling sulphuric acid and boiling dilute sodium hydroxide. Crude fiber is made largely of cellulose together with a little lignin include accoutrements that are inedible in mortal and beast organism. This analysis is carried out in order to estimate the quantum of fiber in the sample.

Procedure

2g of the powdered samples date fruit (*Phoenix dactylifera L.*) and tigernut (*Cyperus esculentus*) were purred in a clean round bottom beaker and hydrolyzed with 20ml of 1.25 sulphuric acid (H_2SO_4) and boiled for 30minutes under influx. The result was snappily filtered and the undoable matters were washed several times in hot distilled water to make it acid free. The acid free residue of the sample was decanted into a round bottom beaker and boiled again for another 30minutes with 20ml of 1.25 sodium hydroxide (NaOH). The undoable residue was washed with hot distilled water to make it base free. The residue was dried to a constant weight in an roaster at 105^0c , cooled in a desiccator and counted (C_2). It was latterly incinerated in muffle furnace at 500^0c for 2- 4 hours also cooled in a desiccators and weigh again (C_3). The percent crude fiber was calculated using the ensuing expression.

$$\text{Crude fibre} = \frac{C_2 - C_3}{\text{Weight of sample}} \times 100 \%$$

Where, W = weight of original sample

$(C_2 - C_3)$ = The loss in weight on washing (incineration).

2.4.4 Crude Fat/Lipid Determination

Lipids are characterized by their sparingly solubility in water and their considerable solubility in organic detergent. The study has shown that fat makes up to about 99 of lipid bit of a food. In food analysis total lipid content is what determines rather than the true fat content. This analysis is carried out to determine the volume or quantum of fat present in the sample (Date fruit (*Phoenix dactylifera L.*)) and tigernut (*Cyperus esculentus*).

Procedure

Crude fat was determined by either extraction system using soxhlet outfit also known as the dry extraction system for fat; it correspond of rooting dry samples with some organic reagent,



since all the fat accoutrements e.g. fats, phospholipids, sterols, adipose acid, carotenoids colors, chlorophyll etc are uprooted together, thus the results are constantly appertained to as crude fat. 2g of the sample was counted and wrapped in filtered paper, placed in a fat free thimble and also introduced in the birth tube. About 20ml of petroleum ether was poured into a flat bottom beaker (guttled and dried) and filtered into the outfit. The water and heater (heating mantle) were turned in to start birth. After 4- 6 siphoning, the either was allowed to dematerialize and the teacup was dissociated before the last siphoning. Rotary vacuum evaporator was used to dematerialize the solvent leaving the uprooted lipid in the soxhlet. The sludge paper containing the sample was removed from the thimble and dried to a constant weight in the roaster at 70⁰c, cooled in a desiccators and counted (W₃), the percent lipid content was determined as follows.

$$\text{Lipid content (W/W)} = \frac{\text{Weight of lipid extracted}}{\text{Weight of direct sample}} \times 100 \%$$

$$\text{Lipid (W/W)} = \frac{W_2 - W_3}{W_2 - W_1} \times 100 \%$$

Given, weight of lipid extracted (crude fat) is given by loss in weight (W₂-W₁) of the thimble content after extraction.

2.4.5 Crude Protein Determination (Formal Titration Methods)

Amino acids are the structure blocks of proteins. Proteins are thus polymers of amino acids, utmost of which are nascence-amino acids having the general formula NH₂CHR₂COOH. It's the only macronutrient in food that contains high content of nitrogen. The nitrogen in protein, this becomes the introductory of the estimation of protein in food. This is achieved by the determination of the chance of nitrogen. The analysis was carried out to determine the chance of crude protein present in the sample (Date fruit (*Phoenix dactylifera* L.) and tigernut (*Cyperus esculentus*)).

Procedure

2g of the sample (Date fruit (*Phoenix dactylifera* L.) and tigernut (*Cyperus esculentus*)) was counted into a teacup and dissolved with 10 ml of the distilled water. The sample was pipette into a separate conical beaker and two drops of phenolphthalein index was added. The result was annulled precisely with a many drops of sodium hydroxide until a faint pink colour was noted. 2 ml of annulled formaldehyde was added to each sample using a clean hype and the result was swirled and left to stand for 2 twinkles. The performing result of the sample was also titrated with standard sodium hydroxide until a pink color was achieved. The burette



readings were taken for each sample. The process was repeated 3 times so as to gain the average volume of the readings

Blank Preparation Procedure

The blank readings were attained by titration 2ml of 40% formaldehyde result plus 10 ml of distilled water with 0.1 ml NaOH (sodium hydroxide result). The chance crude protein was attained using the following formula.

% crude protein = $V_a - V_b \times \text{formula factor}$

Where V_a = volume of 0.1M NaOH used to titrate after addition of formaldehyde

V_b = volume of 0.1M NaOH used to titrate blank formula factor = 4.26.

$V_a - V_b$ = formaldehyde value

Therefore: % crude protein = $V_a - V_b \times 4.26$

2.4.6 Total Carbohydrate Determination

This was determined using the AOAC (Association of sanctioned agrarian druggists) (2010) standard. The chance of the remaining ingredients are added up and abated from 100. The value attained from the procedures gave the crude carbohydrate contents of the sample. Carbohydrate can be calculated using the ensuing expression. Carbohydrate = 100- (crude protein crude lipid ash moisture content crude fibre) %

3.0 RESULTS AND DISCUSSION

3.1 Results

The results of the proximate analysis of Date fruit (*Phoenix dactylifera*) and Tigernut are summarized in the tables below.

Table 1: Proximate composition of date fruit (*Phoenix dactylifera*). Concentration (% dry weight).

Parameter	Date Fruit (%)	Tigernut (%)
Moisture	3.00	3.50
Ash	10.00	9.50
Crude lipid	4.60	10.65
Crude protein	4.00	9.50



Crude fibre	4.50	22.00
Carbohydrate	73.90	44.85

3.2 Discussion

The results of the proximate analysis of the date fruit and tigernut studied are presented in table above. In the table, the loftiest among the proximate parameters anatomized was set up to be carbohydrate, which was 73.90 and 44.85% for the date fruit and tigernut respectively. This value is much higher compared to 60.46 and 34.5 for cotton seed and sunflower seed and lower than date fruit at 45.50 respectively as reported by FAO (2018). It's important to note that date fruit could be explained for oil painting product. Oil painting provides concentrated energy in diet and enhanced delectability. It's good to note that major comestible oil painting are from win oil painting and peanut which are capital and labour ferocious and thus there's need to reference for good, cheap and new source of canvases that would be useful domestically, and maybe industrially (Hassan *et al.*, 2018) (Ozcan, 2019). The crude proteins content showed the value of 4.00 and 9.50 independently. This value is analogous to those of sesame seed, cape, cactus, carob seeds, almond and cereals (Acar *et al.*, 2012). Piecemeal from their eventuality as a source of protein, the fruits generally are reported to contain roughly 35 protein by weight of decorticated seeds that have a nutritionally acceptable amino acid profile (Jack, 2017). The product of food protein in served quantities possesses numerous problems especially since they're more precious to produce than carbohydrate on lipids. In order to satisfy this steady growing demand for protein, new protein sources must be explored (Wilcox, 2016). Former workshop on kinds of *Phoenix dactylifera* seed have shown that it has high protein value that makes the seed precious as a good source of protein. It contains lipid, carbohydrate and minerals, making it a complete food (Ojieh *et al.*, 2018). The crude fibre content attained from the analysis was 4.50 and 22.00 independently. The fibre in foods is known to expand the inside walls of the colon, easing the passage of water, therefore making it effective against constipation. It lowers cholesterol position in the blood and reduce the threat of colorful cancers. The humidity content for date fruit attained for this analysis was 3.00 and 3.50. The humidity content attained was set up to be lower compared to 6.46 and 6.56 reported for cotton seeds and sunflower seed. And has the same humidity with watermelon (FAO, 2010). The ash



content attained were 10.00 and 9.50, the ash chance of the samples which gives a suggestion of its mineral composition. Sample with high ash content is anticipated to have high attention of colorful mineral rudiments, which are anticipated to speed up metabolic processes, ameliorate growth and development.

4.0 CONCLUSION

The study shows that date fruit (*Phoenix dactylifera*) and Tigernut (*Cyperus esculentus*) is a good source of energy. They are rich sources of Crude lipid and carbohydrate that are essential in the body system. Although no single seed can provide man with adequate level of all nutrients required, yet date fruit and tigernut contains many essential nutrients like fat, lipid, fibre, moisture, carbohydrate and ash. Moderate enough to meet the recommended daily value. The date fruit and Tigernut may provide considerable medical health and economic benefits if freshly consumed or utilized in food product. Oil extract from the seed can also be used for cooking.

It is recommended that:

- More research should be made on the best way that these fruits can be eaten easily and enjoyable.
- It should be recommended or included in daily dietary meal including other seed such as sesame seed, sunflower seed etc.
- More research should be carried out on date fruit to know exactly how they can be applied and modified in different industries to maximize their nutritional importance and usefulness.



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COMPARISON OF THE PROXIMATE ANALYSIS OF CUCUMBER AND SPINACH LEAVES SOLD IN INTERNATIONAL MARKET, LOKOJA METROPOLIS

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Abstract

Spinach is vegetable fruit which can be produce fresh, numerous fruits that are in a botanical sense are true fruits that are actually treated as vegetables, these culinary vegetables include cucurbits. e.g (Squash, cucumber and spinach). Spinach and Cucumber were presumably domesticated in Asia and also introduces in the 1700s. Cucumbers were brought to America by Christopher Columbus. The spinach is grown for its fruit which are eaten fresh or picked in utmost countries, but which are also eaten fried. The sample was washed with distilled water and air dried and counted. The fruits were also sun dried for 2 days after which they were halved, oven dried and pulverized into a coarse greaselpaint using mortar and pestle. After the medication process, the sample was anatomized for moisture, ash, crude fiber, fat/ lipid, crude protein and carbohydrate content. The proximate composition and analysis of cucumber and spinach leaves was to assess the nutritive value of cucumber and spinach leaves by analysis the amino acid profile and mineral ingredients. The results showed that cucumber have the moisture content of 30 and spinach 29, Fat content of cucumber is 25.00 and that of spinach leaves is 24.50. Cucumber has the loftiest crude fibre of while spinach is lower 12.00. The Ash content of cucumber is 10 and spinach is 13, the chance of protein present in cucumber is 1.58 while spinach is lower with 1.50 and carbohydrate content of both of them is 20.92 and 20 respectively. Based on these finding, cucumbers and spinach are good source of vitamins and minerals demanded for structure of the body.

Keywords: Spinach, Cucumber, presumably, distilled water, proximate, analysis, crude protein, crude fat, crude fibre, carbohydrate, moisture and ash content



1.0 INTRODUCTION

Spinach is leafy vegetable which can be produced fresh, numerous fruits that are in a botanical sense are true fruits that are actually treated as vegetables, these culinary vegetables include cucurbits, e.g (squash, cucumber and spinach). The spinach is allowed to have begun in India where it's set up wild and is cultivated in numerous different forms. Accessions of *cucumis sativus* L. Var *hardwicki* is related to the original ancestors of the spinach (Maynard *et al.*, 2018). Secondary centers of diversity for the spinach live in China and near east. Species are *cucumis hystrix* from China and Africa. *Cucumis hystrix* from demitasse and the African *cucumis*, similar as cucumber (Spinach and Wild relative (Douglas *et al.*, 2019). Spinach and Cucumber were presumably domesticated in Asia and also introduced in the 1700s. Cucumbers were brought to America by Christopher Columbus. The spinach is grown for its leafy vegetables which are eaten fresh or picked in utmost countries, but which are also eaten fried. Bate *et al* (2015) slicing and selecting of Spinach and Cucumber fruits are substantially water but they give some vitamin A and C, especially when picked with other species (Yadav *et al.*, 2013). Spinach and Cucumber are the ideal food for people having trouble with body weight because it's substantially water and some filaments and many calories. Cucumber beget shambling and mild stomach derangement in people when eaten raw but not when soaked in ginger or pickled before eating (Bate *et al.*, 2015). Spinach (*Spinacia oleracea*) is a comestible factory in the family of Amaranthaceae. It's native to central and southwestern Asia. It's an periodic factory (infrequently biennia), which grows to a height of over to 30 cm. Spinach leaves are alternate, simple, ovate to triangular- grounded, veritably variable in size from about 2 – 30 cm long and 1.15 cm broad; with large leaves at the base of the factory and small leaves higher on the unfolding stem. The flowers are invisible (Nazzaro *et al.*, 2014). unheroic green, 3 – 4 mm periphery growing into a small, hard, dry, lumpy fruit cluster 5 – 10 mm across containing several seeds. Common spinach, *Spinacia oleracea*, was long considered to be in the chinopodiaceae family, but in 2003 the chinopodiaceae family was combined with the Amarantuaceae family under the family name 'Amarantuaceae' in the order caryophyllaeas (Lakshmi and Shalni, 2016). Within the Amaratuaceae family there are now a subfamily Amaratuoldeae and a subfamily chenopodioideae, for the amaratus and the chenopods, independently (Rosemary *et al*, 2017). The aim of this study was to assess the nutritive and



medicinal implicit contents set up in Spinach and Cucumber vended in International Market Lokoja, Kogi State.

2.0 MATERIALS AND METHOD

2.1 Materials

All the material used were of analytical standard, which includes; Desiccator, Beakers, Retort stand, Conical flask, Volumetric flask, Filter paper (Whatman's), Crucible, Burette, Spatula, Measuring cylinder, Stirring rod, Funnel, Heating mantle, Cotton wool, Plain sample bottles, Soxhlet extraction and reflux unit, Extraction thimbles, Flat bottom flask, Mortar and pestle, Water bath, Muffle furnace, Oven and Grinding machine (blender).

2.2 Reagents

0.1M hydrochloric acid, 1.25% sulphuric acid solution, Petroleum ether, Phenolphthalein indicator, 0.1M sodium hydroxide, 40% formaldehyde solution, Saturated potassium oxalate, Concentrated (H_2SO_4) sulphuric acid solution, 1.25% sodium hydroxide solution, Distilled water and Raw nitric acid solution (HNO_3).

2.3 Sample Preparations

The sample was washed with distilled water and air dried and weighed. The fruits were then sun dried for 2 days after which they were halved, oven dried and pulverized into a coarse powder using mortar and pestle. This was safely kept in an air tight container (desiccators) at room temperature prior to the commencement of the analysis.

2.4 Proximate Analysis

After the preparation process, the sample was analyzed for moisture, ash, crude fiber, fat/ lipid, crude protein and carbohydrate content and these were conducted in the chemistry laboratory of Kogi state polytechnic Lokoja, Kogi state. The proximate analysis was carried out in trinity according to the AOAC (2019) methodology. The energy content of the samples was estimated by multiplying the crude protein, crude lipids and carbohydrate with the recommended factors of 2.

2.4.1 Moisture Content Determination

Moisture content of food is of great important to every food processor as a number of biochemical and physiological changes in food which depend veritably much on the moisture content. Thus moisture content determination is one of the vital factors of food determination



in the laboratory. This analysis is carried out to determine the quantum of moisture content contained in the sample using the styles described by AOAC (2019).

Procedure

A clean gauntlet (crucible) was dried to a constant weigh in an air oven at 105⁰c for 30minutes, cooled in a desiccator and counted (W₁). 2 gram of the sample powdered (Spinach and Cucumber) was directly counted into the clean, preweighed gauntlet (W₂) and place into a hot oven at 105⁰C for 6 – 8 hours until a constant weight was attained. The gauntlet was also removed and placed in a desiccators for 30minutes to cool after which it was weigh again (W₃). The percentage moisture content was calculated for the sample using the expression below;

$$\text{Moisture content} = \frac{W_2 - W_3}{W_2 - W_1} \times 100 \%$$

Where, W₁ = weight of empty crucible.

W₂ = weight of empty crucible + sample before oven drying.

W₃ = weight of empty crucible + sample after oven drying.

2.4.2 Ash Content Determination

Ash in food constitute the residue remaining after all moisture has been removed as well as organic accoutrements (carbohydrates, protein, fats, vitamins, organic acid etc.) this analysis is carried out in order to determine the inorganic matter of sample after burning(incinerating) in muffle furnace. The ash content was determined using the sanctioned system of AOAC (2010).

Procedure

A clean gauntlet (crucible) was dried to a constant temperature, counted (W₁) and enkindle to a muffle furnace of 550⁰C for 1 hour and cooled in the desiccator. 2g of the sample flour was counted into the gauntlet and counted again (W₂). The gauntlet and its content was transfer into the muffle furnace and the temperature was gradationally increased until it reaches 550⁰C. The temperature was maintained for 8 hrs. The appearance of the argentine white indicates complete oxidation of all organic matter in the sample. After ashing, the gauntlet was removed cooled in a desicator and counted (W₃). The ash content present in the sample was attained using the formula;

$$\text{Ash content} = \frac{\text{Loss of Weight}}{\text{Weight of Sample}} \times 100 \%$$

$$\text{Ash content} = \frac{W_3 - W_1}{W_2 - W_1} \times 100 \%$$

W₂ = weight of sample in crucible before incineration



W_3 = weight of sample in the curable after incineration.

2.4.3 Crude Fibre Determination

Crude fibre represent the organic residue after the accoutrements have been treated under standard condition with boiling sulphuric acid and boiling dilute sodium hydroxide. Crude fiber is made largely of cellulose together with a little lignin include accoutrements that are inedible in mortal and beast organism. This analysis is carried out in order to estimate the quantum of fiber in the sample.

Procedure

2g of the powdered samples (Spinach and Cucumber) was purred in a clean round bottom beaker and hydrolyzed with 20ml of 1.25 sulphuric acid result (H_2SO_4) and boiled for 30minutes under influx. The result was snappily filtered and the undoable matters were washed several times in hot distilled water to make it acid free. The acid free residue of the sample was decanted into a round bottom beaker and boiled again for another 30minutes with 20ml of 1.25 sodium hydroxide (NaOH). The undoable residue was washed with hot distilled water to make it base free. The residue was dried to a constant weight in an oven at 100^0c , cooled in a desiccator and counted (C_1). It was latterly incinerated in muffle furnace at 600^0c for 2- 4 hours also cooled in a desiccators and weigh again (C_2). The percent crude fiber was calculated using the ensuing expression.

$$\text{Crude fibre} = \frac{C_2 - C_3}{\text{Weight of sample}} \times 100 \%$$

Where, W = weight of original sample

$(C_2 - C_3)$ = The loss in weight on washing (incineration).

2.4.4 Crude Fat/Lipid Determination

Lipids are characterized by their sparingly solubility in water and their considerable solubility in organic reagent. The study has shown that fat makes up to about 99 of lipid bit of a food. In food analysis total lipid content is what determines rather than the true fat content. This analysis is carried out to determine the volume or quantum of fat present in the sample (Date fruit (*Phoenix dactylifera L.*)) and tigernut (*Cyperus esculentus*).

Procedure

Crude fat was determined by either extraction system using soxhlet outfit also known as the dry extraction system for fat; it correspond of rooting dry samples with some organic reagent,



since all the fat accoutrements e.g. fats, phospholipids, sterols, adipose acid, carotenoids colors, chlorophyll etc are uprooted together, thus the results are constantly appertained to as crude fat. 2g of the sample was counted and wrapped in filtered paper, placed in a fat free thimble and also introduced in the test tube. About 20ml of petroleum ether was poured into a flat bottom beaker (guttled and dried) and filtered into the outfit. The water and heater (heating mantle) were turned in to start birth. After 4- 6 siphoning, the either was allowed to dematerialize and the teacup was dissociated before the last siphoning. Rotary vacuum evaporator was used to dematerialize the solvent leaving the uprooted lipid in the soxhlet. The sludge paper containing the sample was removed from the thimble and dried to a constant weight in the oven at 70⁰c, cooled in a desiccators and counted (W₃), the percent lipid content was determined as follows.

$$\text{Lipid content (W/W)} = \frac{\text{Weight of lipid extracted}}{\text{Weight of direct sample}} \times 100 \%$$

$$\text{Lipid (W/W)} = \frac{W_2 - W_3}{W_2 - W_1} \times 100 \%$$

Given, weight of lipid extracted (crude fat) is given by loss in weight (W₂-W₁) of the thimble content after extraction.

2.4.5 Crude Protein Determination (Formal Titration Methods)

Amino acids are the structure blocks of proteins. Proteins are thus polymers of amino acids, utmost of which are nascence-amino acids having the general formula NH₂CHR₂COOH. It's the only macronutrient in food that contains high content of nitrogen. The nitrogen in protein, this becomes the introductory of the estimation of protein in food. This is achieved by the determination of the chance of nitrogen. The analysis was carried out to determine the chance of crude protein present in the sample (Date fruit (Spinach and Cucumber))).

Procedure

2g of the sample (Date fruit (Spinach and Cucumber)) was counted into a teacup and dissolved with 10 ml of the distilled water. The sample was pipette into a separate conical beaker and two drops of phenolplithalein index was added. The result was annulled precisely with a many drops of sodium hydroxide until a faint pink colour was noted. 2 ml of annulled formaldehyde was added to each sample using a clean hype and the result was swirled and left to stand for 2 twinkles. The performing result of the sample was also titrated with standard sodium hydroxide until a endless pink color was achieved. The burette readings were taken for each sample. The process was repeated 3 times so as to gain the average volume of the readings



Blank Preparation Procedure

The blank readings were attained by titration 2ml of 40% formaldehyde result plus 10ml of distilled water with 0.1ml NaOH (sodium hydroxide result). The crude protein was attained using the following formula.

% crude protein = $V_a - V_b \times \text{formula factor}$

Where V_a = volume of 0.1M NaOH used to titrate after addition of formaldehyde

V_b = volume of 0.1M NaOH used to titrate blank formula factor = 4.26.

$V_a - V_b$ = formaldehyde value

Therefore: % crude protein = $V_a - V_b \times 4.26$

2.4.6 Total Carbohydrate Determination

This was determined using the AOAC (Association of sanctioned agrarian druggists) (2010) standard. The sum of the remaining ingredients are added up and abated from 100. The value attained from the procedures gave the crude carbohydrate contents of the sample. Carbohydrate can be calculated using the ensuing expression. Carbohydrate = 100- (crude protein crude lipid ash moisture content crude fibre) %

3.0 Results and Discussion

3.1 Results

Proximate composition	Spinach	Cucumber
Moisture (g/100g)	29.00±0.07	30.00±0.6*
Ash(g/100g)	13.00±0.4	10.00±0.7*
Fat(g/100g)	24.50±0.3	25.00±0.3*
Crude Fiber(g/100g)	12.00±0.4	12.50±0.42*
Protein(g/100g)	1.50±0.4	1.58±0.43*
Carbohydrate(g/100g)	20.00±0.07	20.92±0.56*

Values are mean ± standard deviation of triplicate determinations

3.2 Discussion



The result shows the composition and analysis of cucumber and spinach leaves. The percentage composition of moisture content is 30% on cucumber while spinach leaves is 29% which is in agreement with the research of Oluwafemi *et al.*, 2019 and slightly lower than Sofora, 2018. Fat content of cucumber is 25.00 and that of spinach leaves is 24.50% which is in agreement with the research work of Sofora, 2018. Cucumber has the highest crude fibre of 12.50 while spinach is lower 12.00. The Ash content of cucumber is 10% and spinach is 13%, the percentage of protein present in cucumber is 1.58 while spinach is lower with 1.50 % and carbohydrate content of both of them is 20.92% and 20% respectively.

4.0 CONCLUSION

Form the results of the analyses, it can be shown that cucumber and spinach leaves could be important green leaves vegetables as a source of nutrient to food supplement. Based on the findings, cucumber have the higher composition than spinach in the respective parameter, moisture content, crude fibre, fat content, protein and carbohydrate content while spinach have the higher of ash content. Both vegetables are good for human consumption.

Cucumber and spinach are rich in vitamins and minerals based on this finding; it is recommended that:

- Cucumber and spinach should be used in making sandwiches and salads owing to their high nutritional value
- It should be given to pregnant women and children so as to meet up the body nutrient.
- Further study should be carried out to understand the phytochemicals and antinutrients present on both the Cucumber and Spinach.



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APPLICATION OF PROPORTION DEFECTIVE CONTROL METHOD ON WEEKLY SACHET WATER PRODUCTION IN LOKOJA

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Abstract

This study examines the Proportion defective in weekly sachet water production. The data was collected from Ebunza venture Limited Lokoja Kogi state. The research is aimed to monitor the proportion of the number of defective in sachet water produced every week, during a year under production. Secondary source of data collection was used to obtain 50 sample size of sachet water. From the chart, we found the P-chart has three control limits which consist of the Upper Control Limit (UCL), Lower Control Limit (LCL) and Centre line values were 0.377, 0.0344 and 0.206 respectively. The maximum acceptable proportion of defective units is 0.377 if the proportion of defectives exceeds this limit the process is considered out of control and need attention, The minimum acceptable proportion of defectives units is 0.0344 if the proportion of defective fall below this limit, the process is also considered out of control and needs attention and the center limit = 0.206 represent the average proportion of defective units in the process and the target value that the process is aimed at, though there is no complete natural cause of variation. But from the result we found the process to be in control.

Keyword: P-chart, Sachet water, Process control, Lokoja



1.0 INTRODUCTION

Sachet water a brand of packaging water has gradually become the most widely consumed liquid for both the rich and the poor in Nigeria, it is a cheaper alternative of the affluent hygiene purity tastes and most importantly safety is probably amongst various reasons for sachet stream water consumption unfortunately the problems of its purity and health concerns have begun to manifest. Sachet stream water is regulated as a food product in Nigeria by national agency for foods drugs administration and control (NAFDAC) the agency relies on world health organization standard for the product regulation registration and certification, there has been a tremendous improvement in sachet water regulation by NAFDAC as the number of illegal producers has drastically reduced and most brand on sale now have NAFDAC registration number. The Global Sachet Water market is anticipated to rise at a considerable rate during the forecast period, between 2023 and 2030. In 2022, the market is growing at a steady rate and with the rising adoption of strategies by key players; the market is expected to rise over the projected horizon. North America, especially The United States, Europe also plays important roles in global market, with a magnificent growth in CAGR during the Forecast period 2022-2029.

Chemical contaminants such as PTEs pose health risks to water consumers, while physical parameters such as colour, taste, and odour make water unpleasant to drink ([WHO, 2017](#)). To illustrate, PTEs such as As, Cd, Hg, and Pb have no health benefits when ingested through drinking water; rather, they are associated with cardiovascular disorders, renal injuries, and cancer risk in humans ([Yao et al., 2021](#)). Also, they can induce neurotoxicity, oxidative stress, and alter immune systems in aquatic animals ([Ihunwo et al., 2020](#)). A. K. Singh et al. (2019) in a paper titled "Water Quality Monitoring Using Statistical Process Control" concludes that Proportion defective charts effectively monitored water quality parameters like pH, turbidity, and bacterial contamination. S. K. Goyal et al. (2018) in a paper titled "Application of Statistical Quality Control in Water Treatment Plant concludes: Proportion defective charts identified abnormal variations in water quality parameters, enabling timely corrective actions. R. K. Sharma et al. (2017) in a paper "Water Quality Analysis Using Control Charts" opined that: Proportion defective charts were useful for monitoring water quality parameters like BOD,



COD, and TSS. A. M. Abdel-Salam et al. (2016) "Statistical Quality Control in Water Supply Systems" opined that, Proportion defective charts monitored water quality parameters like chlorine residual and pH effectively. H. A. Najafabadi et al. (2015) "Monitoring Water Quality Using Statistical Process Control Concludes: Proportion defective charts detected anomalies in water quality parameters like turbidity and bacterial contamination. P. S. Kumar et al. (2014) "Water Quality Control Using Statistical Methods" opined: Proportion defective charts were applied to monitor water quality parameters like pH, temperature, and conductivity. "Application of Control Charts in Water Quality Monitoring" by S. S. Rao et al. (2013) concludes: Proportion defective charts effectively monitored water quality parameters like BOD, COD, and TSS. "Statistical Quality Control in Water Treatment Plants" by A. K. Verma et al. (2012) opined that Proportion defective charts identified abnormal variations in water quality parameters, enabling timely corrective actions. "Water Quality Analysis Using Statistical Methods" by R. K. Garg et al. (2011) opined that: Proportion defective charts were applied to monitor water quality parameters like pH, turbidity, and bacterial contamination. "Monitoring Water Quality Using Proportion Defective Charts" by S. K. Singh et al. (2010) Concludes: Proportion defective charts effectively monitored water quality parameters like chlorine residual and pH. Statistical quality control method are analytical tools for evaluate materials, method, or process.

This research work is aim at determining the defect process of sachet water, and its state of statistical process control.

2.0 MATERIAL AND METHODS

2.1 STUDY AREA

Nigeria is the most populous country south of the Sahara. She has 36 States and federal capital in Abuja. By geo-political system, she has six zones namely South-East, South-South, North-West, North-East, North-Central and South-West. Kogi state is located in the North – Central region of Nigeria, with a focus on sachet water production in Lokoja kogi state.

2.2 STUDY POPULATION



The study population involved records of fifty (50) sample size sachet bags of water produced per week for the period of thirty weeks obtained as a secondary source of data collection from Ebunza water ventures Lokoja.

2.3 SAMPLING METHODS

Simple random sample method was used to identify the defective units or number, in which case every unit of the sachet water out a total population of fifty sample size was observed to identify the defective ones or units. The P chart is given thus;

$$= \bar{P} + 3 \sqrt{\frac{\bar{P}(1-\bar{P})}{n_j}}$$

Limits where n are the size of the sample that produces the ith observation of p-chart control limits are:

$$\sqrt{\frac{\bar{P}(1-\bar{P})}{n_j}}$$

Use control limit based on an average sample size where n is the average size of all the samples on p – chart.

$$\bar{P} = \frac{D_i}{n}; i = 1, 2, 3, \dots, m. D_i \text{ is the nonconforming units in the } i\text{th sample}$$

Compute $\bar{P} = \frac{\sum_i^m \bar{P}}{m}$ where the statistic $\bar{P}$ estimates the unknown Fraction conforming p.

The control limit is given by:

$$UCL = \bar{P} + 3 * \sqrt{\frac{\bar{P}(1-\bar{P})}{n_j}}$$

$$\text{Central line} = \bar{P}$$

$$LCL = \bar{P} - 3 * \sqrt{\frac{\bar{P}(1-\bar{P})}{n_j}}$$

With p – chart a sample is taken periodically from the production process and the proportion of defective items in the sample is determined to see if the proportion falls within the control



limits on the charts. although a p –chart employs a discrete attribute measure i.e. number of defective items and thus is not continue , it is assumed that as the sample size of get large , the normal distribution can be used to approximate the distribution of the proportion defective . this enables us to use the following formula s based on the normal distribution to compute the upper control limit (UCL) and lower control limit [LCL] of a p – chart .

$$UCL = p + z \sigma p$$

$$UCL = p + z \sigma p \text{ where}$$

z = the number of standard deviations from the process average

p = the sample proportion defective, an estimate of the process average.

σp = the standard deviations of the sample proportion. The sample standard deviation is computed. Where n is the sample size. Without a control chart, there is no way to know if the process has changed or to identify sources of process variability.

3.0 RESULTS AND DISCUSSION

3.1 RESULTS

DATA ANALYSIS

Defective	PPOI1	CENL	CONL1	CONL2	SSIZ1
6	0.12	0.206	0.0344147	0.377585	50
8	0.16	0.206	0.0344147	0.377585	50
10	0.20	0.206	0.0344147	0.377585	50
10	0.20	0.206	0.0344147	0.377585	50
11	0.22	0.206	0.0344147	0.377585	50
4	0.08	0.206	0.0344147	0.377585	50
3	0.06	0.206	0.0344147	0.377585	50
7	0.14	0.206	0.0344147	0.377585	50
4	0.08	0.206	0.0344147	0.377585	50
5	0.10	0.206	0.0344147	0.377585	50
15	0.30	0.206	0.0344147	0.377585	50



Proceedings of the 2024 National Conference of the School of Applied Sciences, Kogi State Polytechnic, Lokoja held between 2nd – 4th July 2024.



6	0.12	0.206	0.0344147	0.377585	50
17	0.34	0.206	0.0344147	0.377585	50
12	0.24	0.206	0.0344147	0.377585	50
10	0.20	0.206	0.0344147	0.377585	50
8	0.16	0.206	0.0344147	0.377585	50
4	0.08	0.206	0.0344147	0.377585	50
12	0.24	0.206	0.0344147	0.377585	50
10	0.20	0.206	0.0344147	0.377585	50
13	0.26	0.206	0.0344147	0.377585	50
16	0.32	0.206	0.0344147	0.377585	50
12	0.24	0.206	0.0344147	0.377585	50
18	0.36	0.206	0.0344147	0.377585	50
7	0.14	0.206	0.0344147	0.377585	50
5	0.10	0.206	0.0344147	0.377585	50
18	0.36	0.206	0.0344147	0.377585	50
16	0.32	0.206	0.0344147	0.377585	50
14	0.28	0.206	0.0344147	0.377585	50
18	0.36	0.206	0.0344147	0.377585	50
10	0.20	0.206	0.0344147	0.377585	50

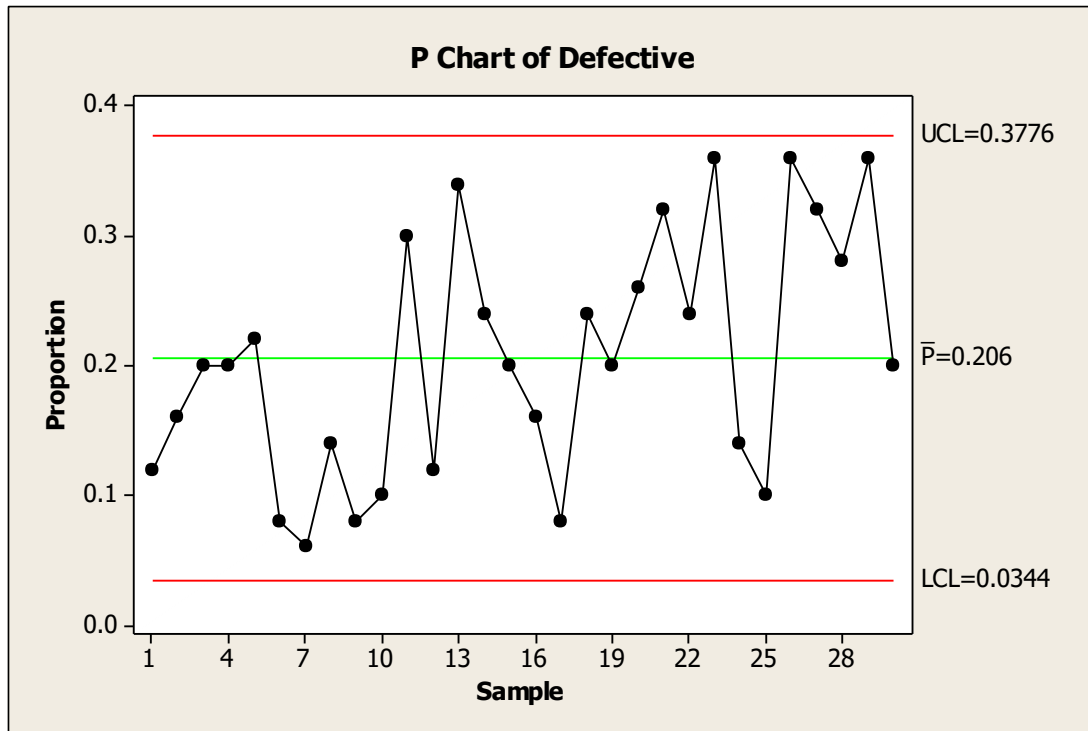


Figure 4.1: P-chart

3.2 DISCUSSION OF RESULTS

The figure 4.1, P-chart shows that the process is in control, with all the points on the chart fallen within set limits, that is the upper and lower limits, the study makes use of P-chart to track the proportion of defective units per production of sachet weekly. P-chart for the number of defective in sachet water, we had the average or center of the sample proportions to be 0.0206 and the two dashed lines are the upper control limit (UCL) and the lower control limit (LCL). The value of the UCL is 0.3776 and LCL is 0.0344, the two control limits reflected the expected amount of variation in the number of defective units, Upper control limit (UCL) = 0.3775 indicated the maximum acceptable proportion of defective units, if the proportion of defectives exceeds this limit the process is considered out of control and need attention, the Lower control limit (LCL) = 0.0344 the minimum acceptable proportion of defectives units, if the proportion of defective fall below this limit, the process is also considered out of control and needs attention and the center limit = 0.206 represent the average proportion of defective units in the process and the target value that the process is aimed at, however the variability neither exceeded the upper control limits nor the lower control limits though there is no



complete natural cause of variation.

4.0 CONCLUSION

The chart looks good because all the points vary within the control limits, the upper control 0.3776 and lower control 0.0344 which implies that the process is in the state of statistical control. The graph revealed that chance causes of variation and cyclical pattern of variation in the defective units are present.

From the findings of this study we recommend:

1. Training and retraining of workers should be encouraged in the company.
2. The workers should be more vigilant in during the production in order to reduce the amount of defective record at every production period.
3. Good raw materials should be purchased for the production. E.g. nylon etc.

Artificial Intelligence AI solutions can enhance process control by:

- Monitoring production data in real-time
- Detecting anomalies and predicting potential quality issues
- Optimizing production processes for maximum efficiency and quality
- Ensuring water security and public health safety in Lokola, Kogi State
- Contributing to economic stability by reducing waste and improving productivity
- By leveraging AI-driven process control, water production facilities can ensure a secure and stable supply of clean water, critical for public health and economic development.

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PREVALENCE AND RISK FACTORS OF ASCARIASIS (*Ascaris lumbricoides*) AMONG PATIENCE IN MURTALA MUHAMMED HOSPITAL KANO METROPOLIS, KANO STATE NIGERIA

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ABSTARCT

Ascariasis (*Ascaris lumbricoides*) is an intestinal parasite in human. This study was carried out to determine the prevalence of *Ascaris lumbricoides* infestation among patience in Murtala Muhammed Hospital Kano Metropolis, Kano State Nigeria. A total of 200 stool samples were collected, the stool sample was collected in a sample bottle labeled with the patient name, age, and sex. A drop of normal saline was placed on the center of microscopic slide, 2mg of stool sample was taken and mixed with saline solution on the slide and covered with coverslip and was examined under microscope. Out of 200 stool sample viewed under microscope only 17 (8.50%) samples were positive to *Ascaris lumbricoides* infestation. Based on age and sex group, age group 3-15 years a total of 47 samples were collected and viewed under microscope and 9 (19.10%) samples were positive of the 9 samples that were positive, 6 (66.7%) samples were male and 3 (33.3%) samples were female. Age group 16 – 28 years 55 samples were collected and viewed under microscope and 6 (10.9%) samples were positive of these 6 samples 5 (83.3%) were male while 1 (16.7%) was female. Age group 29 – 41 years 98 sample were collected and view, only 2 (2.00%) samples were positive and the 2 were male. This study showed that *Ascaris lumbricoides* infestation is more common in children within the age of 3 and 15 years and requires annual de-worming to control morbidity associated with intestinal parasite.

Keywords: *Ascaris lumbricoides*, stool samples, microscope, microscopic slide, coverslip, saline, sample bottle Murtala Muhammed Hospital Kano.



1.0 INTRODUCTION

Ascaris lumbricoides a nematode, or roundworm, which parasitizes the human gastrointestinal tract is one of the major human intestinal parasites especially in the children. It may be due to fertilization capacity of female worms to deliver huge numbers of eggs that are characterized by being profoundly safe to natural conditions as well as to the case of contamination among individuals due to the injection of eggs containing the hatchlings in its moment arrange with nourishment and water that are sullied with them. There is no insusceptibility when re-infection happens.

Worldwide, *ascaris lumbricpoides* is among the most common helminth human infections with an estimated 800 million to 1.2 billion people affected, and it causes more than 60,000 deaths annually (shah *et al.*, 2018; Dold and Holand 2011). Infection occure in both male and female, but children are more susceptible to infection compared to adults, especially between the age of 3 and 8 years (Scolt 2008)

Ascaris lumbricoides is the large round worm of humans, growing to a length up to 31cm (12 inches in male) and 49cm (19 inches in female) *A. lumbricoides* infection is a major public health problem especially in developing countries and infects the gastrointestinal tract of man (Tefara *et al.*, 2017; Sowol *et al.*, 2017). *A. lumbricoides* are soil transmitted helminth (STH), a group of human gastrointestinal nematodes transmitted through injection of embryonated eggs in raw vegetables, water or soil contaminated hand and through direct contact with eggs or larva in the soil environment (Asemoto *et al.*, 2014; Iwu *et al.*, 2016). *A. lumbricoides* infection are among the most prevalent and widespread chronic human intestinal infection worldwide with the greatest public health burden occurring in developing countries, particularly in sub-Sahara Africa (De Silva *et al.*, 2003; Bethony *et al.*, 2006). *A. lumbricoides* infection rate among children is more prevalent in countries with poor socio-economic status, where living conditions are unhygienic and untreated wastewater, unsafe and inadequate provision of water, poor personal hygiene and environmental sanitation (Pal and Anberber 2014; WHO 2019).

Ascariasis lumbricoides infection associated with socio-economic status (poverty and sanitation), socio-demographic factors including source of drinking water at home (protected or unprotected), absence of toilet at the home, toilet type, poor personal hygiene and environmental sanitation, drinking polluted water, eating contaminated food with *A.*



lumbricoides eggs, eating unwashed or raw vegetables, lack of hand washing before meal and after defecation. The highest risk factors for contracting *A. lumbricoides* infection are poor sanitation and poor hygiene (Chen *et al.* 2007).

Poor environmental sanitation, irrigation, overcrowding, relocation, and low altitude were prompt to be blame for high prevalence of internal organ parasitic infection within the country (Tedla 1981; Tedla and Jemaneh 1985). Unfortunately, data is lacking on the burden of intestinal parasites among the patience in Murtala Muhammed Hospital Kano. Therefore, the proposed work was the first attempt to determine the prevalence of *A. Lumbricoides* associated with the patience from the study hospital. The result of the proposed study is highlighted and discussed briefly below. Analysis facts may provide evidence on the dissemination and generality of intestinal parasites and may aid in suggesting a new plan to combat those groups that might be at risk of infection.

Final, data were summarized in percentage and presented in the form of tables. P value < 0.05 were considered as statistically significant.

2.0 METHOD

Inclusion Criteria: The study was consented and enrolled patience from three different age group in Murtala Muhammed Hospital Kano, willing to participate in accordance with written consent to participate, and able to give a stool sample and undergo 10 minutes face to face interview.

Exclusion Criteria: The participants were excluded from the study if they are unwilling to participate in accordance with written consent to participate and were not ready to give a stool sample and undergo 10 minutes face to face interview.

Sampling Procedure: After proper instruction, each patient was given clean, dry, and leak-proof sample bottle along with piece of applicator sticks to bring proper fresh stool sample. All participants were informed to bring approximately 5g of stool sample so that no contaminant can be mixed. The unique code (sex, age, grade level) of the patient was labelled on collection of the stool sample.

A total of 200 samples were collected and examined, two techniques were used for each sample.

➤ Direct Microscopic Examination



A drop of normal saline was placed on the center of microscopic slide, 2mg of stool sample was taken and mixed with the saline solution on the slide and covered with coverslip and then examined under microscope. Helminth's eggs were observed under microscope (10 x 10 and 10 x 40).

➤ **Sedimentation**

In 5ml of a 5% acetic acid solution 1g of stool sample was suspended by shaking, the suspension was kept for 1 minute to settle and then filtered through a tea sieve in a centrifuge tube, and equal amount of ether was added, mixed and shaken vigorously and centrifuged for 1 minute at 1500rpm. The sediment containing eggs was formed in the centrifuge tube with above is the acid layer and ether layer, between the ether and the acid layer there was a layer of dirt that was removed from the tube by means of an applicator. The supernatant (ether, acid, and dirt) was decanted all at once only sediment remained and that was diluted with water, mixed homogeneously, a few drops of the mixture was placed on glass slide and examine under microscope (10 x 10 and 10 x 40)

Data Collection

Data were collected by conducting face to face interview from the patience in Murtara Muhammed Hospital Kano. Questionnaire involve sex of the patience, age of the patience, habit of hand washing before meal and after defecation, toilet type which the patience used, drinking water source, educational level of the patience/parents, presence or absence of toilet at their home and eating habit of unwashed raw vegetables.

Data Analysis

Data were analyzed by using SPSS statistical software package version 27. Descriptive statistics were calculated to describe the study population characteristics and infection rate of *A. lumbricoidse*. Chi-square used to analyze association between *A. lumbricoides* infection and associated risk factors among patience in Murtala Muhammed Hospital Kano. The dependent variables were the infection rate of *A. lumbricoides* (positive or negative status of *A. lumbricoides*).Independent variables were the grade level of patience, age category of patience, sex, washing habit of vegetables, fruits and hands, water handling practice, eating habit of raw



vegetables, personal hygiene practice, parent income levels, parents educational level, the habits of environmental sanitation and presence or absence of toilet

3.0 RESULTS AND DISCUSSION

3.1 RESULTS

From the 200 patients selected all 200 (100%) provided a stool sample for this study. 48.0% of study subjects were males and 52.0% of study subjects were females. Seventeen of the study subjects 17/200 (8.5%) had a stool sample positive for *A. lumbricoides*. Male participant (13.5%) showed a higher infection rate than female participants (3.85%). About age groups, age from 3-15 years had higher prevalence (19.1%) compared to age from 16-28 years 6(10.9%), 29-41 and above had the lowest prevalence 2(2.00%).

Socio-demographic Characteristics

A total of 200 male and female patients selected of different age groups and divided into three age groups (3-15 years, 16-28 years and 29-41 years and above). Out of 200 participants 96 (48.0%) were male patients and 104 (52.0%) were female. About 47(23.5%) of the patients were in the age group of 3-15 years, 55 (27.5%) were in the age group of 16-28 years and 98(49.0%) were in the age group of 29-41 years and above. 30.0% of the parents were found illiterate, and they didn't know anything about an intestinal parasite. Regarding sanitary characteristic, use of unprotected water accounts 117 (58.5%), 13(6.50%) patients lack of toilet at home, 38(19.0%) patients never wash their hands before eating food and 10 (5.50%) never wash their hands with soap after defecation. In addition, 88 (44.0%) of the patients always eat raw unwashed vegetable (table).

Prevalence of Intestinal Parasites

From the 47 participants stool sample examined, 9/47 (19.1%) participants were found positive (+) for *A. lumbricoides* infection from age group of 3-15 years. Out of 55 participants from age group of 16-28 years, 6/55 (10.9%) participants found positive (+) for *A. lumbricoides* infection. From 98 participants stool samples examined by microscopy, 2/98 (2.00%) participants were found positive (+) for *A. lumbricoides*



infection of age group 29-41 and above years. The highest prevalence of *A. lumbricodes* infection 9/47(19.1%) was observed in children of age 3-15 years and age group of 16-28 years 6/55(10.9%) and lowest prevalence of *A. lumbricodes* infection was reported in age group 29-41 and above 2/98(2.00%) by using the microscopic examination of stool sample.

Other Helminthes Observed During Microscopic Examination

Two different helminth species were identified among the study subject with the most dominant helminth parasite being *A. lumbricodes* 17/200(8.50%) followed by *Tania solium* 13/200(6.5%) and *Ancylostomaduodenale* 9/200(4.5%). Distribution of intestinal helminth parasites infection in patients surveyed showed that the highest infection rate of *A. lumbricodes* followed by *Tania solium* in the selected patients in Murtala Muhammed Hospital Kano.

Table 1

Socio-demographic and characteristic of the study participants

Characters		Frequency	Percentage
Socio-demographic factors			
Sex	Male	96	48.0
	Female	104	52.0
Age	3 – 15	47	23.5
	16 – 28	55	27.5
	29 – 41 and above	98	49.0
Parent educational categories	Illiterate	60	+30.0
	Elementary	70	35.0
	Secondary	45	22.5
	Diploma/Degree	25	12.5
Sanitary Factors			
Source of drinking water	Protected	83	41.5
	Unprotected	117	58.5
	Present	187	93.5



Status of latrine at home	Absent	13	6.50
Latrine type	Pit with cover	80	42.8
	Pit without cover	107	55.2
Place of defecation	Open field	7	53.8
	Neighbor latrine	2	15.4
	Public latrine	4	30.8
Hand wash with before mael	Always	51	25.5
	Some times	111	55.5
	Never	38	19.0
Hand washing with soap after defication	Always	20	10.0
	Sometimes	99	49.5
	Never	81	40.5
Eating habit of unwashed raw vegetables	Always	88	44.0
	Sometime	101	50.5
	Never	11	5.50

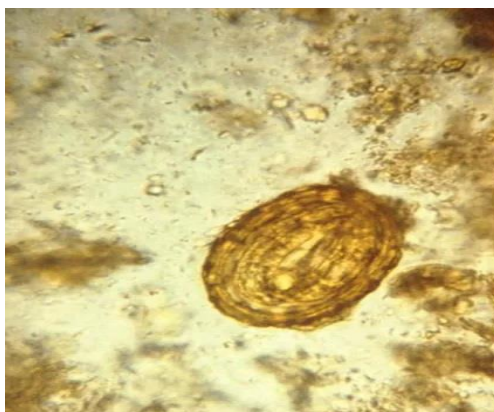


Figure 1 A. *lumbricoides* egg

Table 2: Prevalence of *Ascaris lumbricoides* among Patience in Murtala Muhammed Hospital Kano



Helminths	Ascariasis (+) or (-) %			Over all infection (%)
	3 – 15 N=47	16 – 28 N=55	29 – 41 and above N=98	
<i>Ascaris lumbricoides</i> +	9 (19.1)	6 (10.9)	2 (2.00)	17 (8.50)
<i>Ascaris lumbricoides</i> -	38 (80.9)	49 (89.1)	96 (98.0)	183 (91.5)

Table 3

Distribution of other Helminths Infection Observed during Microscopic Examination of Patient Stool Sample

S/N	Helminths	Patient			Total infection (%)
		3 – 15 N=47 (%)	16 – 28 N=55 (%)	29 – 41 + N=98 (%)	
1	<i>Ascaris lumbricoides</i>	9 (19.1)	6 (10.9)	2 (2.00)	17 (8.50)
2	<i>Tania solium</i>	7 (14.9)	5 (9.10)	1 (1.00)	13 (6.50)
3	<i>Ancylostoma duodenale</i>	5 (10.6)	3 (5.50)	1 (1.00)	9 (4.50)
	Total	21 (10.5)	14 (7.00)	4 (2.00)	39 (19.5)

Table 4

Prevalence of *Ascaris lumbricoides* among Patient in Mutala Muhammed Hospital Knao by Age and Sex



Age and Sex		Total No. Examined (%)	No. of Ascariases Pos (+) (%)	No. of Ascariases Neg (-) (%)	χ^2	P-Value
Sex	Male	96 (48.0)	13 (13.5)	83 (86.5)	6.034	0.014
	Female	104 (52.0)	4 (3.85)	100 (96.15)		
Age	3 – 15	47 (23.5)	9 (19.1)	38 (80.9)	12.52	0.002
	16 – 28	55 (27.5)	6 (10.9)	49 (89.1)		
	29 – 41+	98 (49.0)	2 (2.00)	96 (98.0)		

Table 5

Association between *Ascarislumbricoides* infection with parent's educational level, and source of drinking water among study participants.

Risk factors (Variables)		Total No. examined (%)	No. of Ascariasis Pos(+)(%)	No. of Ascariasis Neg(-) (%)	χ^2	P-Value
Parent's educational level	Illiterate	60 (30.0)	8 (13.3)	52 (86.7)	2.703	0.440
	Elementary	70 (35.0)	4 (5.70)	66 (94.3)		
	Secondary	45 (22.5)	3 (6.70)	42 (93.3)		
	Tertiary	25 (12.5)	2 (8.00)	23 (92.0)		
Source of drinking water	Protected pipe water	83 (41.5)	11 (13.3)	72 (86.7)	4.121	0.42
	Unprotected	117 (58.5)	6 (5.10)	111 (94.9)		

Table 6

Association between *Ascarislumbricoides* Infection and Present or Absent of Toilet at Home, Types of Toilet, Place of Defecation in the Study Area.



Risk factors (variables)		Total No. examined (%)	No of ascariasis Pos (+) (%)	No of ascariasis Neg (-)	χ^2	P Value
Latrine facilities at home	Present	187(93.5)	5(2.70)	182(97.3)	125.6	0.001
	Absent	13(6.50)	12(92.3)	1(7.70)		
Latrine type	With cover	80(42.8)	1(1.25)	79(98.75)	1.089	0.297
	Without cover	107(57.2)	4(3.74)	103(96.26)		
Place of Defecation	Open field	7(53.8)	7(100)	0(0.0)	5.958	0.051
	Neighbor toilet	2(15.4)	1(50.0)	1(50.0)		
	Public toilet	4(30.8)	4(100)	0(0.0)		

Table 7: Association between *A. lumbricoides* Infection with Habit of Hand Washing with Soap before Meal, after Defecation, and Eating Habit of Unwashed Raw Vegetables

Risk factors		Total No. examined (%)	No. of Ascariasis Pos(+) (%)	No. of Ascariasis Neg (-) (%)	χ^2	P Value
Hand washing before meal	Every time	51(25.5)	3(5.90)	48(94.1)	13.993	0.001
	Some time	111(55.5)	5(4.50)	106(95.5)		
	Never	38(19.0)	9(23.7)	29(76.3)		
Hand washing with soap after defecation	Every time	20(10.0)	2(10.0)	18(90.0)	3.113	0.211
	Sometime	99(19.5)	5(5.00)	94(95.0)		
	Never	81(40.5)	10(12.35)	71(87.65)		



Eating Habit of unwashed raw vegetable	Every time	88(44.0)	11(12.5)	77(87.5)	5.812	0.055
	Sometime	101(50.5)	4(4.00)	97(96.0)		
	Never	11(5.50)	2(18.2)	9(81.8)		

3.2 DISCUSSION

The two known soil-transmitted helminth infections, *Ascarislumbricoides* and *Taniasolium* are major clinical disorders in man especially in children. The gastrointestinal tract of a child living in poverty in a less developed country is likely to be parasitized with at least one and in several cases these two soil-transmitted helminth, with resultant impairment in physical, intellectual, and psychological development (Bethony *et al.*, 2006).

On the other hand, this finding showed that the prevalence of intestinal parasite was lower than the studies conducted among children conducted in, Dawro Zone (47.3%) (Alemayehu and Tomas 2015), Chench Town (60.5%) (Abossie and Seid 2014), Wondo-genet (83.4%) (Berhanu and Germany 2003). These differences in prevalence of *A. lumbricoides* in different study areas may be due to the differences soil types, geographic, environmental sanitation, economic and educational status of parents, accessibility of safe drinking water, personal hygiene socioeconomic conditions as well as differences in an altitude (Padmaja *et al.*, 2004). This finding indicates that the source of *A. lumbricoides* infection might be contaminated stool, vegetables, water and food by *A. lumbricoides* eggs. Transmission of *A. lumbricoides* is by the ingestion of the infective eggs from soiled hands and food contaminated with human stool (Bethony *et al.*, 2006).

The overall prevalence of *A. lumbricoides* in this study was 8.5%. According to WHO, soil-transmitted helminth endemic area classification, there are three categories in line with the application of MDA: (i) high transmission (where prevalence is > 50%), (ii) moderate transmission (where prevalence is between 20 and 50%) and (iii) low transmission (where prevalence is < 20%) (WHO 2006: 2012). As such the proposed area of work can be classified as low transmission group. Calling for deworming yearly.

4.0 CONCLUSION

In general, this study showed a high prevalence of *A. lumbricoides* within the selected patients of the study indicated that parasitic infection are a major public health issues. This study has



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additionally discovered that *A. lumbricodes* a typical parasite species that causes infection among children of 3-15 years old. Therefore, there is an urgent need to improve socioeconomic status, enhancing sanitation services, instilling health education and to implement integrated control programs for *A. lumbricodes* infection prevention.

At the end of the research, the following are recommended.

- Government should provide good water source in primary school.
- Government should also organize sensitization campaign on the dangers of intestinal helminthes.
- People should be advised to always practice and maintain good sanitary conditions.



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AWARENESS ON BIOMASS BRIQUETTES PRODUCTION AND ADOPTION IN AYEDE- AMURO COMMUNITY IN KOGI STATE AS A RENEWABLE ENERGY SOURCE FOR SUSTAINABLE DEVELOPMENT

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ABSTRACT

The pressing challenges of climate change and access to clean and affordable energy in rural and urban areas and the importance of sustainable development in the world as a whole have become very imperative. This study examines the economic impact of briquette adoption in rural communities, with a particular focus on its potential to foster economic development, alleviate poverty amongst rural dwellers, and enhance environmental sustainability. Biomass is a renewable energy that is very abundant in our environment and it presents an alternative to fossil fuel; however, it is generally considered a waste in Nigeria. The effective utilization of these materials offers many advantages among which is being a renewable and sustainable energy feedstock for the production of solid fuel -briquettes. One method of achieving this is through briquetting. Briquetting is a relatively new technology in Nigeria as it is in most African countries. The adoption of the energy from biomass briquettes would help Improve access and adoption of the life changing products to end users influencing their lives socially, economically and financially, improving sales and stability which will translate to more employment and more taxes for the government and improve the economy of Nigeria. This study explained how agro waste and other environmental waste can be harnessed and converted to other products through the process of gathering, sorting, mixing, forming into shapes, drying and packaging thereby reducing reliance on fossil fuel as a means of generating energy, and mitigating deforestation which in turn reduces the effect of greenhouse gases and its role in the development of rural livelihood challenges and recommendations.

Key words: Renewable Energy, Briquette Adoption, Sustainable Economy



1.0. INTRODUCTION

Nigeria, the largest African country, faces underdevelopment in its power sector and relies heavily on dwindling fossil fuel reserves. However, the country's abundant renewable energy resources, including hydropower, solar, wind, and biomass, can help increase energy supply, universal energy access, and reduce greenhouse gas emissions (Patomsok, W. 2008 p7). Biomass, a renewable organic material, is a promising energy source for developing nations, but its use exposes women and children to harmful pollutants. Agricultural waste, such as wood pulp and coconut shells, can be combined with coal for a more economical and environmentally friendly fuel source. Biomass briquettes can be an efficient energy source, transforming waste materials and plant residues into clean fuel (Onuegbu, T. U. 2010, P. 35-39).

The need for long-term sustainable development in Nigeria's rural communities is significant, as poverty rates are higher in these areas compared to urban areas. Agriculture plays a crucial role in their economic development, and the use of renewable energy, such as biomass briquetting, can help boost rural economies. This transition can create opportunities for a **new** rural bio-based economy, reducing the indiscriminate burning and disposal of agricultural waste. The renewable energy sector is labor-intensive, making it a significant source of employment (Grassi, G. 2023). The transition to biomass as an energy resource can also help address the issue of indiscriminate burning and disposal of agricultural waste (Trebbs, G. 1993, 46: 23 – 29).

Briquettes, compressed biomass fuel, are gaining interest as a sustainable alternative to traditional fuels in rural areas. They offer benefits like reduced carbon emissions, improved indoor air quality, and reduced deforestation. However, their economic impact requires thorough examination, considering household income, job creation, entrepreneurship opportunities, and market dynamics.



This study explores the economic impact of briquette adoption in rural communities, aiming to inform policymakers, development organizations, and stakeholders for sustainable energy solutions and inclusive economic growth.

Briquette making aims to provide clean cooking fuel, reduce indoor air pollution, save time on firewood fetching, and lower energy costs compared to charcoal, assess the economic benefits of briquette adoption in rural communities, including income generation and cost savings, to analyze the entrepreneurial opportunities associated with the production, marketing, and distribution of briquettes in rural areas , as well as to provide recommendations for policymakers, development practitioners, and community stakeholders on effectively promoting and sustaining briquette adoption for economic development in rural communities.

2.0 LITERATURE REVIEW

2.1. Renewable Energy in Nigeria

Nigeria has significant potential for renewable energy sources, but their implementation has been slow due to deforestation and lack of sustainable wood harvesting. The Renewable Energy Master Plan aims to diversify Nigeria's energy mix and reduce dependence on fossil fuels, but the country needs to develop sustainable biomass energy sources to meet energy demands and address health issues.

2.2 Briquette History

Briquetting, a process of converting organic chemical energy into fuels, began in the late 70s with European companies using briquette making machines. African countries like Nigeria, Gambia, Malawi, Kenya, and Zimbabwe adopted briquette making plants. Renewable energy, particularly biomass energy, has gained interest due to rising fossil fuel prices, decline in export volume, and power utility crises. (Emodi, N. V., & Boo, K. J. 2015,p. 51, 356-381).

2.3 Characteristics of Biomass Briquettes

Biomass briquettes, made from agro and forestry residues, offer a sustainable alternative to non-renewable energy sources in developing countries like Nigeria. They reduce pollution, offer better combustion properties, and aid in waste management, reducing deforestation and greenhouse gas emissions. Biomass briquettes, produced from various biomass sources like



corn stalk, sugar cane bagasse, wheat straw, grass, rice straw, and rice husk, have a calorific value of 16,800-18,500KJ/Kg.

2.4. Limitations to the use of biomass briquettes

1. Knowledge Gap: The adoption of biomass briquettes in Nigeria faces challenges due to lack of awareness, inadequate infrastructure, and limited market acceptance. Consumer preferences, cultural practices, and perceived convenience of traditional fuels contribute to the slow market uptake in rural communities. (Onwudili, J. A., Williams, P. T., & Ogah, E.2020, p. 162, 1278–1289).

2. Insufficient Access to Finance and Funding: Limited access to finance and funding options restricts investment in biomass briquette production infrastructure and technologies in rural areas (Abraham, M. A., Ogugbue, C. J., & Ogugbue, C. J.2019,P. 36).

2.5. Benefits of Biomass Briquette Adoption in Rural Communities

1. Economic Benefits: Briquette can replace wood fuel in households, reducing deforestation and environmental degradation. It also fosters local businesses along the supply chain (Felfli, F.F., Mesa P, J. M., Rocha, J.D., Filippetto, D., Luengo, C.A. & Pippo, W.A. 2011, P. 236 – 242).

2. Social Benefits: Biomass briquettes could improve health and wellbeing, especially in marginalized communities, by providing abundant natural resources and green cover.(World Health Organization,2016).

3. Environmental Benefits: Briquettes, a renewable fuel source, are a solution to Nigeria's deforestation and climate change issues, but their pollution and greenhouse gas emissions pose significant environmental challenges.

2.7. Appliances for Biomass Briquettes

Briquettes can be used in appliances for burning wood or coal, but changes in operating parameters, such as air distribution, are necessary. Briquettes have a density twice that of wood and low porosity, making them denser than wood or biomass charcoal due to larger surface area and lower flammability resistance.



The applications of briquettes include the following:

(1). Boilers (2). Food processing industries. (3). Domestic use. (4). Gasification

3.0. MATERIALS AND METHOD

The study was conducted in a rural area the western part of Kogi State, Nigeria. A total of 100 respondents were interviewed were mostly farmers and petty traders. The response rate represents 100% acceptance ratio, which is above the 65% level set by (Dolsen, D. E. et al 1991). Out of the total household respondents, N=100, 15% were male and. 85% were female.

Table 3.1: Respondent's Education level.

Levels of Education	Frequency	Percentage (%)
Tertiary	5	5
Secondary	14	14
Primary	70	70
Informal	11	11

Table 3.1 shows that among the respondents, n=100, 12% had tertiary and university education, 14% had secondary education, 70% had primary education and 4% had no formal education. From the study it indicated that 89% (n=89) of the respondents had primary education and above, implying that education had a role in the response being given for each question responded in the research tools applied. The education level was important to the study as part of the study's hypothesis was analyzing the relationship between relative low education and the challenges of adopting biomass briquette as alternative source of energy.

Biomass briquettes can be made from a variety of materials, including:

1. Sawdust: A byproduct of woodworking and lumber processing.
2. Agricultural residues: Such as rice husks, straw, corn stalks, and sugarcane bagasse.
3. Forestry residues: Like bark, branches, and leaves.



4. Paper waste: Shredded paper or cardboard.
5. Nut shells: Such as walnut, almond, or coconut shells.
6. Grass clippings: Dried grass can also be used as a biomass material.

Water and Binders are also used to improve briquette stability; materials like starch or molasses can also be used as binders.

3.1. Equipments

The basic materials for making Biomass briquettes includes the following:

1. Briquetting Press : Simple hand presses to large-scale hydraulic presses
2. Drying equipment: Feedstock needs to be dried before Briquetting.
3. Crusher or grinder: To reduce the size of biomass feedstock into smaller particles.
4. Mixer: To mix the biomass feedstock with any binder or water thoroughly before Briquetting.
5. Packaging equipment: Depending on the scale of usage or distribution, they're needed for packaging and sealing.
6. Weighing balance: A weighing scale is needed as it helps to determine the moisture content of the feedstock.

3.2. Briquetting Process

The Briquetting process consists of the following process:

- 1. Collection of Biomass materials or Feedstock:** The initial step involves gathering dry biomass feedstock like saw dust, agricultural or forestry residues, which should be free from contaminants and uniformly sized.
- 2. Size reduction:** This process reduces biomass materials to smaller sizes, reducing moisture content and facilitating uniform mixing and compaction.
- 3. Mixing:** The biomass material is mixed with a binder like starch, molasses, or clay to enhance the durability and strength of the briquette, sometimes requiring water for consistency.
- 4. Briquette Formation:** High pressure and temperature are applied to crushed material, forming a compact, dense briquette using press methods like piston, screw, or roller press.
- 5. Drying:** This step involves removing excess moisture from the briquette to increase its calorific value and shelf life. The drying can be done using sun, artificial, or kiln drying.



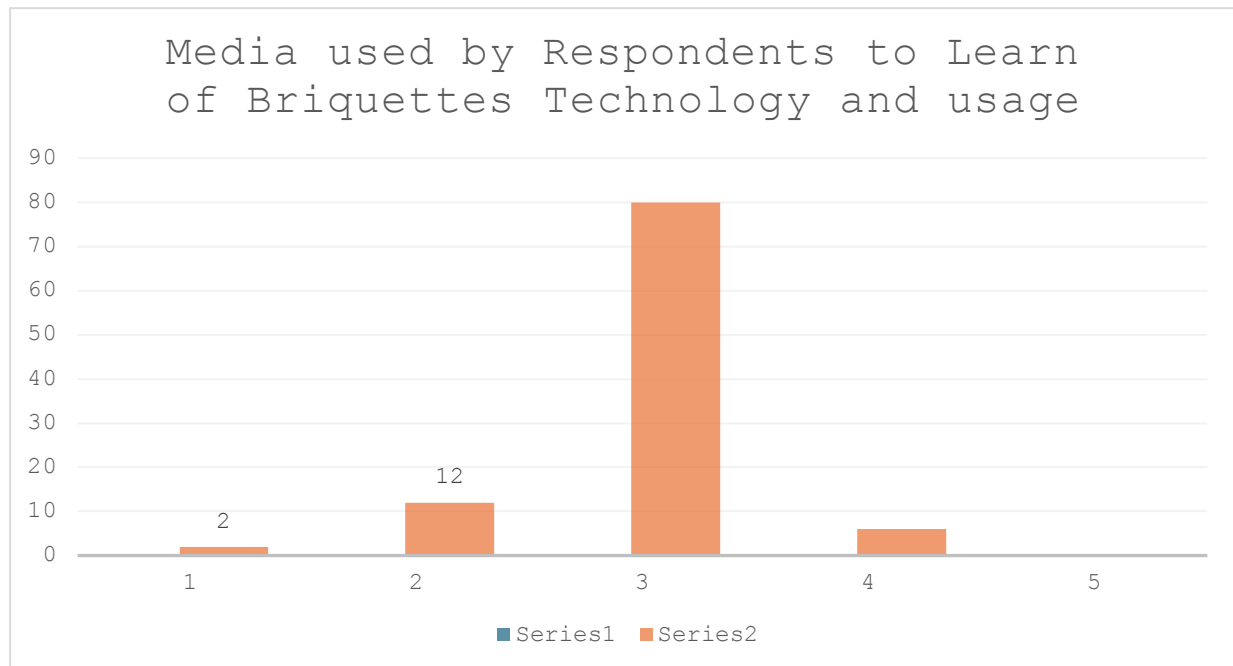
6. Cooling and Packaging: After drying, the briquettes are allowed to cool before packaging. The briquettes are packaged in suitable containers for storage or transportation (Ngo, H. H., Guo, W. S., & Chang, S. W. (2020, P. 134).

4. RESULTS AND DISCUSSIONS.

Biomass briquettes is gaining attention as a renewable energy source to address environmental issues. However, challenges include variability in feedstock, cultural preferences, resistance to change, and skepticism towards new technologies. Traditional cooking practices, resistance to change, and ingrained cultural beliefs also impact consumer behavior and adoption decisions (Almeida, L.(2021, P.45-60).

Table 4.1: Media used by respondents to learn of briquettes technology and usage.

M	PERCENTAGE %
Total number that have heard about briquettes	2
Total number that rely solely on charcoal	12
Total number that rely solely on firewood	80
total number with alternative heat source	6



From Table 4.1 above, the respondents (N=100) 98% said they have never heard about briquettes before that time therefore a lot of awareness about its usefulness and production must still be made.

Biomass briquette adoption in rural communities is hindered by limited access to briquetting equipment, infrastructure, and technical expertise. Economic viability and financial barriers, particularly in low-income regions, further exacerbate these challenges, particularly in low-income areas.(Nizami, A. 2021).

Biomass briquettes offer numerous benefits, including reduced greenhouse gas emissions, forest management, rural development, improved energy access, and indoor air quality improvement, while also reducing health risks associated with traditional fuels. Despite facing technological, economic, and logistical challenges, offer environmental sustainability, rural development, and improved public health, necessitating widespread policymakers' and stakeholders' efforts. (Ghafghazi, S. et al. 2021).



5.0 CONCLUSION

Biomass residues in Nigeria offer an alternative energy source, particularly in rural areas where agriculture is the mainstay. This would generate additional cash flow and employment opportunities, while also addressing Nigeria's high unemployment and poverty rates. Briquetting businesses could address health issues, environmental degradation, and provide a safer alternative and income source. Clean energy in households improves health, reduces climate change impacts, and saves millions, especially women and children. Adopting biomass briquettes can improve access, sales, and stability, leading to increased employment, taxes, and economic growth in Nigeria. This also contributes to achieving the NDC commitment of 20%-45% emission reduction.

Finally, the study suggests that biomass briquettes, a sustainable energy solution for rural households, can be beneficial if adequate funding, technical expertise, and awareness are provided, thereby contributing to poverty alleviation, environmental conservation, and enhanced energy access.

The Study recommends that;

1. Forest guards should be provided with adequate resources and welfare to safe guard our green cover, wildlife and other natural resources.
2. It's crucial to legislate Policies prosecuting individuals and companies that participate in indiscriminate felling of trees for wood fuel and other purposes.
3. The dwellers of the rural communities should be educated on the biomass briquette-making skills and given the funds to support them in adopting the briquette making technology, thus promoting briquettes as alternative sources of energy.
4. Established briquette making factories, be utilized to mentor the youths and women in the briquette making business, so they're educated on the relatively high demand of biomass briquettes in other energy demanding sectors.



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BIOCONTROL POTENTIAL OF *ASPERGILLUS* SPP AGAINST THE LARVAE OF *ANOPHELES* MOSQUITO.

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Abstract

Aspergillus species are common soil saprobe belonging to a group of important filamentous fungi reported to exhibit insecticidal activity against mosquitoes and other insects. The biological control potential of *Aspergillus* spp against *Anopheles* mosquito larvae was evaluated. The fungus was isolated from the soil using the soil suspension technique with selective isolation media procedures. Bioassay was conducted to determine the efficacy of conidia suspension of *Aspergillus* spp against the fourth instar larvae of the *Anopheles* mosquito. Three different concentrations of *Aspergillus* spp isolate; 1×10^1 , 1×10^2 and 1×10^3 conidia/ml were made and tested. The mortality recorded in lowest dose of 10^1 conidia /ml was 10% and 75%. The highest dose level of 10^3 conidia/ml of the isolate caused high mortality up to 40% and 85% respectively. The result showed that LC_{50} values of *Aspergillus* spp. isolate after 24, 48, 72 and 96-Hour's exposure time were 3.4×10^7 , 2.5×10^6 , 2.6×10^3 and 1.6×10^6 conidia/ml. These results revealed that conidia suspension of *Aspergillus* spp. exhibit larvicidal activity and could be used for biological control of mosquito.

Keywords: Bioassay, Larvicidal, *Aspergillus* spp, Mortality, *Anopheles* mosquito



1.0 INTRODUCTION

Malaria is a vector-borne infectious disease caused by the transmission of Plasmodium parasite by infected female *Anopheline* mosquito (Gimba and Umar, 2014). The disease is one most worrisome disease found mainly in Asia, Africa, and South and Central American regions (Kirchgatter and Del-Portillo, 2005). Over 200 species of Plasmodium have been identified as causative agents of malaria in different vertebrate hosts, of which five species, including *P. falciparum*, *P. ovale*, *P. vivax*, *P. malariae* and *P. knowlesi*, are responsible for malaria in humans (Antinori *et al.*, 2012). In an attempt to avert malaria, two lines of action, including prevention and control (vaccines and insecticides) and treatment (Anti-malaria drugs), have been utilized (Fang *et al.*, 2011). Several anti-plasmodium drugs, such as chloroquine, sulphadoxine, pyrimethamine, quinine, piperazine and others have lately been utilized as curative measures against malaria infection. In 2015, the World Health Organization reported an 18% decrease in cases and a 48% decrease in mortality compared to the year 2000 (Thu *et al.*, 2017). This stimulated efforts to eradicate malaria, which is hardly possible without effective mosquito control in a multifaceted approach that combines treatment and prevention (Hemingway *et al.*, 2016).

Several approaches have been utilized to control the mosquito population. These range from environmental sanitation, destruction of breeding sites, and mechanical control to the application of larvicides and insecticides (Jackman and Olson, 2011). These compel scientists to search for a natural, more efficient, and environmentally friendly control agent less prone to resistance (Dong *et al.*, 2016). Several biological control agents have been evaluated against larvae and adult of mosquitoes, including predatory fish, bacteria, nematodes, as well as entomopathogenic fungi and their extracts, which are the most widely exploited and preferred source of alternative bio-larvicide and insecticide (Toledo *et al.*, 2013; Paramasivam and Selvi, 2017).

Entomopathogenic fungi (EPF) are phylogenetically diverse, heterotrophic, eukaryotic unicellular or multi-cellular organisms characterized by chitinized cells that generally require an insect host to complete certain parts of their life cycle (Mora *et al.*, 2018). These fungi act by invading host insects using physical and enzymatic means to penetrate insect's cuticle and, subsequently, its hemocoel causing widespread illnesses that ultimately result to the death of

the target organism (Farenhorst *et al.*, 2008). EPF has been used effectively in controlling sucking insects, reducing the frequency of their feeding activities (Yun *et al.*, 2017). During this process, several EPF secrete certain low-molecular-weight of bio-active secondary metabolites that exhibit the insecticidal, anti-microbial, and antioxidant properties of those pathogenic fungi (Goettel *et al.*, 2005) and this resulted in a killing effect towards the host. Among these fungi includes *Paecilomyces* sp, *Aspergillus* sp, *Aspergillus* sp, *Hirsutella thompsoni*, *Beauveria bassiana* (Balsamo) Vuillemin, *Metarhizium anisopliae* (Metschn) Sorokin are the most studied fungi in terms of commercial production. Therefore, this study aims to isolate the entomopathogenic fungus *Aspergillus* spp and evaluate its efficacy as anti-larvicidal of *Anopheline* mosquito

2.0 MATERIALS AND METHODS

Soil sample collection and storage

The soil samples were collected from three locations around the Zoological Garden, Department of Science Laboratory Technology, Kogi State Polytechnic Lokoja, Nigeria (78419°N, 6.7400°E). The soil surface was first cleared of leaves and other litter, and a hole 10cm below the ground was made using a hand trowel. About 200 gram of soil was then collected in a clean polyethene bag. The soil collected was air-dried and then stored at room temperature (Dong *et al.*, 2017), an illustration of the sample site map is presented in Figure 1.

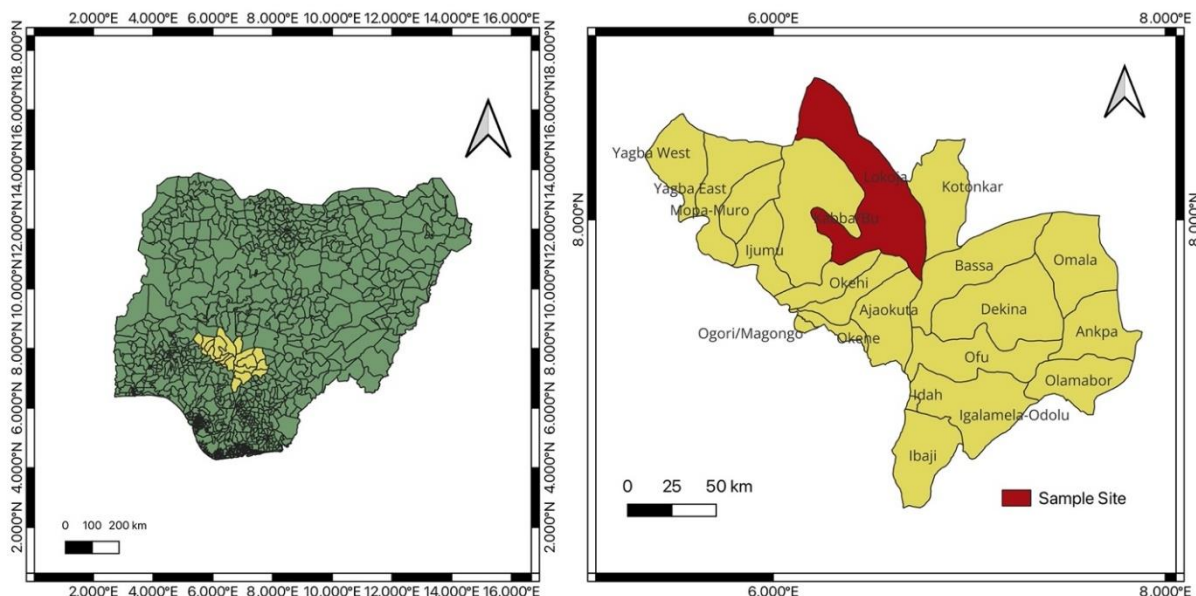


Figure 1: Sample Site Map.



Isolation and identification of entomopathogenic fungi

Aspergillus sp. was obtained by the isolation process from soil samples collected at the stated site of location. Prior to utilization, the samples underwent a meticulous mixing process and were afterwards subjected to a 0.4mm screen sieve to disintegrate any soil aggregates. The process of serial dilution involved the creation of three successive dilutions. The dilutions were applied to a selective medium known as DOA (dodine oatmeal agar) in order to screen for entomopathogenic fungi. This medium contained dodine at a concentration of 200 µg/ml (Beilharz *et al.*, 1982) and streptomycin at a concentration of 50 µg/ml (Chase *et al.*, 1986; Hazrat *et al.*, 2012). The plates underwent incubation for a duration of 14 days at a temperature of 28°C. Following a 14-day incubation period, the colonies were subjected to purification on Sabouraud dextrose agar (SDAY) and subsequently identified utilizing established mycological keys. The isolates of *Aspergillus* sp. were cultivated on a medium consisting of potato dextrose agar (PDA) and subjected to incubation at a temperature of 28°C for 14 days subsequent to inoculation. The conidia were collected using the process of scraping the surface of 14 days cultures. Next the sample was suspended in a solution consisting of 0.01% Tween80 in distilled water. The solution was agitated using a magnetic stirrer for 10 minutes. The determination of the conidial concentration of the final suspension was conducted through direct counting using a hemocytometer, as described in reference (Meyling, and Eilenberg, 2007).

Mosquito larvae rearing

The laboratory conditions for the maintenance of *Anopheles* mosquito larvae included a temperature of $27 \pm 2^\circ\text{C}$, a relative humidity of $70 \pm 5\%$, and a photoperiod of 14:10 hours. Various developmental stages of mosquitoes were kept in individual enamel containers, with a larval density of 200 larvae per container. The larvae were supplied with a composite diet consisting of yeast powder and biscuit, which was administered at a frequency of once in every 24 hours. The larvae were cultivated in distilled water at a pH of 7.0. In order to mitigate the process of evaporation, a daily addition of water was implemented.

Broth preparation



The media was prepared following the procedure of Freed *et al.* 2012 with a slight modification: 3g NaNO₃, 0.5g MgSO₄.7H₂O, 1g K₂HPO₄, 0.5g KCl and 0.01g FeSO₄.7H₂O were weighted into the 1-litre conical flask, 30g of glucose was added, and the resulting mixture was dissolved to 1-litre volume using distilled water. The media prepared was autoclaved at 121°C and 15psi for 15 minutes.

Conidia Bioassay

The bioassay was conducted adopting the protocol of WHO (2005) with slight modifications. Conidia of *Aspergillus* species were tested against mosquito larvae by adding fungal suspension to plastic cups containing 50 ml of distilled water with 20 larvae of the 4th instar. Each cup was inoculated with 1ml of fungal suspensions (10¹, 10², 10³ conidia/ml). Control treatments were carried out by addition of 10 ml of distilled water. Each assay was conducted in triplicates.

Identification of mosquito larvae

Mosquito larvae of the genus *Anopheles* were identified by the absence of a breathing tube (siphon). These larvae breathe through a cluster of small abdominal plates and possess palmate hairs (instead of lateral hair in other mosquitoes) and, thus, are observed to lie flat just below the water surface (when not diving and swimming). This categorically distinguishes them from larvae of other mosquito species, characterized by having a siphon located near the last segment of their abdomen and are therefore observed to suspend vertically at an angle (Tyagi *et al.*, 2015).

Statistical analysis

The estimation of lethal quantities causing 50% mortality (LC50) was conducted through the application of probit analysis, utilizing the Statistical Package of Social Sciences (SPSS) - 20, a statistical computer program.

Results and Discussions

Conidia Bioassay

Table 1 shows the larvicidal activity of *Aspergillus* spp conidial suspension against *Anopheles* mosquito larvae. spp. has been identified as a highly efficient biological control agent against a wide range of plant diseases, insect pests, and plant-parasitic nematodes



(Ragavendran and Natarajan, 2015). A total of approximately fifteen formulations utilizing *Aspergillus* spp have been created, as indicated by previous research (Suleiman *et al.*, 2021). **The results showed that *Aspergillus* spp conidia were pathogenic against *Anopheles* mosquito larvae after 96 hours exposure time with mortality reaching 90%.** Three different concentrations of *Aspergillus* spp isolate; 1×10^1 , 1×10^2 and 1×10^3 conidia/ml were tested. The mortality recorded in lowest dose of 10^1 conidia/ml was 10% and 75%. The highest dose level of 10^3 conidia/ml of the isolate caused high mortality up to 40% and 85% respectively (Table 1).

Table 1: Larvicidal efficiency of conidial suspension of *Aspergillus* spp against *Anopheles* mosquito

Fungal Species	Concentration (Conidia/ml)	Exposure Time			
		24Hours	48Hours	72Hours	96Hours
<i>Aspergillus</i> spp	10^1	10	20	40	45
	10^2	30	50	60	80
	10^3	40	60	80	85
Control	0	0	0	0	0

Control group treated by addition of 10 ml of distilled water recorded no mortality for, 24, 48, 72, 96-hours respectively.

The LC₅₀ values of *Aspergillus* spp

Table 2 shows the LC₅₀ values of *Aspergillus* spp against 4th instar mosquito larvae of *Anopheles* mosquito after 24, 48, 72, and 96 hours exposure time. It was observed that the LC₅₀ values of *Aspergillus* spp decreases with increase in concentration and time of exposure. The result showed that LC₅₀ values of *Aspergillus* spp. isolate after 24-, 48-, 72- and 96-Hour's exposure time were 3.9×10^8 , 2.6×10^6 , 2.6×10^4 and 1.6×10^7 conidia/ml (Table2).



Table 2: The LC₅₀ values of *Aspergillus spp* against 4th instar mosquito larvae of *Anopheles mosquito* after 24, 48, 72, and 96hours exposure time

Fungal Specie	Exposure Time (Hours)	Probit Equations	LC ₅₀ (Conidia/ml)
<i>Aspergillus spp</i>	24	0.531x + 3.285	3.4 × 10 ⁷
	48	0.242x + 2.345	2.5 × 10 ⁶
	72	0.286x + 2.267	2.6 × 10 ³
	96	0.234x + 3.255	1.6 × 10 ⁶

The LC₅₀ values for 4th instar mosquito larvae of *Anopheles mosquito* after 24, 48, 72, and 96hours decreases with increased exposure time.

4.0 CONCLUSION

This research isolated the entomopathogenic fungus *Aspergillus sp* using soil suspension procedures and DOA (dodine oatmeal agar) selective medium for screening entomopathogenic fungi. *Anopheles* mosquito was exposed to isolates of the entomopathogen *Aspergillus sp*. Results indicate that efficacy and LC₅₀ varied according to the concentration of the extract tested and exposure time. Among the two extract tests, the isolate's Chloroform extract recorded a lower LC₅₀ value than the ethyl acetate extract. It was highly pathogenic to the 4th instar larvae of the *Anopheles* mosquito but not as effective as chemical larvicides.



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ASSESSMENT OF PREVALENCE OF IXODID TICK INFESTATION AND SPECIES DISTRIBUTION AMONG CATTLE SOLD IN BANDA AND FELELE LIVESTOCK MARKETS IN LOKOJA, KOGI STATE

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Abstract

Ticks are ectoparasites of public health importance owing to their tendency to act as vectors of pathogens in wild and domesticated vertebrates, as well as posing threat of zoonoses. Tick infestation is responsible for tick-stress and tick-borne diseases in livestock. It is considered as being responsible for major economic losses in livestock business in the tropical and subtropical regions. The climatic conditions of the geographical location of Lokoja, makes it suitable for ticks to infest several wild and domesticated vertebrates particularly cattle, thus undermining their fitness and productivity. This study aimed at determining the prevalence of ixodid ticks and identifying the genus and species composition of ticks, while assessing the physical burden of their infestation. This study was carried out between February-March, 2024, in two livestock markets in Lokoja metropolis, where 105 ticks all belonging to Ixodides group, were collected from 50 randomly selected cattle (25 from each market). Upon identification, the ticks were found to be members of three (3) genera (Rhipicephalus, Amblyoma and Hyalomma), out of which five (5) species were identified. Four of the species belonging to the genus Rhipicephalus and one belonging to Amblyoma were identified, while, many of the infested cattle showed weight loss and emaciation, which are common symptoms of anaemia resulting from tick infestation.

Keywords: Ticks infestation: Prevalence; Ixodid; Zoonoses; Genera; Species



1.0 INTRODUCTION

Ticks are one of the oldest and most successful groups of arthropods which have existed in their current forms for millions of years. The ancient Greeks described ticks as pest of farm-animals, particularly the terrestrial vertebrates of the order herbivora and Carnivora. They are described as hermatophagous obligate ectoparasites, which prey on all classes of vertebrates and establishing themselves as vectors of infectious and zoonotic diseases (Gilbert, 2021; Boulanger *et al.*, 2019). They are known to colonise the external surfaces of their hosts, mostly the hiding crevices on body surfaces, to suck blood, derive nourishment and infecting them with pathogens (Lorusso *et al.*, 2013). The common hosts of ticks include cattle, buffalo, horse, sheep, goat, dogs and some wild animals.

Ticks are distributed worldwide and they inhabit different range of habitats from the temperate to tropical regions (Cunze *et al.*, 2022). They are considered as the second most important parasitic member of arthropods after mosquitoes, known to affect mammals and aves (Elu *et al.*, 2022). They impact the lives of humans and other hosts, creating socioeconomic implications in their habitats of occurrence. Ticks are grouped into two major families Ixodidae and Argasidae. More recently, a third family known as the Nutalliellidae which contains only one species *Nutalliella namaqua* has recently been discovered.

The ixodidae are termed as hard ticks, owing to their possession of shields known as conscutum in male which cover their entire body and scutum in females which cover only their ventral part. Their mouth part is protruding and well obvious, and there are about 700 known species in the family ixodidae. Their larva feed on small mammals, drops off and molt into nymph which then seeks new adult to parasitize. Their bite is painless and they feed for several hours or days thus, making them easier to be noticed. Conversely, argasidae are described as soft ticks which lack the hard shield, and there about 200 known species of ticks in this group. Just like the hard ticks, their bite is painless but they only feed for 15-30 minutes, making them difficult to be noticed. Also, the nymphs of argasidae require more blood meal at every stage of their metamorphosis than the ixodides.

Tick infestation is the leading cause of tick-stress and tick-borne diseases in livestock, which is considered as the major cause of economic losses in livestock business in the tropical and



sub-tropical regions (Ghafar *et al.*, 2020). Tick bite is responsible for direct effects such as irritation, allergy, anaemia and sometimes paralysis in the affected animals, and indirect effect like the transmission of pathogens including bacteria, viruses and protozoa. Both the direct and indirect these effects results in diminished productivity in the affected animals, thereby resulting in economic loss (Jongelan and Uilengerg, 2004: as cited in Silatsa *et al.*, 2019). The menace of tick infestation in cattle reared in the sub-Saharan African has made it difficult for other exotic breeds susceptible to tick-borne infections such as Babesiosis, dermatophilosis and ehrlichiosis to survive in the region (Silatsa *et al.*, 2019).

2.0 LITERATURE REVIEW

Worldwide, about 80% of cattle reared are affected by tick and tick-borne infections (Hussein *et al.*, 2023) resulting in the transmission of pathogens, some of which have zoonotic potentials (Tadesse *et al.*, 2023; Gilbert, 2021). Currently, there is a tremendous increase in population of Western and Central African countries, putting more pressure on the accelerated demand for livestock meat especially Cattle, being a common and good source of protein often used in meals; leading to amplified trans-boundary livestock movement for trading purpose across the region, and increasing the risks of disease transmission. Also, migratory birds like the passerines which are often parasitize by ticks and tick-borne pathogens are vectors of Ixodid ticks and their pathogens in many ecosystem (Hasle, 2013). However, the prevalence of ticks on these birds depend on the species involved, changes in seasonal climate, degree of ground feeding and the geographical location of the birds. Thus, understanding the migratory routes and the biology of such avian vectors is important in controlling tick infestation and their pathogens in livestock which are known symbionts of the birds (Hasle, 2013).

In Nigeria, the common hosts of ticks are cattle, dogs, goat, horse, camels and sheep which are often reared in the traditional husbandry pastoral system; and in cattle alone ticks are considered as the major cause of anaemia, emaciation, distress and reduction in milk production. Cattles are generally reared by the Fulani herders in Nigeria, with about 90% of the cattle being managed in the traditional free-range pastoral husbandry system that is mostly practiced in the Northern Nigeria (Owogbade, 1979; as cited in Lorusso *et al.*, 2013). This pastoral system predisposed cattle to a number of parasites and pathogens (Nguhiu-Mwangi, 2023), especially ticks and tick-borne pathogens that are widely distributed across Nigeria



(Kyari *et al.*, 2022). Geographically, Lokoja is suitable for livestock rearing and marketing due to its warm climate, confluence of two large source of water and booming agricultural activities. Hence, the increase in livestock rearing and marketing, which in turn can result in a possible increase in tick and tick-borne diseases in this location.

Among the various groups of ticks in Nigeria, the ixodid ticks are the commonest and the most pathogenic (Kyari *et al.*, 2022), their occurrence have been reported in many States across the North-central part of Nigeria. Hence, understanding the species distribution and occurrence of the ixodid ticks in Nigeria is imperative to designing effective combative strategy to eliminate tick and tick-borne infestation in cattle reared in Lokoja.

3.0 MATERIAL AND METHODS

3.1 Study Area

This current research was conducted in Lokoja, and sampling was done in two livestock markets namely Banda and Felele livestock markets. Lokoja is a town located at the confluence of river Niger and river Benue at latitude 70 80' 23' 'N and 70 90' 75''N and longitude 60 57' 83''E and 60 79' 33'E at an altitude of 53m (173ft). Lokoja is the capital of Kogi State, with an area of 3180km square and population of 196, 261 as reported by the 2006 population census. It has a mean annual rainfall of 870mm, and with average temperature of 300⁰C. It lies about 165 km Southwest of the FCT as the crow flies, and 390 km Northeast of Lagos. Residential districts are of varying density, and many suburbs including Felele, Adankolo, Otokiti and Ganaja. The town is situated in the tropical wet and dry savanna climate zone of Nigeria, and temperatures remain hot year-round.

3.2 Sampling for Ticks and Identification

Sampling was carried out in Felele and Banda livestock markets after a prior visitation to seek approval from the cattle markets chairmen to facilitate the inspection of the cattle. White Fulani breeds of cattle (*Bos indicus*) were inspected between February and March 2024, during which a total of hundred (50) cattle (*Bos indicus*) of both sexes, and all adults were randomly inspected in each of the markets taking into consideration the number of available cattle in each



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market at each time of inspection. Total of 105 ticks were collected from the external surfaces of inspected cattle with the assistance of two cattle marketers from the two inspections, and kept in escape-tight containers. Fifty-six (56) ticks were collected from Banda market while, forty-nine (49) ticks were collected from Felele market. The samples were transported to the Federal University, Lokoja, Biological Sciences department laboratory for proper identification. With the aid of stereomicroscope and Walker *et al.* (2003) identification guide, using morphological keys like the presence/absence of scutum/conscutum, presence/absence of eyes, shape of capitulum, presence/absence of adanal plates and festoons in the ticks, three genera and five species were identified.



4.0 RESULTS AND DISCUSSION

4.1 Results

Table 1

Market location	Cattle available	Cattle inspected	Cattle infested	Ticks collected	Genera identified	No. of each genera	Prevalence (%)		
Banda	43	25	25	56	<i>Rhipicephalus</i>	31	55		
					<i>Amblyoma</i>	15	27		
					<i>Hyaloma</i>	10	18		

Table 2

Market location	Cattle available	Cattle inspected	Cattle infested	Ticks collected	Genera identified	No. of each genera	Prevalence (%)
Felele	57	25	23	49	<i>Rhipicephalus</i>	28	57
					<i>Amblyoma</i>	21	43



Table 3

Locations	Ticks collected	Genus <i>Amblyoma</i>	Genus <i>Hyaloma</i>	Genus <i>Rhipicephalus</i>	Male	Female
Banda	56	9	15	32	26	30
Felele	49	8	19	22	21	28

The prevalence of infestation in each study location was calculated and expressed in percentage as shown in the table 1.

4.2 Discussion

Upon the identification of the specimen using morphologically observable characteristics, it was found that all the ticks belong to the group Ixodid, family ixodidae; with 58 being females, 47 males. Report from Walker *et al.*, (2003) guide showed that 32 of the ticks picked from cattle in Banda market belong to the genus *Rhipicephalus* and 9 belong to the genus *Amblyoma*, while 9 belong to the genus *Hyaloma*. And, ticks picked from cattle in Felele livestock market, 28 were identified as belonging to the genus *Hyaloma*, 22 were identified as *Rhipicephalus*, while 8 were *Amblyoma*.

The results showed high infestation of ixodides ticks among cattle sold in Lokoja, particularly the members of the genus *Rhipicephalus* that are known to transmit diseases such as Anaplasmosis, Rickettsiosis, Babesiosis, Lyme disease, ehrlichiosis etc. The high infestation of Ixodids showed their widespread distribution and occurrence within the study area, considering the fact that it is the only group that was captured in the sampling process. This agrees with research by Aminu (2015) as cited in (Kyari *et al.*, 2022) on their widespread distribution in the northern Nigeria; and the dominance of genus *Rhipicephalus* (60 members) among the ticks in the current research gives an indication of the likelihood of transmission of some of the aforementioned diseases like bovine anaplasmosis and ehrlichiosis which have



zoonotic potentials (Parvizi *et al.*, 2020), and this could negatively impact humans lives within the study location.

The number of the genus *Hyaloma* (28) captured in this research also indicates a high level of exposure of the cattle in both markets to parasitic diseases, which is capable of jeopardizing their productivity, thereby impacting the socioeconomic parameters of livestock. The genus *Hyaloma* besides being a vector of some of the diseases mentioned earlier as being transmitted by the *Rhipicephelus*, they are known to be a vector of some *Trypanoma spp.* that infect cattle and wild animals (Bonnet *et al.*, 2023). An important part of the findings in this research is the existence of *Amblyoma variegatum* which is a known vector of veterinary and public health importance, as it transmits pathogens responsible for ehrlichiosis (*Ehrlichia ruminantum*) and dermatophilosis (*Dermatophilus congolensis*) both of which are endemic in Nigeria (Gado *et al.*, 2023).

It was observed from the research findings that there was paucity of nymphs among the ticks captured, and this could be due to their small sizes which could easily made them evade being picked, but they still constitute important agents of disease transmission, that needs to be studied and accounted for. However, the paucity of cattle inspected in this research can be attributed to the difficulty encountered in picking ticks from their body due to the crude nature of the hand picking method of tick collection, and the aggressiveness of the animals when approach to be observed. Thus, fewer numbers were inspected in the process, and this also indicates the need for more improved and effective ways of tick collection like the use of acaricides to minimize the danger of being attacked in the course of sampling. Most of the cattle sampled in the current research showed obvious signs of weight loss, restlessness and unhealthy appearance, indicating the possibility of underlying diseases in them.

5.0 CONCLUSION

This research provides valuable information on the prevalence of ticks in Lokoja, and the genus composition of the ticks collected. Also, the degree of tick infestation on the cattle inspected shows that tick infestation in cattle sold in Lokoja is an issue of veterinary importance affecting livestock rearing and marketing that needs to be addressed, to prevent the occurrence of bovine zoonotic diseases in the nearest future. The representative tick species observed are vectors of



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deadly veterinary diseases, and this indicates the need for improvement in quarantine services on the animals transported into Lokoja and Kogi State in generally, to ensure high level of safety in cattle meat and milk consumption. Further research is required in the current premise to ascertain the specific diseases that are being transmitted among the cattle in Lokoja. Lastly, there should be periodic use of acaricides like Permethrin or pyrethroid to eliminate ticks infestation in cattle, and improve their overall health and economic values.



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ASSESSMENT OF IMPACT OF ROOT-KNOT NEMATODE ON THE GROWTH OF TWO LOCAL TOMATO VARIETIES IN LOKOJA METROPOLIS

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Abstract

Tomato (*Lycopersicon esculentum* Mill) is a widely grown vegetable crop in Nigeria and around the world. It is considered as second most important vegetable crop after Potato, and it accounts for 18% of the daily consumption of vegetable in Nigeria. Nematode disease of tomato plant especially the root knot nematode, whose exclusive symptom root is the presence of root galls, which occurs due to parasitism by these sedentary endoparasites, leading to stunting, wilting and general chlorosis in tomato plant is a major cause of yield loss. The aim of this study is to assess the impact of root knot nematode on the plant height of local variety of tomato in Lokoja. Simple randomized design was used in this study, in which two local tomato varieties (Danyeka and Tangino) after two weeks of germination on the seed bed were transplanted into separate containers, and each is inoculated with the egg masses of the root knot nematode extracted from the infected tomato plant and labeled as experimental group. Another three sets of transplanted tomato of the same varieties as in the above were put in different containers, allowed to grow un-inoculated and used as the control group. The respective heights of each variety in both the inoculated and un-inoculated were measured weekly for six (6) weeks, and their difference were compared using t-test. The result obtained showed that there was no significant difference in height between the inoculated and un-inoculated Tangino variety; while there was a significant difference in height between the inoculated and uninoculated Danyeka variety. Thus, Tangino variety was observed to less susceptible or relatively resistant to root-knot nematode infection.

Keywords: Root-knot; nematode; Tomato; Varieties; Inoculated



1.0 INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill) is a widely grown vegetable crop in Nigeria and around the world. It is considered as the second most important vegetable crop after Potato (Costa and Heuvelink, 2018) and it accounts for about 18% of the daily consumption of vegetable in Nigeria (Kumar *et al.*, 2020). The genus *lycopersicon* belongs to the family Solanaceae which comprises Pepper, Groundnut, Cherry and Egg plant etc. The present day tomato was introduced into the West African countries in the 20th century (Audu-Peters and Obalola, 2022), today it is widely accepted due to its ability to adapt to various soil types, ecology and uses. Large quantities of tomato are produced in Nigeria yearly with the vast majority of the produce from the northern part of the country, though no reliable production figures are available.

Morphologically, tomatoes may be pear-shaped, elongated, compacted and even heart shaped. In any of these shapes, tomatoes are always edible, fleshy and reddish in colour when ripe and vary in acidic content, with white and yellow ones being less acidic (Ibrahim *et al.*, 2019). Tomatoes can be used as savoury or flavouring in soups and cooked foods or can as well be eaten as fruits. It is used in many dishes, salads, sauces and can also be dried and ground into pancakes (Ramya *et al.*, 2023). Ripe tomatoes possess high nutritive values, with good amount of lycopene, carotene, vitamin, C and minerals (Ramya *et al.*, 2023; Ayuso-Yuste *et al.*, 2021).

In addition, tomato possesses certain medicinal properties including being a stimulant for kidneys, livers, allergies and its ability to remove toxins that contaminate the body systems (Saleh *et al.*, 2019). It also improves the status of dietary anti-oxidants (like the lycopene, ascorbic acid and phenols) in diet (Ibrahim *et al.*, 2019). Tomato juice is known to be effective against intestinal and liver disorders. The cultivation and production of this crop has not been without problems mostly arising from unfavourable local weather conditions, flood, menace of pests and disease; but it is most affected by diseases (Lizardo *et al.*, 2022). These factors have resulted in the low yield of tomato plant across the country in recent times. The low yield of tomato is attributable to number of biotic factors including bacteria, fungi, virus and particularly nematodes which is known to reduce the quality and quantity of tomato. It has been estimated that 20-50 % of tomato vegetables are lost to infections particularly the root knot



nematode which affects the root, suppressing their growth and consequently reducing the yield of tomatoes (Rudolph *et al.*, 2023).

2.0 LITERATURE REVIEW

Plant parasitic nematode is one of the major challenges affecting tomato production around the world. Among these plant parasites the root knot nematode, *Meloidogyne* species are the major pests of vegetable crops that are often implicated in tomato yield losses resulting from diseases (Rudolph *et al.*, 2023). In India for example, the species *Meloidogyne incognita* has been reported to be responsible for about 35 percent of the yield loss (Gharabdiyan *et al.*, 2021). The existence of root-knot nematode disease in tomato and other some other vegetable crops in Nigeria has already been established, and yield losses due to root-knot nematodes has been estimated to reach over 30% for susceptible crops, including Tomato, Eggplant and Melon (Tesleem *et al.*, 2014 cited in Rudolph *et al.*, 2023).

Root-knot disease of tomato is caused by the plant-parasitic nematodes belonging to the genus *Meloidogyne*, with most of the species parasitizing vegetables, particularly tomato. The exclusive symptom of root knot disease is the presence of galls in the roots, which occurs due to parasitism by these sedentary endoparasites, thereby affecting the absorption and transportation of water and nutrients from the soil. This leads to stunting, wilting and general chlorosis in such plant (Lizardo *et al.*, 2022). The impact of root galling in tomato depends on some factors such as the extent of root galling, magnitude of *Meloidogyne* population density, host plant species and the local variety in the planting location (van Bruggen *et al.*, 2016). Root knot nematode reduced the growth of tomato plant, lower the yield and vigor of plants and sometimes resulting in the death of affected plants (Rudolph *et al.*, 2023). Generally, plant parasitic nematodes are microscopic organisms that dwell in the soil within the roots of plants and multiply; but when not properly managed they increase rapidly in number every year, and infect subsequent planting resulting in persistence nematode infection.

There are eight distinct genera of plant nematodes which include *Helicotylenchus*, *Hoplolaimus*, *Pratylenchus*, *Rotylenchus*, *Scutellonema*, *Tylenchulus*, *Xiphinema* and *Meloidogyne* that infect vegetable (Eche and Okafor, 2020); among these nematodes the genera *Meloidogyne* are the most destructive with the species *Meloidogyne incognita* being the most



economically important (Shukuru *et al.*, 2023). Rudolph *et al.* (2023) further noted that Root-knot nematodes have wide host range of host which include over 500 species of various plants, like the ornamental fruits and vegetables which are susceptible to root knot nematodes. There are many species of root knot nematodes worldwide but, some of the most economically important species that infect vegetable crops in Africa include *Meloidogyne incognita*, *Meloidogyne javanica*, *Meloidogyne arenaria* and *Meloidogyne hapla* (Kankam and Adomako, 2014).

In view of the devastating effect of nematodes on plant productivity, it is therefore essential to design a strategy of eliminating or controlling their infection rate in plants, so as to minimize losses in crops and ensure self-sufficiency in food and industrial raw materials production. Pre-plant fumigation of soil with Methyl bromide or other nematicides is the primary technique used to control root-knot nematodes in vegetables across Africa and around worldwide. However, this technique is not cost-effective, and the routine use of pesticides including nematicides is initiating a growing public concern on their potential hazards on human, as well as in global agriculture. The public concern has resulted in the need to develop alternative pest control management strategies. Hence, the effort to cultivate improved variety, with high nutritive value, as well as improved resistance to biotic and abiotic environmental stress (El-Sappah *et al.*, 2019).

As an alternative strategy to the use of fumigant nematicides, plants identified with nematocidal or nematostatic potentials in their seeds, fruits, roots, leaves, or barks have been used in crop rotational practices to control root-knot nematodes (Bawa *et al.*, 2014). Evidence from previous research has shown that host plants can be protected against nematode infection through intercropping practices particularly when plants susceptible to nematodes are grown alongside plants that possess nematocidal properties. The cultivation of resistant varieties of tomato is the most effective, cheap, economically viable and environmentally pleasant technique of combating root knot nematode infection, particularly by the species *Meloidogyne incognita* compared to the use of nematicides (Eche and Okafor, 2020; Patra and Nayak, 2019). Incidentally, the root-knot nematodes may enter susceptible and resistant tomato varieties in about equal numbers. Hence, breaking of resistance in tomato varieties by *Meloidogyne incognita* species may occur naturally or by selection of tomato plants with one or more



resistant genes. It was against this backdrop that this current study was designed to assess the impact of root knot nematode on the height of tomato plant.

BOTANICAL CLASSIFICATION OF TOMATO

Kingdom	Eukaryota
Division	Spermatophyta
Subdivision	Angiospermae
Class	Dicotyledonae
Order	Solanales
Family	Solanaceae
Genus	Solanum
Species	<i>Solanum Lycopersicon</i> L. <i>Lycopersicon esculentum</i> M.

2.1 CLASSIFICATION OF ROOT KNOT NEMATODE

KINGDOM	Eukaryota
Phylum	Nematoda
Class	Secernentea
Order	Tylenchida
Family	Meloidogynidae
Genus	Meloidogyne
Species	<i>Meloidogyne</i> spp.

2.2 LOCAL VARIETIES OF TOMATO



There are many local varieties of tomato cultivated across Nigeria, and they are named based on the location and dialect of the natives. They include “Gboko cultivar”, “Igede cultivar”, “Ibadan rome”, “Dan hausa”, “Danyeka”, “Tangino”, “Danka”, and “Derika” etc. For the purpose of this study, two of these local tomato varieties were selected namely; Danyeka and Tangino. They were considered suitable for this research based on their obvious morphological difference in terms of sizes and shapes. The Tangino variety is physically smooth, round and smaller in size compared to Danyeka, and it is mostly found in the South-western part of Nigeria; though it is now grown and cultivated nationwide. Danyeka variety is slender, smooth and somewhat pointed at one end and it is found across Nigeria, but believed to be an indigenous variety of Benue State.

3.0 MATERIALS AND METHOD

3.1 STUDY AREA

The study was conducted in Lokoja and the samples were collected from Lokoja International Market. Lokoja is a city in Nigeria and the capital of Kogi State. It lies about 7.8023° North of the equator and 6.7333° E east of the Meridian. It is about 165 km Southwest of Abuja as the crow flies, and 390 km Northeast of Lagos by same measure. Residential districts are of varying density, and the city has various suburbs such as Felele, Adankolo, Otokiti and Ganaja. The town is situated in the tropical wet and dry savanna climate zone of Nigeria, and temperatures remain hot year-round.

It lies at the confluence of the Niger and Benue rivers and is the capital city of Kogi State. The Oworo, Bassa Nge and Nupe are indigenous to the area; other ethnic groups of Nigeria found here include the Kupa-Nupe, Hausa, Ebira, Igala, Igbo, Bini/Edo, and Tiv. Lokoja is projected to be the third fastest growing African continent city between 2020 and 2025, with a 5.93% growth.

3.2 PLANTING OF THE VARIETIES OF TOMATO (*Lycopersicon esculentum* Mill)

The two local varieties of tomato used for the susceptibility test were; Danyeka and Tangino and they were obtained from Kpata market in Lokoja. The seeds of each variety were spread on two separately prepared heap of soil (seedbed) at the biological garden of Federal University, Lokoja by squeezing the tomato. The seeds were watered twice daily before Sunrise



and after Sunset to enable the seed germinate on time. The seeds of the two varieties germinated after ten (10) days, with the Danyeka varieties germinating within the first six (6) days.

3.3 EXPERIMENTAL DESIGN

The simple randomized design was used in this study. The local varieties (Danyeka and Tangino) upon germination on the seed bed, were transplanted after two weeks into separate containers and inoculated with the egg masses of the root knot nematode extracted from the infected tomato plant and labeled as experimental group. Another two sets of transplanted tomato of the same varieties as in the above were put into different containers, allowed to grow un-inoculated and used as the control group.

3.4 EXTRACTION OF EGG MASSES

The egg masses were obtained from the root of infected tomato plant showing obvious wilting and chlorosis with massive galls, from a farm in Ganaja village. The roots were chopped into smaller pieces with a razor blade, put into a beaker containing 0.5% by volume Sodium hypochlorite (NaOCl) and agitated for 3-4 minutes vigorously to enhance the degradation of the microbial cell structures of the nematode upon contact with the chopped root, thus resulting in the extraction of the egg masses. The mixture (NaOCl/gall extract) was sieved under a gently running tap water to wash off the debris (dirt). A hand lens was then used to observe the egg masses and then kept in a Petri dish until ready for inoculation.

3.5 INOCULATION OF THE EXPERIMENTAL SETUP

After a week of transplanting, the plants were inoculated with the egg masses of the root knot nematode. Thereafter, the height and number of leaves produced by each variety were measured weekly for six weeks, and compared to the control setup. Other physically observable defects in the plants such as yellowing of the leaves, reduced stem width, delayed fruiting and cracking of the base of the plant close to the root were also studied in both set ups.

3.6 DATA ANALYSIS

The experimental data comprises height of each variety and the number of leaves produced per plants in both Control and the Experimental setups were analysed using ANOVA and T-test.



The difference between the experimental and the control setups in terms of the data were compared at a significance level of 0.05.

4.0 RESULTS AND DISCUSSION

4.1 RESULTS

TABLE 1:

HEIGHT OF INOCULATED TOMATO PLANT VARIETIES (cm) (*Lycopersicon esculentum* Mill) labeled A.

TOMATO VARIETIES	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	STANDARD ERRORS
DANYEKA	8.40	10.30	13.00	14.00	16.00	18.30	1.43
TANGINO	11.70	15.30	16.00	18.00	19.00	21.10	1.34

Mean of the Heights of Tomato Varieties in the Treated setup (A)

$$\text{Danyeka} = 80.60/6 = 13.43$$

$$\text{Tangino} = 101.10/6 = 16.86$$

TABLE 2: HEIGHT OF UN-INOCULATED TOMATO PLANT VARIETIES (cm) (*Lycopersicon esculentum* Mill) (CONTROL) labeled B.

TOMATO VARIETIES	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	STANDARD ERROR
DANYEKA	11.80	14.10	17.00	24.00	28.00	33.00	3.41
TANGINO	14.10	18.00	23.40	27.30	32.20	37.10	3.54

Mean of the Heights of Tomato Varieties in the Control setup (B)

$$\text{Danyeka} = 127.90/6 = 21.3$$

$$\text{Tangino} = 152.10/6 = 25.35$$



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Anova: Two-Factor Without Replication						
<i>SUMMARY</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>		
DANYEKA	6	80	13.33333	13.17467		
TANGINO	6	101.1	16.85	10.731		
WEEK 1	2	20.1	10.05	5.445		
WEEK 2	2	25.6	12.8	12.5		
WEEK 3	2	29	14.5	4.5		
WEEK 4	2	32	16	8		
WEEK 5	2	35	17.5	4.5		
WEEK 6	2	39.4	19.7	3.92		
ANOVA						
<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Rows	37.10083	1	37.10083	105.1512	0.000152	6.607891
Columns	117.7642	5	23.55283	66.75342	0.000142	5.050329
Error	1.764167	5	0.352833			
Total	156.6292	11				



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Anova: Two-Factor Without Replication						
<i>SUMMARY</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>		
DANYEKA	6	127.9	21.31667	69.92967		
TANGINO	6	152.1	25.35	74.635		
WEEK 1	2	25.9	12.95	2.645		
WEEK 2	2	32.1	16.05	7.605		
WEEK 3	2	40.4	20.2	20.48		
WEEK 4	2	51.3	25.65	5.445		
WEEK 5	2	60.2	30.1	8.82		
WEEK 6	2	70.1	35.05	8.405		
ANOVA						
<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Rows	48.80333	1	48.80333	53.08557	0.000762	6.607891
Columns	718.2267	5	143.6453	156.2495	1.74E-05	5.050329
Error	4.596667	5	0.919333			
Total	771.6267	11				

Anova: Two-Factor Without Replication						
<i>SUMMARY</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>		
DANYEKA	6	90	15	12		
TANGINO	6	71	11.83333	8.166667		



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WEEK 1	2	21	10.5	0.5		
WEEK 2	2	26	13	2		
WEEK 3	2	34	17	2		
WEEK 4	2	34	17	18		
WEEK 5	2	26	13	8		
WEEK 6	2	20	10	8		
ANOVA						
<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Rows	30.08333	1	30.08333	17.87129	0.008269	6.607891
Columns	92.41667	5	18.48333	10.9802	0.009974	5.050329
Error	8.416667	5	1.683333			
Total	130.9167	11				

Anova: Two-Factor Without Replication						
<i>SUMMARY</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>		
DANYEKA	6	171	28.5	122.7		
TANGINO	6	186	31	154.8		
WEEK 1	2	25	12.5	0.5		
WEEK 2	2	42	21	2		
WEEK 3	2	56	28	8		
WEEK 4	2	68	34	8		



WEEK 5	2	77	38.5	4.5		
WEEK 6	2	89	44.5	4.5		
ANOVA						
<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Rows	18.75	1	18.75	10.71429	0.022118	6.607891
Columns	1378.75	5	275.75	157.5714	1.7E-05	5.050329
Error	8.75	5	1.75			
Total	1406.25	11				

Standard Deviation, Standard Error & Standard Error Deviation for Height of Tangino Tomato Varieties in the Treated set up (A)

Standard Deviation on the Height of Inoculated Danyeka Variety

A	A – X	(A – X)	(A – X) ²
8.40	8.40-13.43	-5.00	25.00
10.30	10.30-13.43	-3.10	9.61
13.00	13.00-13.43	-0.40	0.16
14.00	14.00-13.43	1.20	1.44
16.00	16.00-13.43	2.60	6.76
18.30	18.30-13.43	4.90	24.01
			Total= 66.76

Standard deviation = $\sqrt{66.76}/5$



Standard deviation for Danyeka = 3.65;

Standard Error = $3.65/\sqrt{6}$

Standard Error = 1.49

Standard Error deviation = $\sqrt{3.41} + 1.49^2$

= $\sqrt{11.63} + 2.22$

Standard Error = 3.72,

T, calculated = $\frac{21.30 - 13.40}{3.72}$

T = 2.12.

T calculated > the tabulated value, thus there is a significant difference between the height of the inoculated and the control for Danyeka variety.

Tangino = 3.28; 1.34, 3.78

T, calculated = $\frac{25-16.85}{3.78}$

T, calculated = 2.24

P = ≤ 0.10

Tabulated value = 2.02

T, calculated > T, tabulated. Hence, there is a significant difference between the plant height in both setups.

Standard Deviation & Standard Error for the Height of Tomato Varieties in Control (B)

Danyeka = 8.36; 3.41

Tangino = 8.64; 3.53



TABLE 3: NUMBER OF LEAVES OF INOCULATED TOMATO PLANT VARIETIES
(*Lycopersicon esculentum* Mill) labeled A.

TOMATO VARIETIES	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	STANDARD ERROR
DANYEKA	11.00	14.00	18.00	20.00	15.00	12.00	1.41
TANGINO	10.00	12.00	16.00	14.00	11.00	8.00	1.17

TABLE 4: NUMBER OF LEAVES OF UN-INOCULATED TOMATO PLANT VARIETIES (*Lycopersicon esculentum* Mill) Labeled B

TOMATO VARIETIES	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	STANDARD ERROR
DANYEKA	13.00	20.00	26.00	32.00	37.00	43.00	4.52
TANGINO	12.00	22.00	30.00	36.00	40.00	46.00	4.27

Findings obtained with respect to the height and number of leaves in the treated (experimental setup) in relation to the untreated setup showed that the Danyeka variety is the least susceptible to the root knot nematode infection

5.0 CONCLUSION

The findings from this research has shown that the Danyeka variety is the least susceptible variety of tomato to the root knot nematode, as indicated by the relatively smaller difference in the plant height between the inoculated and un-inoculated setup. The same trend is also observed in the number of leaves produced by the plant.



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COLUMN STUDIES ON THE ADSORPTION OF COPPER IN EFFLUENT FROM ITAKPE IRON ORE MINING COMPANY USING PALM KERNEL SHELL AS ADSORBENT

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ABSTRACT

This work involved evaluation of palm kernel shell activated carbon (PKSAC) as adsorbent for removal of copper from water through column studies. Palm kernel shell (PKS) was collected, washed, sundried and carbonized at 500⁰C for 3 hours after which it was crushed, then activated with 3.0M of KOH and heated using a burner for 30 mins., then packed and stored for the experiment after cooling. The activated carbon prepared from the PKS was characterized. Column studies were carried out on the adsorption of Cu from wastewater from Itakpe Iron Ore Company using the PKSAC as adsorbent under conditions such as bed height and flow rate. The physico-chemical parameters show that PKSAC has a surface area of 772.29m²/g and 85% organic carbon with pH of 7.5. Results also showed that optimum adsorption capacity was found at lower flow rate of 20 ml/min, and 12 cm bed height. The appropriate service times to breakthrough were 195 – 210 mins. The sorption capacity by the column was 15.47 mg/g. This study showed that activated carbon prepared from palm kernel shell is suitable for the adsorption of Cu ion and as such could be used as a cost-effective adsorbent in the treatment of polluted water.

KEYWORDS: Palm Kernel Shell, Adsorbent, Column, Adsorption, Copper, Itakpe, Iron ore, Kogi State, Mining.



1.0 INTRODUCTION

The advancement of technology has given us much comfort. At the same time, the technological innovations and industrialization has greatly contributed pollution in our environment, e.g, air pollutions, soil pollutions and water pollutions of heavy metals. The ecological effects of heavy metals vary and are often interrelated. Heavy metals are non-biodegradable, they can accumulate in human body throughout his life span and could have serious negative effects like damage to the brain, diseases on skins, liver damage, failure of the kidney, anemia and can also be carcinogenic (Sardans *et al.*, 2011; Yang *et al.*, 2018 and Tlili, 2019).

There are different methods that are available and used in the removal of heavy metals from effluent, of which adsorption using activated carbon have been considered to be the best in heavy metals removal (Yang *et al.*, 2018). Not too much works has been done exploiting Palm Kernel Shell (PKS) as low cost adsorbent in the removal of Cu ion from water especially in environment polluted by iron ore mining activity.

Another environmental problem is the annual large production of palm oil; consequently, large quantities of oil palm wastes are generated which constitute environmental problem due to lack of proper waste management and disposal methods. So, the researcher sought a way of converting this low valued waste into activated carbon (adsorbent) which has the ability to expunge toxic heavy metal; Cu from wastewater which will form a major contribution to the search for cheaper adsorbent materials with a plus of another environmental problem being solved by another. The study aims to evaluate PKS as adsorbent for removal of Cu in water through column studies.

2.0 LITERATURE REVIEW

Water Pollution

Water is a substance that is composed of the chemical elements, hydrogen and oxygen (H₂O) and existing in gaseous, liquid and solid states. Although during the hydrological cycle, natural water is capable of dissolving some heavy metals or trace elements, but the quantities into waters from anthropogenic sources (the several activities embarked by human) are the main cause of water pollution (Saifuddin and Kumaran, 2005). Indiscriminate disposal of municipal,



industrial and domestic wastes in rivers, lakes, water channels and streams are the main activities leading to pollution (Azizullah *et al.*, 2011).

Heavy metals are defined as those elements having an atomic number greater than 20 and atomic density above 5 g cm⁻³ and must exhibit the properties of metals (Sarmistha *et al.*, 2021). They are a group of metals and metalloids that have relatively high density and are toxic even at ppb levels. Examples are Fe, Cu, Zn, Pb, Cr, Cd, Ag, Ni, Pt, Hg, Pd and As. Contamination of water by toxic heavy metals through the discharge of industrial wastewater is a worldwide environmental problem.

The extent of damages done to the inhabitants of Itakpe mining communities due to heavy pollution of surface water (Eika- Adagu river) by heavy metals like Iron, Copper, Cendium , Zinc and Lead was investigated by Abu and Ifatimehin (2016). Their analysis shows considerable/substantial contents of chemical pollutants, with iron (Fe) constituting the highest (15.6 mg/l) of the pollutants and Cendium (Ce) constituting the lowest (0.16 mg/l) of the pollutants. The other chemical pollutants found are; Lead (12 mg/l), zinc (16.0 mg/l), copper (4.5 mg/l), and Chromium (absent).

Treatment Technologies for Heavy Metals in Contaminated Environment

Heavy metal removal has become a burning issue in the industrialized as well as in the developing world where industrial use and discharging of heavy metal is gradually increasing. The adverse and toxic effect of heavy metal on aquatic life and the environment is well established. Humans are not free from this pollution because the toxic metals are entering into the human body through the complex and diverse food chain (Liu *et al.*, 2007). In these circumstances sustainable heavy metals removal is a serious research concern among researchers and technologists (Al-Rub, 2006). The commonly used methods for removing metal ions from aqueous streams include physical, chemical and biological methods used separately or inclusively based on need. The available methods are chemical precipitation, lime coagulation, ion exchange, reverse osmosis and solvent extraction (Areco *et al.*, 2012).

Based upon the metal binding capacities of various biological materials, biosorption can separate heavy metals from wastewater (Vilar *et al.*, 2007). Lately, biosorption has emerged as a cost-effective and efficient alternative for application to low strength wastewaters (Pavasant *et al.*, 2006). Biosorption is a term used here to describe the removal of heavy metals using a



passive binding process with nonliving microorganisms including bacteria, fungi, and yeasts (Parvathi and Nagendran, 2007), and other biomass types that are capable of efficiently collecting heavy metals. Obviously, some of the advantages biosorption has over conventional treatment methods include low cost, high efficiency for dilute concentration solutions, an a minimal amount of chemical and/or biological sludge, no additional nutrients required and the possibility of biosorbent regeneration and metal recovery (Vilar *et al.*, 2007).

The sorption of heavy metals onto these biomaterials is attributed to their constituents, which are mainly proteins, carbohydrates and phenolic compounds, since they contain functional groups such as carboxylates, hydroxyls and amines, which are able to attach to the metal ions (Choi and Yun, 2006).

3.0 MATERIALS AND METHODS

The Study Area

The Itakpe mining company is located in Okehi L.G.A., Kogi State. Its within latitudes of 7°36'N to 7°39'N, longitudes 6°17'E to 6°22'E. Okehi is sharing boundary with Lokoja towards the North, Kabba towards west, Adavi and Okene towards the southern and Ajaokuta towards east.

There are many ridges of hills that surround Itakpe with height of about 360m on average above the sea level above mean sea level. Rivers like Eika-Adagu and Osara river take their source from the Eika hills and then discharges their contents into the river Niger. The river Osara is season, but Eika-Adagu river is not (Oyekunle *et al.*, 2012). The Itakpe soil is that of ferrallitics soils.

Collection of Palm Kernel Shells (PKS) and Processing

Palm kernel shell (PKS) was used in the production of the activated carbon. PKS were gotten from palm oil mill, in Ikanekpo, Ankpa L.G.A, Kogi State, Nigeria. The sample was washed with distilled water in removing impurities, then sun-dried for three days, after which the PKS was crushed using a milling machine. The crushed particles of the PKS were then sieved in order to obtain the particles size of 1 – 3mm.

Carbonization



Carbonization was done using a digital furnace in Metallurgy Engineering Laboratory, Kogi State, Polytechnic, Itakpe campus. The PKS were taken to the furnace for carbonization. In the furnace, it was heated at a constant temperature (500°C) for 3 hours. After carbonization, the samples were allowed to cool at room-temperature. The carbonized sample was crushed using mortar and pestle and then sieved to obtain particle sizes of 1 – 3mm.

Activation

The modification was done by chemical treatment of the sieved carbonized PKS with 3.0 M potassium hydroxide (KOH) heated with a burner for 30 mins for activation. The modified sample were washed using the de-ionized water after which it was sun-dried. The activated sample was again crushed, then sieved, now, so as to obtain the particle sizes of 0.5mm – 3mm for the studies. The product (adsorbent) was stored in a clean and dry polythene bag and labeled accordingly. The adsorbent is referred to as palm kernel shell activated carbon (PKSAC) in this report.

Description of the column experiment

Continuous flow adsorption experiments were conducted; the column reactor setup used in this study was constructed using pyrex plastic tube (30 cm height, and 3 cm internal diameter). To give room for visual examination of the progress of the wetting front, and so as to detect preferential flow channels through the wall of the column, the column was made using methacrylate cylinder. A glass wool was placed at the bottom of the column. Known quantities of adsorbent were placed into the column on different occasions to obtain the bed height of 6 cm (24 g), 9 cm (36 g) and, 12cm (48 g) at a constant optimum flowing rate of 20ml/ min for each. Wastewaters of known concentration were introduced downward through the column bed by gravity. The samples were collected at the column outlet at 15 minutes interval and was analysed for Cu concentrations using ICE 3000 Series Atomic Absorption Spectrometer. The flow rate was varied from 20 to 40ml/min (20, 30 and 40 ml/min) at optimum constant bed height of 6cm.

4.0 RESULTS AND DISCUSSION

Characterization

The physico-chemical parameters (Table 1) show that PKSAC is a very good adsorbent, with high surface area of 772.29m²/g and 85% organic carbon. The pH of 7.5 (near neutral) is also



a good indicator of high quality of the adsorbent, as near neutral pH are helpful for the treatment of all cases of wastewater and the carbons can also be used for drinking water purification (Baseri *et al.*, 2012; Igwegbe *et. al.*, 2016). The Scanning Electron Microscopy (SEM) and FTIR (Figure 1 and 2) also show its high quality in water treatment.

Table-1: Physicochemical Attributes/characteristics of Palm Kernel Shell Activated Carbon

S/No.	Parameters	Composition
1	Moisture content	0.095 %
2	pH	7.5
3	Bulk density	0.7130 g/cm ³
4	Particle size	0.1 – 0.3 mm
5	Organic carbon	85 %
6	Organic matter	1.47 %
7	Specific surface area	722.29 m ² /g

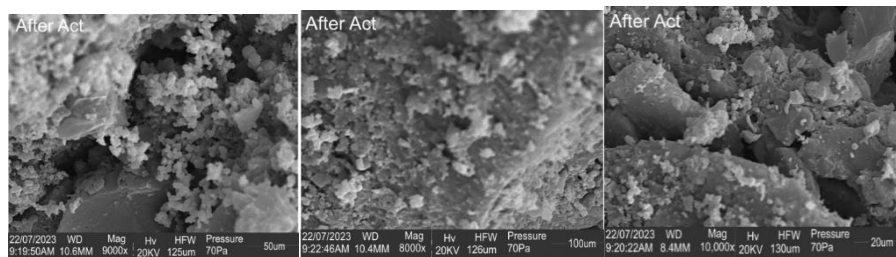


Figure 1: The Scanning Electron Microscopy of the PKSAC

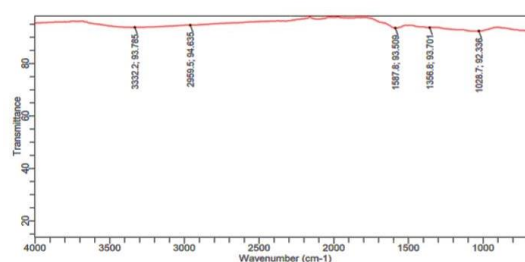


Figure 2: FTIR spectrum of the PKSAC



Effects of the flow rate

The fixed-bed-column was operated at three different flow rates of 20ml/ min (1.2L/hr), 30ml/min (1.8L/hr) and 40 ml/min (2.4L/hr) with constant optimum bed height of 6cm (that is, PKSAC of 24g). The break-through curve achieved is as presented in the Figure 3.

Figure 3 shows that break-through time and the exhaustion time increased with decrease in flow rate for Cu adsorption respectively. The plots' slope from break-through time to exhaustion time increases as the flow rate was increases from 1.20 l/hr. to 2.40 l/hr. It then means the break-through curve produced a steep slope with the increased flow rate for adsorption of Cu. Higher flow-rate resulted in lower time of residence inside the column, and vice-versa. Increase in flow rate reduced contact time between metal ion and PKSAC; and also reduced the volume of the effluent efficiently treated before bed became saturated. Therefore, it decreased service time of the bed (Figures 3); it implies the column was got saturated early. On the other hand, lower flow-rates caused longer contact time and a shallow zone of adsorption. Higher flow-rates are seen by steeper curve with measurably early break-through and exhaustion-time; they then resulted in a less adsorption uptake (Sarin *et al.*, 2006).

Kananpanah *et al.* (2009) reported that decrease in the volume of the flow-rate favour more metal ion exchange condition. As the flow rate increases, the break-through curve gets steeper, reaching the breakthrough more quickly. They further buttress that it is because of the time of residence of adsorbate in the column, which is longer enough for the adsorption equilibrium to be reached at a high-flow rate. This then means the contact time between the adsorbate and adsorbent is reduced, thus, leads to the early breakthrough (Sivakumar and Palanisamy, 2009) as seen in this our findings. This might occur as a result of bypass of flow in clod formation at higher flow-rate. Increasing the flow-rate caused shorter time for saturation while decreasing the flow-rate caused longer saturation time.

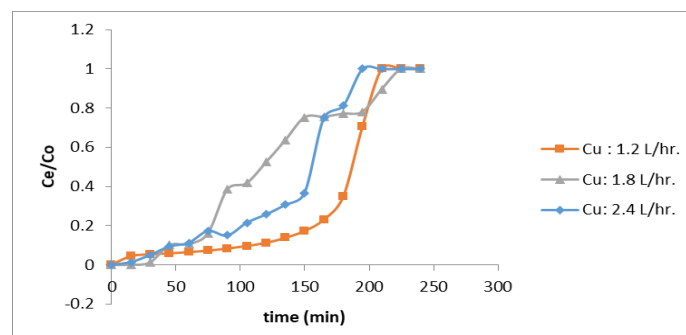




Figure 3: Breakthrough Curve for Cu Sorption on-to PKSAC at Different Flow Rates (Bed-Height = 6cm, Particle Size >0.5mm, Adsorbent weight = 24g, influent pH = 7.0 and temperature = room temperature)

Bed-height Effect

Bed-height serves as important parameter in designing a fixed-bed column for continuous water treatment systems. In this work, three bed-heights of 6cm (24g of PKSAC), 9cm (36g of PKSAC) and 12cm (48g of PKSAC) were used for removal of Cu from solution at a constant optimum flow-rate of 20ml-min. The experimental result is shown in Figure 4.

There was significant effect of bed-height on effluent concentration of Cu. As the bed-height increases, the metals concentrations decreased at various flow time (service time) and vice-versa. Similar results were earlier reported by Unuabonah *et al.* (2010) and Noren *et al.* (2013.). Lower concentration obtained at higher bed-height could be as a result of large amount of binding sites that are available than that obtained with lower bed heights. Further-more, the smaller bed-height is saturated in a lesser time than higher bed-heights, hence they correspond to a lesser amount of adsorbent and subsequently, smaller capacity of the smaller bed in adsorbing the adsorbate from solution.

It's visible from Figure 4 that characteristic 'S' shaped profile is generated in an ideal sorption system. This can be said that the break-through volumes varies with bed-height. Axial-dispersion-phenomena predominate in the mass transfer and thus reduced the diffusion of metallic ions when the bed-height is reduced. The solute (Cu ion) don't have enough time in diffusing into the whole adsorbent mass (Taty-Costodes *et al.*, 2005).

As seen from Figures 4, total metal (Cu) removed were increased as the column bed height was increased (6cm to 12cm) even at the same flow rate of 1.2 l/hr (20 ml/min). The treated volume of water increased, but was not commensurate to the drastic increase observed in the total metal removed (Table 2). Treated volume of water increased alongside increase in column bed height as a result of availability of more sorption sites, this agrees with the findings of Sivakumar and Palanisamy (2009). At higher bed-height, PKSAC sorbent was not dispersed appropriately in the used flow-rate so as the volume treated is reduced (Sousa *et al.*, 2010; Valderrama *et al.*, 2010).



When the bed height is small, adsorbate concentration of the effluent increases rapidly as compared to a higher bed height. Furthermore, the column bed gets saturated in shorter time for smaller column bed heights. Smaller column bed height implies fewer adsorbent amounts and binding sites while higher bed height corresponds to more adsorbents and binding sites.

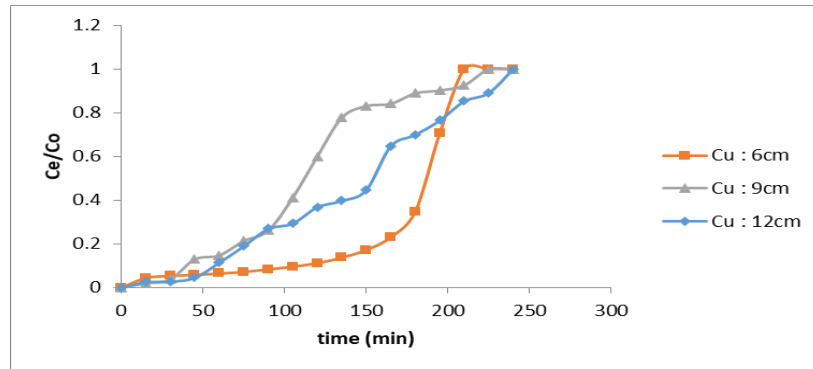


Figure 4: Break-through Curve for Cu Sorption on-to PKSAC at Different Bed-Height (Flow rate = 1.2 L/hr., Particle Size >0.5mm, Adsorbent weight = 24g, influent pH = 7.0 and temperature = room temperature)

Metals uptake at a different parameters

Maximum capacity of column, q_{total} (mg) for given sets of condition in the used column was calculated from the area that is under the plot of the adsorbed Cu concentration, C_{ad} (mg/l), versus time as given in the equation (1) as presented by Ahmad and Hameed (2010):

$$q_{total} = \frac{QA}{1000} = \frac{Q}{1000} \int_{t_0}^{t_{total}} C_{ad} dt \quad (1)$$

$C_{ad} = C_0 - C_e$ (mg/ l), t_{total} is the total flow-time (min.) at breakthrough, Q is the flow-rate (ml/min) and A is given by the area that's under the break-through curve (cm^2).

The equilibrium uptake ($q_{e(exp)}$), (amount of Cu ion that is adsorbed (mg) per unit dry-weight of the adsorbent (mg/g) in the column, was calculated by following equation 2.

$$q_{e(exp)} = \frac{q_{total}}{m} \quad (2)$$

m = total dry-weight of PKSAC inside the column (g). The total amount of water treated, V_{eff} (ml), is calculated from the equation [3]:

$$V_{eff} = Q \cdot t_{total} \quad (3)$$



The data obtained from the experimental running are presented in Table 2. Data from the laboratory test is useful for the design of a full-scale adsorption column. It is discovered that as the flow-rate increases, volume of effluent treated increases while uptake decreased (Table 2).

Optimum capacity of adsorption was found at 20ml/min flow-rate, and 12 cm bed height (Table 2). This experiment has shown the sorption capacity of the column to be 15.47mg/g (Table 2), which is 14.02 time better than the one reported in a batch-system studied by Acheampong *et al.*, (2011). The enhanced sorption-capacity by the column study method can be said to be due to continuously increasing-concentration-gradient in the interface of the sorption zone as it pass through the column, whereas, the gradient-concentration decrease with time in batch-system (Sousa *et al.*, 2010)

The Influence of functional-parameters on break-through curve

Appropriate service times to breakthrough were 195 – 210 mins. The removal capacities are in the order of 30 > 20 > 40 ml/min. A high flow-rate means inadequate time for the Cu ion to diffuse and get into the pores of the adsorbent, leading to a low uptake capacity and removal efficiency (Vijayaraghavan *et al.*, 2004). This may be as a result of the metal ion leaving the column bed before being its adsorption and equilibrium could be attained (Singh and Pant, 2006).

As the bed-height increase, the metal-ion had enough time to get contacted with more particles of PKSAC, thus, higher-uptake of Cu from the column (Table 2). So, at the increase in the bed-height, the maximum sorption capacity of the column will also increase (Malkoc and Nuhoglu, 2006). At a higher bed-height, sorbent particles will stay in compact condition and will not expose to up-take the metal ion. The little increase in the break-through curve slope with increasing bed-height has resulted in a widened mass transfer zone.

Table 2: Up-take of Cu at Different Operating Conditions

Metals name	Bed Height Z(cm)	Flow Rate Q(ml/min)	Initial Conc. C ₀ (mg./L)	Total Flow Time, t _{total} (min)	Total- Treated Volume V _{eff} (ml)	Total- Metals Removed, q _{total} (mg)	Equilibrium Capacity of Adsorption q _e (exp) (mg./g)



Cu

6	20	0.9405	210	4200	242.25	10.09
6	30	0.9405	225	6750	371.31	15.47
6	40	0.9405	195	7800	218.23	9.09
9	20	0.9405	225	4500	390.01	10.83
12	20	0.9405	225	4500	711.03	14.81

5.0 CONCLUSION

The physicochemical properties, SEM and FTIR of the activated-carbon produced from the palm kernel shell in this experiment and its ability in removing Cu shows it's improved adsorption behaviour as compared to the ones of high performing adsorbents. It was noticed that when the carbon bed height is high, the adsorption rate increases. Results showed optimum adsorption at lower flow rate. Based on this study, activated carbon prepared from palm kernel shell is good for Cu ion adsorption and so, could be utilized as a cost-effective adsorbent for the treatment of polluted water.



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THE INFLUENCE OF RADIATIVE HEAT TRANSFER ON MAXWELL AND CASSON NANOFLUIDS FLOWING OVER A VERTICAL PLATE WITH AN INTERNAL HEAT SOURCE.

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ABSTRACT

This Paper examines the flow of Casson nanofluid in a free convective heat transfer scenario over a vertical plate, incorporating heat source effects and exploring its thermophysical properties. The governing partial differential equations were transformed into a set of coupled nonlinear ordinary differential equations using similarity variables. The numerical solution employed the Runge-Kutta fourth-order method with a shooting technique and was implemented using MatLab(R2020b). The impact of key non-dimensional governing parameters, such as Prandtl number, Biot number, Grashof number, heat source parameter, skin-friction coefficient, Nusselt number, and Sherwood number, on Casson nanofluid flow is analyzed, discussed, and visually presented. The findings indicate that an increase in the heat source parameter leads to an augmentation in skin-friction coefficient, velocity, and temperature profiles, while causing a reduction in concentration profiles and Nusselt number.

Keywords: Flow of fluid, Nanoscale particles, Sherwood number, Coefficient of skin friction, Thermal properties, Vertical plate.



1.0 Introduction

This study examines the combined effects of convective heat transfer and the flow of Casson nanofluids over a vertical plate, with a particular focus on the role of a heat source. Understanding how fluid dynamics interact with nanoscale particles is crucial for comprehending the thermal behavior of such systems. The presence of a heat source introduces additional complexity, necessitating an investigation into its impact on various thermophysical parameters. Casson fluids, a type of non-Newtonian fluid, exhibit shear-thinning properties, behaving as a liquid with infinite viscosity at zero shear rate and zero viscosity at infinite shear rate. The significance of non-Newtonian behavior in both industrial and scientific contexts was first noted by Blair (1959). Casson fluids are relevant in industries such as automobile manufacturing, steam electric power generation, energy systems, electronic device cooling, nuclear reactors, thermal devices, medicine, methane hydrate production, and disease characterization and diagnosis (Blair, 1959).

Several studies have focused on the thermal conductivity of fluids with nanoparticles, the flow of Casson fluids, and heat transfer over porous stretching surfaces. Research has also addressed the flow of Casson fluids over vertical porous surfaces in the presence of chemical reactions and magnetic fields, as well as the magnetohydrodynamic (MHD) boundary layer flow of Casson fluids with nanoparticles. Findings indicate that temperature and nanoparticle concentration fields generally decrease as the Casson parameter increases.

Other research includes investigations into the MHD natural convection flow of Casson nanofluids over nonlinearly stretching sheets through porous media with chemical reactions and thermal radiation. Studies also examine the heat and mass transfer characteristics of MHD Casson fluid flow over vertical plates in the presence of thermal radiation, chemical reactions, and heat sources or sinks, with buoyancy effects (Choi & Eastman, 1995; Pramanik, 2014; Arthur et al., 2015; Hussain et al., 2015; Ullah et al., 2016; Vijayaragavan & Kavitha, 2017). Hayat and Nadeem (2017) explored heat transfer enhancement using a hybrid nanofluid composed of Ag-CuO/water. Swarnalathamma (2018) studied heat and mass transfer in the context of MHD flow of nanofluids with thermal slip effects. Dawar et al. (2018) examined magnetohydrodynamic CNTs Casson nanofluids and radiative heat transfer in a rotating channel. Faraz et al. (2019) investigated MHD effects on axisymmetric Casson nanofluid flow



and heat transfer over an unsteady radially stretching sheet. Anwar et al. (2019) provided a numerical solution for Casson nanofluid flow over a nonlinear inclined surface with Soret and Dufour effects using the Keller-Box Method. Oke et al. (2020) analyzed the dynamics of a non-Newtonian Casson fluid over a rotating non-uniform surface subject to Coriolis forces. Gbadeyan et al. (2020) studied the effect of variable thermal conductivity and viscosity on Casson nanofluid flow with convective heating and velocity slip. Kigio et al. (2021) investigated volume fraction and convective heat transfer in MHD Casson nanofluids over a vertical plate. Anwar et al. (2021) researched the unsteady MHD natural convection flow of Casson fluid, incorporating thermal radiative flux and heat injection/suction mechanisms under variable wall conditions. ShanthaSheela et al. (2021) reviewed the magnetohydrodynamic flow of nanofluids past a vertical plate under the influence of thermal radiation. Additional studies were conducted by Koriko et al. (2018) and Oyem et al. (2021).

2.0 LITERATURE REVIEW

Radiative heat transfer significantly impacts the thermal management of nanofluids, enhancing energy transfer mechanisms within the fluid. Mahanthesh, Gireesha, and Gorla (2017) examined the effects of thermal radiation on the boundary layer flow of nanofluids over a vertical stretching sheet, emphasizing how radiative heat transfer can enhance heat transfer rates. This underscores the importance of accounting for radiative effects when analyzing nanofluid dynamics in thermal systems.

Maxwell fluids, known for their viscoelastic properties, and Casson fluids, characterized by their yield stress behavior, present unique challenges and opportunities in fluid dynamics studies. Nadeem and Hussain (2014) investigated the boundary layer flow of a Maxwell fluid over a stretching surface, considering thermal radiation and magnetic fields. Their results demonstrated that radiative heat transfer significantly affects the flow and thermal characteristics of Maxwell fluids.

Similarly, the behavior of Casson fluids has been extensively studied due to their relevance in various applications. Naramgari and Sulochana (2016) analyzed the magnetohydrodynamic (MHD) flow of Casson fluid over a stretching sheet, incorporating the effects of thermal



radiation. They found that the presence of radiation enhances the heat transfer rate, emphasizing the importance of radiative effects in Casson fluid dynamics.

The presence of an internal heat source introduces additional complexity to nanofluid studies, altering the fluid's thermal and flow characteristics. Makinde and Aziz (2010) examined the effects of an internal heat source on the boundary layer flow of a nanofluid over a stretching sheet. Their analysis revealed that the internal heat source enhances the temperature distribution within the fluid, affecting the overall heat transfer rate

The combined effects of radiative heat transfer and an internal heat source on nanofluids have been the subject of several studies. Hayat, Khan, Waqas, and Alsaedi (2017) investigated the radiative flow of Casson nanofluid over a stretching surface with an internal heat source. Their results indicated that both radiation and internal heat significantly influence the thermal boundary layer, leading to enhanced heat transfer rates.

Furthermore, Khan, Malik, Khan, and Gulzar (2015) explored the effects of radiation and an internal heat source on the MHD flow of Maxwell nanofluid over a stretching surface. They found that the interaction between radiation and the internal heat source leads to complex flow and thermal behavior, emphasizing the need for comprehensive studies to fully understand these interactions.

3.0 METHODOLOGY

Examining a stable, two-dimensional, incompressible, laminar magnetohydrodynamic (MHD) free convective flow of a Casson nanofluid with a heat source over a vertical plate. The Casson nanofluid, composed of a base fluid and nanoparticles, is assumed to move over a vertical plate and is subjected to a convective heating boundary condition. In this scenario, the flow is oriented along the x-axis in the upward direction, while the y-axis is perpendicular to the plate. The magnetic field B_0 is applied normal to the flow direction, as illustrated in Figure 1. The effects of induced magnetic field and viscous dissipation are neglected. The variables T_w and C_w represent temperature and concentration over the plate, while T_∞ and C_∞ denote the free stream temperature and concentration, respectively.



In accordance with Boussinesq's approximation, the governing partial differential equations for the flow with a heat source is provided as follows:

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0 \quad (3.1)$$

$$u \frac{\partial u}{\partial x} + v \frac{\partial v}{\partial y} = \frac{\mu_{nf}}{\rho_{nf}} \left(1 + \frac{1}{y} \right) \frac{\partial^2 u}{\partial y^2} + g\beta_T (T - T_\infty) + g\beta_c (C - C_\infty) - \frac{\mu_{nf}\beta_0^2 u}{\rho_{nf}} \quad (2.1)$$

$$u \frac{\partial T}{\partial x} + v \frac{\partial T}{\partial y} = \alpha_{nf} \frac{\partial^2 T}{\partial y^2} + \tau \left(D_B \frac{\partial c}{\partial x} \frac{\partial T}{\partial x} + \frac{D_T}{T_\infty} \left(\frac{\partial y}{\partial x} \right)^2 \right) + \frac{\mu_{nf}}{(\rho c \rho)_{nf}} \left(\frac{\partial u}{\partial x} \right)^2 + \frac{\mu_{nf}\beta_0^2 \mu^2}{(\rho c \rho)_{nf}} +$$

$$\frac{Q_0}{(\rho c \rho)_{nf}} (T - T_\infty) \quad (3.12)$$

$$u \frac{\partial c}{\partial x} + v \frac{\partial c}{\partial y} = D_B \frac{\partial^2 c}{\partial y^2} + \frac{D_\tau}{T_\infty} \frac{\partial^2 T}{\partial y^2} \quad (3.13)$$

The conditions at the vertical plate and in the free stream are defined by

$$u = ax, v = 0, -k_f \frac{\partial T}{\partial y} = h_f (T_f - T), C = C_w(x) \text{ at } y = 0. \quad (3.14)$$

$$u \rightarrow 0, T \rightarrow T_\infty, C \rightarrow C_\infty \text{ as } y \rightarrow \infty. \quad (3.15)$$

Let u and v represent the velocity components in the x and y directions, respectively, with ρ being the viscosity, nf the nanofluid parameter, and bf the base fluid of the Casson nanofluid. By applying stream functions $u = \partial\psi/\partial x$ and $v = -\partial\psi/\partial y$, with assigned values of $u = axf'(\eta)$ and $v = \sqrt{av} f(\eta)$, the continuity equation (1) is satisfied. To facilitate computation, the thermal conductivity, density, viscosity, and specific heat capacity of the nanofluid are defined based



on the works of Yang et al. (1996), Pak and Cho (1998), Maiga et al. (2004), and Kigio et al. (2021). Further simplifying the mathematical problem (2) – (6), the following similarity variables are introduced: $\eta = y/\sqrt{av}$; $\psi = \sqrt{av} \, x f(\eta)$; $T = T_\infty + (T_w - T_\infty)\theta(\eta)$; $C = C_\infty + (C_w - C_\infty)\phi(\eta)$. (3.16)

Utilizing equation (2.6), equations (2.1) – (2.5) undergo a transformation into a set of coupled nonlinear ordinary differential equations:

$$\frac{\mu_{nf}}{\rho_{nf} v_{bf}} \left(1 + \frac{1}{\gamma}\right) \frac{d^3 f}{d\eta^3} - \left(\frac{df}{d\eta}\right)^2 + f \frac{d^2 f}{d\eta^2} + Gr_t \theta + Gr_t \phi - M \frac{df}{d\eta} = 0 \quad (3.17)$$

$$\frac{d^2 \theta}{d\eta^2} + \left(Pr f + N_b \frac{d\theta}{d\eta}\right) \frac{d\theta}{d\eta} + N_t \left(\frac{d\theta}{d\eta}\right)^2 + PrEc \left(\frac{\mu_{nf}}{\rho_{nf} v_{bf}} \left(\frac{d^2 \theta}{d\eta^2}\right)^2 + M \left(\frac{df}{d\eta}\right)^2\right) + PrQ\theta = 0 \quad (3.18)$$

$$\frac{d^2 \phi}{d\eta^2} + Sc \frac{d\phi}{d\eta} f + \frac{N_t}{N_b} \frac{d^2 \theta}{d\eta^2} = 0 \quad (3.19)$$

Rewrite while maintaining the boundary conditions that lack dimensional units

$$f(0) = 0, \frac{d\phi}{d\eta}(0) = 1, \frac{d\theta}{d\eta}(0) = -Bi(1 - \theta), \phi(0) = 0, \frac{df}{d\eta}(\infty) \rightarrow 0, \theta(\infty) \rightarrow 0, \phi(\infty) \rightarrow 0 \quad (3.20)$$

The nonlinear ordinary differential equations (2.7) to (2.9), along with boundary conditions (3.21), are expressed. The notation prime (') denotes differentiation with respect to η . In the equations, $Gr_t = \frac{g\beta(T_w - T_\infty)}{a^2 2x}$ represents the thermal Grashof number, while $Gr_s = \frac{g\beta(C_w - C_\infty)}{a^2 2x}$ denotes the solutal Grashof number. Schmidt number is represented by $Sc = \frac{v}{D_b}$, The Eckert number is given as $Pr = \frac{v_{bf}}{\alpha_{bf}}$, The Prandtl number, Pr , represents the ratio of momentum diffusivity to thermal diffusivity. M stands for the magnetic field parameter, expressed as $M =$



$\frac{\sigma_{nf} B_0^2}{\alpha \rho_{nf}}$, The Brownian parameter, $Nb = \frac{\tau_w}{\alpha_{nf}}$, while the Thermophoretic parameter, Nt , is $\tau_w DT(T_w - T_\infty) / (\alpha_{nf} T_\infty)$. Bi is the Biot number, defined as $hf / (k_\infty \sqrt{av})$. Q represents the heat source parameter, calculated as q/p . Finally, Re_x is the Reynolds number, given by $v_0 x / \nu$. The Nusselt number and Sherwood number are determined as follows.

$$\text{The coefficient of friction, } C_f = \frac{\tau_w}{\rho u_0 v_0} = \frac{\partial u}{\partial x} \Big|_{y=0} \quad (3.22)$$

$$\text{The Nusselt number } Nu_x = x \frac{\frac{\partial T}{\partial y}}{\tau_w - T_\infty} = \frac{Nu_x}{Re_x} = \frac{\partial \theta}{\partial x} \Big|_{y=0} \quad (3.23)$$

$$\text{The Stanton number } Sh = \frac{1}{Re_x} = \frac{\nu}{v_0^x} \quad (3.24)$$

4.0 RESULT AND DISCUSSION

The nonlinear ordinary differential equations (2.7) to (2.9), along with the dimensionless boundary conditions specified in equation (2.10), are tackled numerically using the fourth-order Runge-Kutta, method coupled with the shooting technique. The simulations are conducted utilizing MATLAB software. To simplify the equations (2.7) to (2.9), they are transformed into a system of first-order differential equations. This transformation involves defining new variables: $y_1 = f$, $y_2 = f'$, $y_3 = f''$, $y_4 = \theta$, $y_5 = \theta'$, $y_6 = \phi$, $y_7 = \phi'$,

$$y'_1 = y_2, y'_2 = y_3, y'_3 = \frac{\rho_{nf} \nu_{bf} \gamma}{\mu_{nf} (\gamma + 1)} (y_1 y_3 - y_2^2 + Gr_t y_4 + Gr_s y_6 - M y_2) \quad (4.1)$$

$$y'_4 = y_5$$

$$y'_5 = \left[Pr \left(y_1 y_5 + \frac{\mu_{nf}}{\rho_{nf} \nu_{bf}} y_3^2 + ME c y_2^2 + Q y_4 \right) + N_b y_7 y_5 + N_t y_5^2 \right] \quad (4.2)$$

$$y'_6 = y_7$$

$$y'_7 = -Sc y_1 y_7 - \frac{N_t}{N_b} y'_5$$

Subject to the specified initial conditions:



$$y_1(0) = 0, y_2(0) = 1, y_3(0) = s_1, y_4(0) = s_2, y_5(0) = -bi[1 - y_4], y_6(0) = 0, y_7(0) = s_3, y_2(\infty) = 0$$

$$y_4(\infty) = 0, y_6(\infty) = 0.$$

The numerical calculation employs a step size of $\Delta\eta = 0.001$, chosen to meet the convergence requirement of 10^{-5} . The plate surface temperature $\theta(0)$, skin-friction coefficient $f'(0)$, Nusselt number $-\theta'(0)$, and Sherwood number $-\phi'(0)$ are determined and their numerical outcomes are summarized in Table 1, along with the heat source parameter.

Table 1 presents computational findings for the Heat Source, Skin-friction coefficient, Nusselt number, and Sherwood number under the conditions where $Grt = 1$, $Grs = 3$, $M = 3$, $\phi = 0.01$, $Pr = 7.62$, $Ec = 0.1$, $N_t = N_b = 0.1$, $Sc = 0.62$, $Bi = 0.1$, and $\gamma = 1$.

Q	$Re^{1/2}c_f$	$Re^{-1/2}N_u$	$Re^{-1/2}Sh$
1	-0.4372	-0.0794	1.2861
2.7778	0.0429	-0.323	1.3287
4.5556	0.5019	-0.5593	1.366
6.3333	0.9448	-0.7909	1.399
8.1111	1.3768	-1.2477	1.4563
9.8889	1.8013	-1.4755	1.4818
11.6667	2.2207	-1.704	1.5056
13.4444	2.6368	-1.704	1.5056
15.2222	3.0507	-1.9339	1.5281
17	3.4635	-2.1656	1.5495

The numerical outcomes for various governing thermophysical parameters, with assigned values such as $Grt = 1$, $Grs = 3$, $M = 3$, $Pr = 7.62$, $Ec = 0.1$, $\phi = 0.01$, $N_t = N_b = 0.1$, $Sc = 0.62$, $Bi = 0.1$, $Q = 0.1$, $n = 2$, and $\gamma = 1$ (Kigio et al., 2021), are depicted in Figures (1) – (6),



showcasing velocity, temperature, and concentration profiles. According to Table 1, it was noted that the skin-friction coefficient (Cf) and Sherwood number (Sh) increase with a rise in the heat source parameter, while the Nusselt number (Nu) decreases, holding constant values of $Gr_t = 1$, $Gr_s = 3$, $M = 3$, $Pr = 7.62$, $Ec = 0.1$, $Nt = Nb = 0.1$, $Sc = 0.62$, $Bi = 0.1$, and $\gamma = 1$, as demonstrated in Figure 6.

Figures (1) – (3) depict how variations in the heat source parameter (Q) affect velocity, temperature, and concentration profiles. It can be discerned from Figures (2) and (3) that both velocity and temperature profiles exhibit an increase moving away from the plate towards the free stream boundary layer with an escalation in the heat source parameter. Conversely, the concentration profiles diminish as the heat source parameter increases, as evidenced in Figure (4). Moving on to Figures (6) – (7), they illustrate the impact of the Prandtl number (Pr) on velocity, temperature, and concentration profiles. From Figures (4) and (6), it's evident that velocity and concentration profiles decline towards the plate with an increase in Pr . However, Figure (5) presents a more complex scenario regarding the effect of the Prandtl number on temperature profiles. Initially, temperature profiles escalate away from the plate as the Prandtl number increases, but subsequently, they diminish along the plate towards the free stream boundary layer with rising values of the Prandtl number. It's worth noting that the Prandtl number (Pr) represents the ratio of momentum diffusivity to thermal diffusivity. Hence, an elevation in the Prandtl number is associated with either an increase in momentum diffusivity or a decrease in thermal.

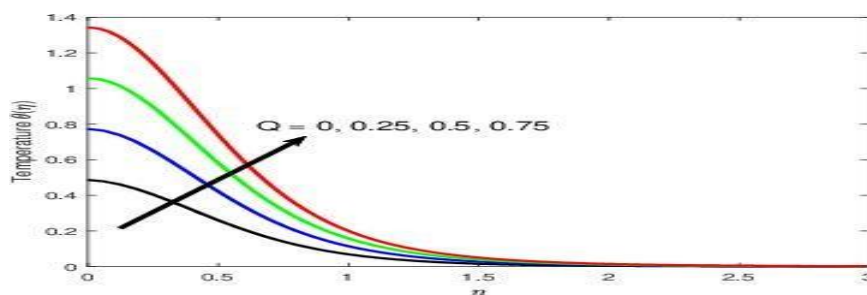


Figure 1: Velocity profiles for Q with $Gr_t = 1$; $Gr_s = 3$; $M = 3$; $Pr = 7.62$; $Ec = 0.1$; $N_t = N_b = 0.1$; $Sc = 0.62$; $Bi = 0.1$; $n = 2$; $\gamma = 1$

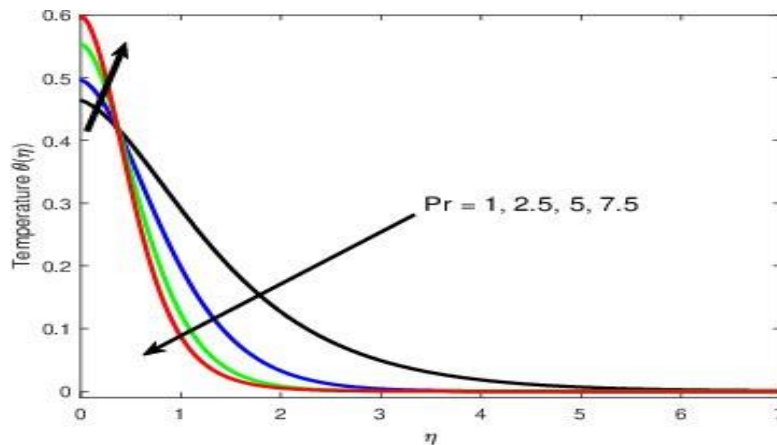


Figure 2: Temperature profiles for Q with $Gr_t = 1$; $Gr_s = 3$; $M = 3$; $Pr = 7.62$; $Ec = 0.1$; $N_t = N_b = 0.1$; $Sc = 0.62$; $Bi = 0.1$; $n = 2$; $\gamma = 1$

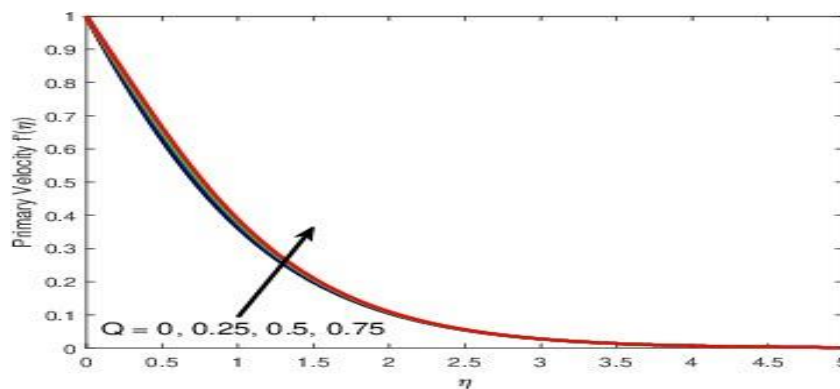


Figure 3: Concentration profiles for Pr with $Gr_t = 1$; $Gr_s = 3$; $M = 3$; $Ec = 0.1$; $N_t = N_b = 0.1$; $Sc = 0.62$; $Bi = 0.1$;

$Q = 0.1$; $n = 2$; $\gamma = 1$

5.0 CONCLUSION

A research investigation into the convective heat flow of Casson nanofluid over a vertical plate incorporating a heat source parameter was conducted. The velocity, temperature, and concentration profiles for various governing parameters were numerically derived using the fourth-order Runge-Kutta technique with the shooting method. The graphical representation of their effects on these profiles revealed the following outcomes:



- (a). An increase in the heat source parameter leads to a rise in the skin-friction coefficient and Sherwood number but results in a decrease in the Nusselt number.
- (b) The thickness of the velocity boundary layer decreases with increasing values of the Prandtl number, Biot number, and volume fraction parameter. However, it increases as the heat source parameter escalates.
- (c) The thermal boundary layer thickness showed an increase with the heat source parameter, Biot number, and volume fraction parameter, but decreased with the Prandtl number. Similarly, concentration profiles decreased with the heat source parameter, Prandtl number, and Biot number, while increasing with the volume fraction parameter.



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ADVANCED NUMERICAL METHODS FOR SOLVING LINEAR SYSTEMS OF EQUATIONS: A COMPARATIVE ANALYSIS OF EFFICIENCY AND ACCURACY.

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ABSTRACT

This paper presents a comparative analysis of advanced numerical methods for solving linear systems of equations, focusing on the Jacobi method, Gauss-Seidel method, and Successive Over-Relaxation (SOR) method. These iterative methods are evaluated in terms of efficiency and accuracy, which are crucial for handling large-scale systems in scientific and engineering applications. The analysis aims to provide insights into the strengths and weaknesses of each method under varying conditions and system sizes. The Jacobi method, known for its simplicity, updates each variable independently using values from the previous iteration, making it easy to implement in parallel computing environments. However, it often requires more iterations to converge compared to other methods. The Gauss-Seidel method, which updates each variable sequentially using the latest available values, typically converges faster than the Jacobi method but may encounter stability issues for certain types of matrices. The SOR method, an enhancement of the Gauss-Seidel approach, introduces a relaxation factor to accelerate convergence. While the choice of relaxation factor can significantly impact the efficiency of the SOR method, it generally outperforms the Gauss-Seidel method when appropriately tuned. Numerical experiments are conducted on linear systems of various sizes and conditions to assess the performance of these methods. Results indicate that while the Gauss-Seidel and SOR methods generally converge faster than the Jacobi method, the SOR method offers superior efficiency with optimal relaxation factors. This study concludes that while all three methods have specific use cases, the SOR method is recommended for its balance of efficiency and accuracy, particularly for large-scale systems where convergence speed is critical.

Keywords: Systems of linear equations, Iterative techniques, Initial guess, Jacobi method, Gauss-Seidel method, Successive Over-Relaxation method.



1.0. INTRODUCTION

Numerical analysis, an essential discipline in mathematics and computer science, focuses on the development, analysis, and implementation of algorithms to solve problems in continuous mathematics. These problems frequently arise from real-world applications across various fields, including algebra, geometry, and calculus, where the variables involved vary continuously (Atkinson & Han, 2004). Numerical methods are crucial in numerous domains such as natural sciences, social sciences, engineering, medicine, and business, where they enable the approximation of solutions that are otherwise difficult or impossible to solve analytically (Burden & Faires, 2010).

In numerical linear algebra, solving systems of linear equations is a foundational task. This can be achieved through either direct or iterative methods. Direct methods, such as Gaussian elimination and LU decomposition, compute an exact solution in a finite number of steps and are highly effective for small to moderately sized systems. However, they become computationally expensive for large-scale problems due to their high memory and processing demands (Trefethen & Bau, 1997).

In contrast, iterative or indirect methods provide an alternative approach, particularly suitable for large-scale systems. These methods start with an initial approximation of the true solution and refine it iteratively. If convergence is achieved, they generate a sequence of progressively accurate approximations, repeating computations until the desired precision is attained (Saad, 2003). The computational effort required by iterative methods is not fixed; it varies according to the precision needed and the convergence characteristics of the specific method used.

Iterative methods, such as the Jacobi, Gauss-Seidel, and Successive Over-Relaxation (SOR) methods, have distinct advantages and limitations. The Jacobi method, for instance, updates each variable independently, making it well-suited for parallel computation. However, it often requires more iterations to converge compared to other methods (Quarteroni, Sacco, & Saleri, 2007). The Gauss-Seidel method, which updates each variable sequentially using the most recent values, typically converges faster but may suffer from stability issues if the matrix does not have certain properties, such as diagonal dominance (Axelsson, 1994). The SOR method



enhances the Gauss-Seidel approach by introducing a relaxation factor to speed up convergence, though it requires careful selection of this factor to ensure optimal performance (Hageman & Young, 1981).

This paper explores these iterative methods, assessing their efficiency and accuracy in solving linear systems of various sizes and complexities. Through a detailed comparison, we aim to provide insights into the conditions under which each method performs best, guiding practitioners in choosing the most suitable technique for their specific applications.

2.0 LITERATURE REVIEW

The numerical solution of linear systems of equations is a cornerstone of scientific computing, integral to applications across engineering, physics, and applied mathematics. Given the complexity and size of real-world problems, the choice of numerical methods can significantly impact computational efficiency and solution accuracy. This literature review explores the development and comparative performance of various advanced numerical methods for solving linear systems, particularly focusing on iterative techniques such as the Jacobi, Gauss-Seidel, and Successive Over-Relaxation (SOR) methods. Numerical methods and optimization are fundamental areas in engineering and science, providing essential tools for solving complex problems that cannot be addressed analytically. This literature review focuses on the contributions of B.S. Grewal's *Numerical Methods in Engineering & Science* (2017) and I.M. Beale's *Introduction to Optimization* (2014) in advancing the understanding and application of numerical techniques and optimization strategies.

The field of linear algebra and iterative methods for solving systems of equations is rich with foundational texts and resources. Friedberg and Spence's *Linear Algebra* (1989), a web resource on the Jacobi method, and Kalambi's project on iterative methods for simultaneous equations (1998). Each source contributes uniquely to the understanding and application of linear algebra techniques and iterative methods. Iterative methods, which approximate solutions through successive refinements, offer a practical alternative for large systems. These methods are particularly useful when dealing with sparse or structured matrices, which are common in scientific and engineering applications (Trefethen & Bau, 1997).



The Jacobi method is noted for its simplicity and parallelization potential. In this method, each variable is updated independently, which makes it suitable for parallel computing environments. However, the Jacobi method often requires a larger number of iterations to converge compared to other iterative methods (Quarteroni, Sacco, & Saleri, 2007). Axelsson (1994) points out that its convergence rate can be slow, particularly for systems with poor diagonal dominance. The Gauss-Seidel method enhances the Jacobi method by updating variables sequentially using the most recent values. This sequential update usually results in faster convergence, making it more efficient for many problems. However, the method can experience stability issues, especially when the system matrix lacks properties like diagonal dominance or positive definiteness (Saad, 2003). Hageman and Young (1981) emphasize that while the Gauss-Seidel method is more efficient than the Jacobi method in many cases, it still struggles with certain types of matrices.

The SOR method is an extension of the Gauss-Seidel method, introducing a relaxation factor to accelerate convergence. This method has been widely studied for its ability to improve convergence speed by appropriately tuning the relaxation factor. As noted by Saad (2003), the SOR method can significantly outperform both the Jacobi and Gauss-Seidel methods when the relaxation factor is optimally chosen. However, determining this optimal factor is non-trivial and often requires empirical testing or prior knowledge of the system's characteristics. Kalambi's (1998) postgraduate diploma project on "Solutions of Simultaneous Equations by Iterative Methods" provides a practical examination of iterative methods applied to simultaneous equations. The project explores various iterative techniques, including the Jacobi method, Gauss-Seidel method, and Successive Over-Relaxation (SOR) method. Kalambi's work is valuable for its practical focus and application of these methods in solving real-world problems.

The project highlights the effectiveness and challenges associated with each iterative method, emphasizing factors such as convergence rates and computational efficiency. Kalambi's findings contribute to the understanding of how different iterative methods perform under various conditions and matrix properties. This practical perspective is essential for practitioners and researchers who need to choose appropriate methods based on specific problem characteristics and computational resources (Kalambi, 1998).



Comparative analyses of these methods often focus on their convergence behavior and computational efficiency across different problem types and sizes. For instance, Quarteroni, Sacco, and Saleri (2007) compare the Jacobi and Gauss-Seidel methods, illustrating that while both are effective for small to medium-sized problems, the Gauss-Seidel method generally converges faster. Similarly, studies by Axelsson (1994) and Saad (2003) highlight the SOR method's superior performance in terms of convergence speed, provided the relaxation factor is well-chosen.

Recent advancements in iterative methods have also explored hybrid and multigrid techniques, which combine the strengths of various approaches to enhance performance further. These methods are particularly effective for solving large, sparse systems that arise in discretized partial differential equations (Trefethen & Bau, 1997).

3.0 METHODOLOGY

In this study, we examine a system of n linear equations with n unknowns, represented as $Ax=b$. We apply three iterative methods, Jacobi, Gauss-Seidel, and Successive Over-Relaxation (SOR) to this system. For each method, we track the number of iterations required to achieve convergence and assess solution accuracy. The relaxation factor in the SOR method is optimized to evaluate its impact on convergence. The performance of each method is compared based on iteration counts and accuracy to determine their efficiency and suitability for solving the system:

$$a_{11}x_1 + a_{12}x_2 + a_{13}x_3 + \dots + a_{1n}x_n = b_1 \quad \text{-----} (3.1)$$

$$a_{21}x_1 + a_{22}x_2 + a_{23}x_3 + \dots + a_{2n}x_n = b_2 \quad \text{-----} (3.11)$$

$$\begin{matrix} \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot \end{matrix}$$

$$a_{n1}x_1 + a_{n2}x_2 + a_{n3}x_3 + \dots + a_{nn}x_n = b_n \quad \text{-----} (3.12)$$



The coefficient matrix A has no zeros on its main diagonal namely $a_{11}, a_{22} \dots a_{nn}$ zeros. Then we should interchange the rows and column to obtain a coefficient matrix that has non-zeros entries on the main diagonal.

In this method we must solve the equation to obtain the value $x_1, x_2, x_3 \dots x_n$. the first equation using formula given below:

$$x_1 = \frac{1}{a_{11}} (b_1 - a_{12}x_2 - a_{13}x_3 - \dots - a_{1n}x_n) \text{ ----- (3.13)}$$

To get x_2 , solve the second equations

$$x_2 = \frac{1}{a_{22}} (b_2 - a_{21}x_1 - a_{23}x_3 - \dots - a_{2n}x_n) \text{ ----- (3.14)}$$

Similarly, to find the value of x_n , solve the n th equation.

$$x_n = \frac{1}{a_{nn}} (b_n - a_{n1}x_1 - a_{n2}x_2 - \dots - a_{nn}x_n) \text{ ----- (3.15)}$$

If we have an initial estimate $x_1^0, x_2^0, x_3^0 \dots x_n^0$ for all unknowns, we can substitute these values into the right -hand side of the equations. Following various methods based on the utilization of the latest computed guesses, we can then calculate an updated guess for the unknown $x_1^1, x_2^1, x_3^1 \dots x_n^1$.

3.1 JACOBI METHOD

In numerical Linear algebra, the Jacobi method is an iterative algorithm which is used for determining the solutions of a strictly dominant system of linear equations. Until, it converges the process is iterated. Jacobi method methods.is also known as the Jacobi method.

The first iterative technique is called the Jacobi method, named after Carl Gustav Jacob Jacobi (1804 – 1851) to solve the system of linear equations.

In the Jacobi method, all unknown values are updated before incorporating any new information into the calculations. In other words, starting with the initial guess $x_1^0, x_2^0, x_3^0 \dots x_n^0$ the next approximation of the solution is computed through the iterative process.



$$x_1^1 = \frac{b_1 - (a_{12}x_2^0 + a_{13}x_3^0 + \dots + a_{1n}x_n^0)}{a_{11}} \text{-----} (3.16)$$

$$x_2^1 = \frac{b_2 - (a_{21}x_1^0 + a_{23}x_3^0 + \dots + a_{2n}x_n^0)}{a_{22}} \text{-----} (3.17)$$

$$x_3^1 = \frac{b_3 - (a_{31}x_1^0 + a_{32}x_2^0 + \dots + a_{3n}x_n^0)}{a_{33}} \text{-----} (3.18)$$

.....

$$x_n^1 = \frac{b_n - (a_{n1}x_1^0 + a_{n2}x_2^0 + \dots + a_{nn-1}x_{n-1}^0)}{a_{nn}} \text{-----} (3.19)$$

or after undergoing k iterations of this process

$$x_1^{k+1} = \frac{b_1 - (a_{12}x_2^k + a_{13}x_3^k + \dots + a_{1n}x_n^k)}{a_{11}} \text{-----} (3.20)$$

$$x_2^{k+1} = \frac{b_2 - (a_{21}x_1^k + a_{23}x_3^{k+1} + \dots + a_{2n}x_n^k)}{a_{22}} \text{-----} (3.21)$$

$$x_n^{k+1} = \frac{b_n - (a_{n1}x_1^k + a_{n3}x_3^{k+1} + \dots + a_{nn-1}x_{n-1}^k)}{a_{nn}} \text{-----} (3.22)$$

Jacobi introduced this technique, known as the method of Jacobi method.

3.2 GAUSS-SEIDEL METHOD

In numerical linear algebra, the Gauss-seidel method also known as the successive displacement method or Liebmann method is an iterative method used to solve a system of linear equations. It is named after the German mathematicians Carl Friedrich Gauss and Philip Ludwig Von Seidel. The Modification of Jacobi Method is called Gauss-Seidel Method. This modification is easier to use than Jacobi Method and it requires fewer iterations to produce the same degree of accuracy. In Jacobi Method, the value of the variables is not modified until next iteration, whereas in Gauss-Seidel method the value of the variables are modified as soon as new value is evaluated. i.e, in Gauss- seidel, once you determined, x_1 from the first equation, its value is then used in the second equation to obtain the new x_2 . Similarly, the new x_1 and x_2 are used in the third equation to obtain new x_3 and so on. If implemented, our method would take the following form.



$$x_1^1 = \frac{b_1 - (a_{12}x_2^0 + a_{13}x_3^0 + \dots + a_{1n}x_n^0)}{a_{11}} \text{-----} (3.23)$$

$$x_2^1 = \frac{b_2 - (a_{21}x_1^1 + a_{23}x_3^0 + \dots + a_{2n}x_n^0)}{a_{22}} \text{-----} (3.24)$$

$$x_3^1 = \frac{b_3 - (a_{31}x_1^1 + a_{32}x_2^1 + \dots + a_{3n}x_n^0)}{a_{33}} \text{-----} (3.25)$$

.....

$$x_n^1 = \frac{b_n - (a_{n1}x_1^1 + a_{n2}x_2^1 + \dots + a_{nn-1}x_{n-1}^1)}{a_{nn}} \text{-----} (3.26)$$

or after undergoing k iterations of this process

$$x_1^{k+1} = \frac{b_1 - (a_{12}x_2^k + a_{13}x_3^k + \dots + a_{1n}x_n^k)}{a_{11}} \text{-----} (3.27)$$

$$x_2^{k+1} = \frac{b_2 - (a_{21}x_1^k + a_{23}x_3^{k+1} + \dots + a_{2n}x_n^{k+1})}{a_{22}} \text{-----} (3.28)$$

.....

$$x_n^{k+1} = \frac{b_n - (a_{n1}x_1^k + a_{n3}x_3^{k+1} + \dots + a_{nn-1}x_{n-1}^k)}{a_{nn}} \text{-----} (3.29)$$

3.3 SUCCESSIVE OVER RELAXATION

In the field of numerical linear algebra, the Successive Over-Relaxation (SOR) method is an enhancement of the Gauss-Seidel technique used to solve systems of linear equations, resulting in faster convergence. This method can be adapted to improve the convergence rate of any iterative process that advances slowly. The SOR method is developed by introducing extrapolation into the Gauss-Seidel method. For a constant $\omega > 1$, called the relaxation factor.

$$x^{(k+1)} = (D + \omega L)^{-1} [(\omega U + (\omega - 1))D] x^{(k)} = L_{\omega} x^{(k)} + c \text{-----} (3.30)$$

Where $x^{(k)}$ is the kth approximation or iteration of x and $x^{(k+1)}$ is the next or k+1 iteration of x.

However, by taking advantage of the triangular form $(D + \omega L)$ the element of $x^{(k+1)}$ can be computed sequentially using forward substitution



$$x_i^{(k+1)} = (1 - \omega)x_i^{(k)} + \frac{\omega}{a_{ii}} \left(b_i - \sum_{j<i} a_{ij}x_j^{(k+1)} - \sum_{j>i} a_{ij}x_j^{(k)} \right), i = 1, 2, 3, 4, \dots, n. \dots\dots (3.31)$$

In the context where x represents a Gauss-Seidel iterate, and ω is the extrapolation factor, the concept is to select a suitable value for ω that enhances the convergence speed of iterates towards the solution. When ω equals 1, the SOR method reduces to the Gauss-Seidel method.

4.0 RESULT AND DISCUSSION

The comparative study of the three iterative methods was evaluated using linear equations of , 3x3, and 4x4 orders. The examples yielded the following results.

Example 1. Solve the following system of linear equations using the Jacobi, Gauss-Seidel, and Successive Over-Relaxation methods.

$$5x_1 - 2x_2 + 3x_3 = -1$$

$$-3x_1 + 9x_2 + x_3 = 2$$

$$-2x_1 + x_2 + 7x_3 = -3$$

To begin, write the system in the Form:

$$x_1 = \frac{1}{5} (-1 + 2x_2 - 3x_3) \text{ -----(i)}$$

$$x_2 = \frac{1}{9} (2 + 3x_1 - x_3) \text{ -----(ii)}$$

$$x_3 = \frac{1}{7} (-3 + 2x_1 - x_2) \text{ ----- (iii)}$$

Because the actual solution is unknown, choose ($x_1=0$, $x_2=0$, $x_3 = 0$) as a convenient initial approximation to get a new values.

First Iteration.

$$x_1^{(1)} = \frac{1}{5} (-1 + 2(0) - 3(0)) = -\frac{1}{5} = -0.200$$

$$x_2^{(1)} = \frac{1}{9} (2 + 3(0) - (0)) = \frac{1}{9} = 0.222$$



$$x_3^{(1)} = \frac{1}{7} (-3 + 2(0) - (0)) = \frac{1}{9} = -0.429$$

The outcomes are presented in Table 1(a).

Table 1(a) displays the iteration counts for the iterative methods

	Jacobi Method			Gauss-Seidel Method			SOR Method		
Iterations	x ₁	x ₂	x ₃	x ₁	x ₂	x ₃	x ₂	x ₃	x ₃
1	-0.200	0.222	-0.429	-0.200	0.156	-0.508	0.156	-0.508	-0.508
2	0.146	0.203	-0.517	0.167	0.334	-0.429	0.186	-0.331	-0.423
3	0.191	0.328	-0.416	0.191	0.333	-0.422			
4	0.181	0.332	-0.416	0.186	0.331	-0.423			
5	0.185	0.329	-0.424	0.186	0.331	-0.423			
6	0.186	0.331	-0.423						
7	0.186	0.331	-0.423						

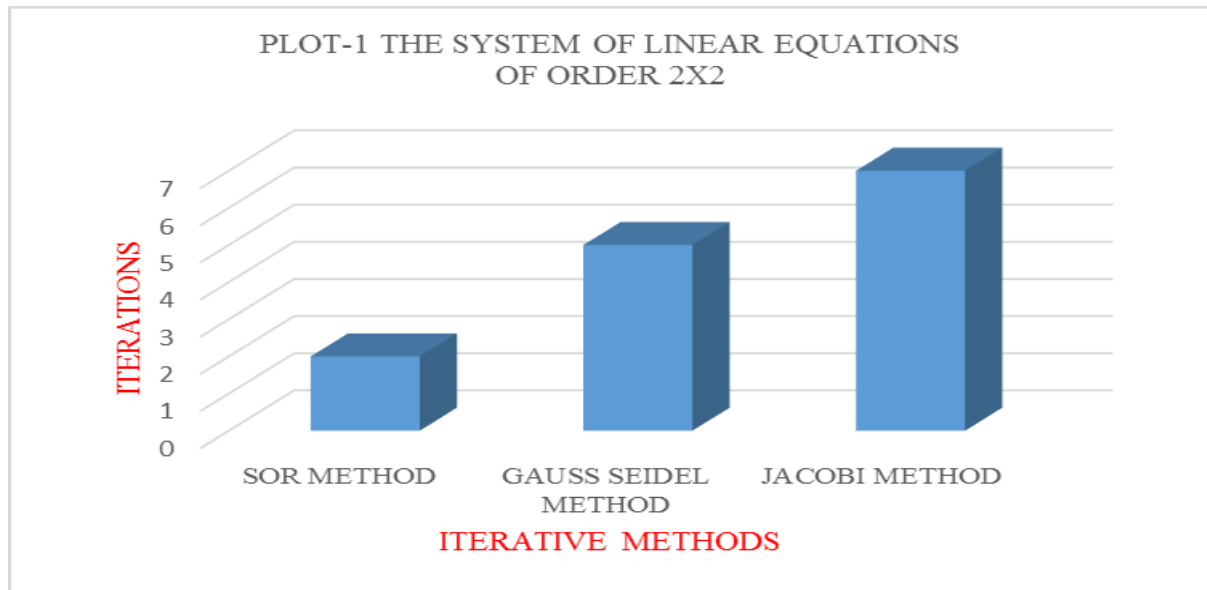


Fig 1. Iterations for the SOR, Gauss-Seidel, and Jacobi iterative methods are illustrated in the plot1

Example 2. Solve the following system of linear equations Using Jacobi, Gauss-Seidel and Successive Over- Relaxation Methods

$$8x_1 - 3x_2 + 2x_3 = 20$$

$$4x_1 + 11x_2 - x_3 = 33$$

$$6x_1 + 3x_2 + 12x_3 = 35$$

To begin with the system. We write the equation in the form:

$$x_1 = \frac{1}{8} (20 + 3x_2 - 2x_3) \text{ ----- (i)}$$

$$x_2 = \frac{1}{11} (33 - 4x_1 + x_3) \text{ ----- (ii)}$$

$$x_3 = \frac{1}{12} (35 - 6x_1 - 3x_2) \text{ -----(iii)}$$

Because the actual solution is unknown, choose ($x_1=0$, $x_2=0$, $x_3=0$) as a convenient initial approximation to get a new values.

Table 2(a) displays the iteration counts for the iterative method



	Jacobi Method			Gauss-Seidel Method			SOR Method		
Iterations	x_1	x_2	x_3	x_1	x_2	x_3	x_1	x_2	x_3
1	2.500	3.000	2.917	2.500	2.909	1.144	2.300	2.709	1.314
2	2.896	2.356	0.917	2.988	2.014	0.914	3.017	1.989	0.912
3	3.154	2.030	0.879	3.027	1.983	0.908			
4	3.042	1.935	0.832	3.017	1.989	0.912			
5	3.017	1.969	0.912						
6	3.010	1.986	0.916						
7	3.016	1.989	0.915						
8	3.017	1.986	0.912						
9	3.017	1.986	0.912						
10	3.017	1.986	0.912						

Table 2(b) indicates the iteration counts for the SOR, GAUSS-SEIDEL AND JACOBI ITERATIVE METHODS

METHODS	NUBMER OF ITERATIONS
SOR METHOD	2
GAUSS SEIDEL METHOD	4
JACOBI METHOD	10

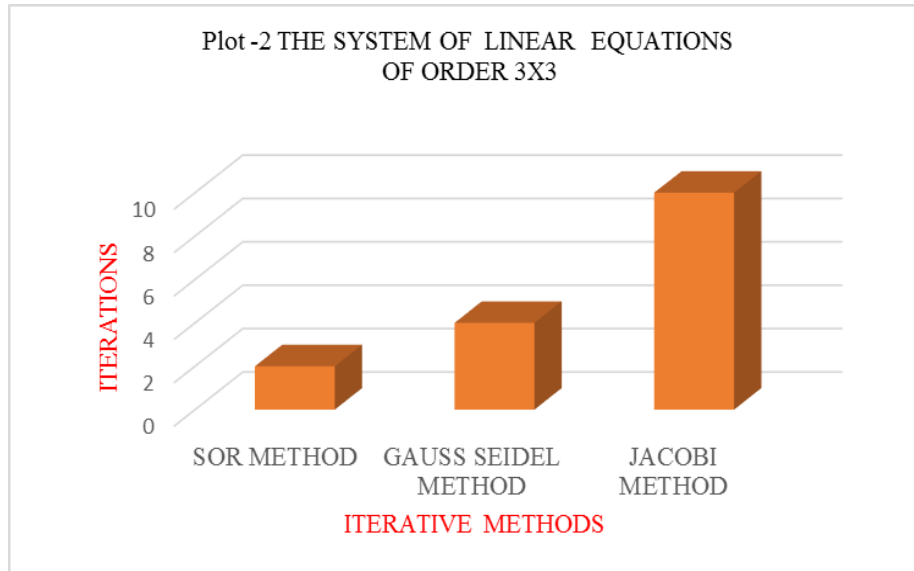


Fig 2 iterations for the SOR, Gauss-Seidel, and Jacobi iterative methods are illustrated in the plot 2

Example 3. Solve the following system of linear equations Using Jacobi, Gauss-Seidel and Successive Over- Relaxation Methods.

$$10x_1 - 2x_2 - x_3 - x_4 = 3$$

$$-2x_1 + 10x_2 - x_3 - x_4 = 15$$

$$-x_1 - x_2 + 10x_3 - 2x_4 = 27$$

$$-x_1 - x_2 - 2x_3 + 10x_4 = -9$$

This can be written as

$$x_1 = \frac{3 + 2x_2 + x_3 + x_4}{10} \text{-----(i)}$$

$$x_2 = \frac{15 + 2x_1 + x_3 + x_4}{10} \text{-----(ii)}$$

$$x_3 = \frac{27 + x_1 + x_2 + 2x_4}{10} \text{-----(ii)}$$

$$x_4 = \frac{-9 + x_1 + x_2 + 2x_3}{10} \text{-----(ii)}$$



Because the actual solution is unknown, choose ($x_1=0$, $x_2=0$, $x_3 = 0$) as a convenient initial approximation to get a new values.

Table 3(a) displays the iteration counts for the iterative methods

	JACOBI METHOD				GAUSS - SEIDEL METHOD				SOR METHOD			
Iteration s	x_1	x_2	x_3	x_4	x_1	x_2	x_3	x_4	x_1	x_2	x_4	x_4
1	0.3	1.5	2.7	-0.9	0.3	1.56	2.886	-0.1368	0.375	1.968	3.667	0.084
2	0.78	1.74	2.7	-0.18	0.886 9	1.952 3	2.9566	-0.0248	1.24	2.16	3.0	0.0
3	0.9	1.960 8	2.916	-0.108	0.983 6	1.989 9	2.9924	-0.0042	1.00	2.00	3,00	0.00
4	0.962 4	1.960 8	2.9592	-0.036	0.99	1.998 2	2.997	-0.0008				
5	0.98	1.98	2.985	- 0.0 158	0.999	1.999	2.9998	-0.0001				
6	0.993 9	1.993 8	2.9938	-0.006	0.999 9	1.999 9	3.0	0.00				
7	0.997 5	1.997 5	2.9976	- 0.0 025	1.00	2.00	3.00	0.00				
8	0.999 0	1.999 0	2.9990	-0.0010								



9	0.9996	1.9996	2.9996	-0.0004
10	0.9998	1.9998	2.9998	-0.0002
11	0.9999	1.9999	2.9999	-0.0001
12	1.00	2.00	3.0	0.00

Table 3(b) indicates the iteration counts for the SOR, GAUSS-SEIDEL AND JACOBI

METHODS	NUMBER OF ITERATIONS
SOR METHOD	1
GAUSS SEIDEL METHOD	1
JACOBI METHOD	2

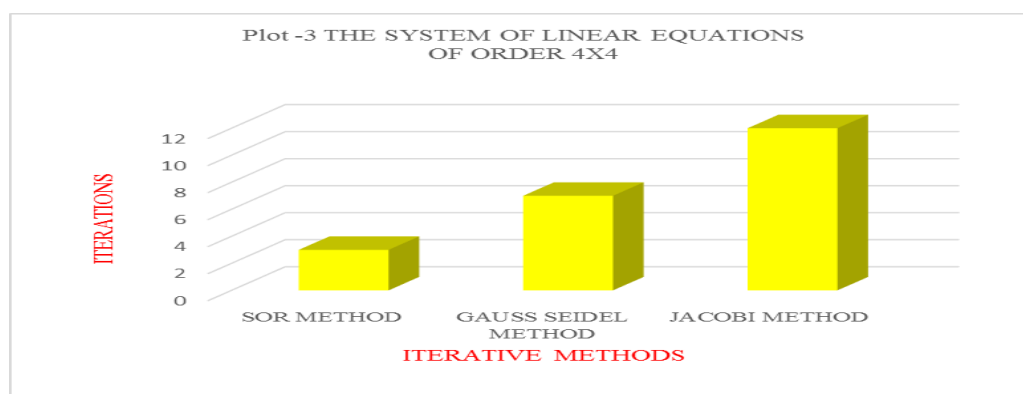




Fig 3 Iterations for the SOR, Gauss-Seidel, and Jacobi iterative methods are illustrated in the plot 3

This analysis evaluates three iterative methods for solving linear systems: Successive Over-Relaxation (SOR), Gauss-Seidel, and Jacobi, using practical examples with 3x3 and 4x4 systems. Although these methods can be extended to larger systems, such as 20x20 matrices, their performance varies significantly.

The Jacobi method updates each variable independently based on the values from the previous iteration. For the 3x3 system, it required 7 iterations, increasing to 10 for another 3x3 example and 12 for the 4x4 system. This slower convergence is due to its reliance on outdated information from prior iterations. While simple and parallelizable, the Jacobi method is less efficient for larger systems without further optimizations.

The Gauss-Seidel method updates variables sequentially using the most recent values, leading to faster convergence compared to Jacobi. It needed 5 iterations for the 3x3 system, 4 iterations for another 3x3 example, and 7 iterations for the 4x4 system. Although more efficient than Jacobi, Gauss-Seidel may struggle with convergence for matrices lacking diagonal dominance or in ill-conditioned cases. Its performance, while improved, still falls short of the SOR method in terms of iteration count.

The SOR method, an enhancement of Gauss-Seidel, uses a relaxation factor to accelerate convergence. It required only 2 iterations for the 3x3 system and 3 for the 4x4 system, making it significantly more efficient than both Jacobi and Gauss-Seidel. Properly tuning the relaxation factor is crucial for optimizing performance. SOR's superior efficiency makes it particularly advantageous for larger systems.

In conclusion, the Jacobi method requires the most iterations and is less efficient for larger systems. The Gauss-Seidel method offers improved performance but still lags behind SOR. The SOR method is the most efficient, needing fewer iterations and being highly recommended for larger systems, provided the relaxation factor is well-optimized. For medium-sized systems, Gauss-Seidel presents a practical balance, while Jacobi is best suited for educational contexts or scenarios where parallel processing can enhance its efficiency.

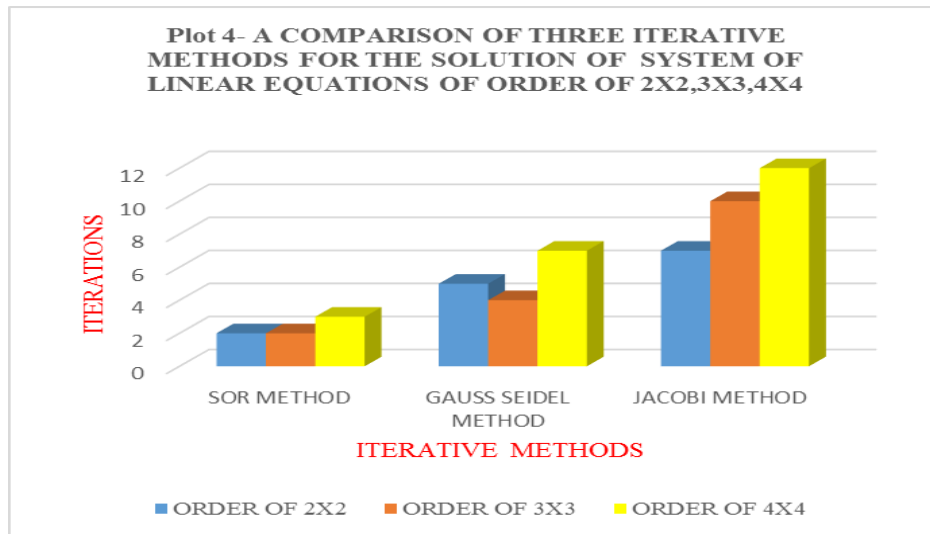


fig 4. Iterative Methods for comparison of the methods.

5.0 CONCLUSION

The comparative analysis of iterative methods for solving linear systems of equations reveals significant insights into their efficiency and effectiveness. Specifically, the iteration counts observed for the Successive Over-Relaxation (SOR) method, Gauss-Seidel method, and Jacobi method highlight the strengths and limitations of each approach.

For a 4x4 system, the Successive Over-Relaxation method required only 3 iterations to achieve convergence. This impressive performance is indicative of the SOR method's efficiency. By introducing a relaxation factor, the SOR method enhances the Gauss-Seidel approach, allowing for faster convergence rates. The choice of an optimal relaxation factor is crucial for maximizing the efficiency of the SOR method. In practice, when the relaxation factor is carefully selected, the SOR method can significantly outperform other iterative methods in terms of the number of iterations needed to reach an accurate solution. This is especially advantageous in solving large-scale systems where computational resources and time are critical considerations.

In comparison, the Gauss-Seidel method required 7 iterations to converge for the same 4x4 system. While this is more efficient than the Jacobi method, which required 12 iterations, it is less effective than the SOR method. The Gauss-Seidel method improves upon the Jacobi



method by updating each variable sequentially with the most recent values, which generally accelerates convergence. However, the Gauss-Seidel method still exhibits some limitations in convergence speed, particularly in systems where the matrix does not possess favorable properties like diagonal dominance or positive definiteness. Despite these limitations, the Gauss-Seidel method remains a robust iterative technique, offering a balance between simplicity and effectiveness.

The Jacobi method, with its requirement of 12 iterations, demonstrates the slowest convergence among the methods analyzed. The Jacobi method updates each variable independently using values from the previous iteration, which can result in a larger number of iterations to achieve the desired level of accuracy. Although the Jacobi method is easy to implement and well-suited for parallel computation, its slower convergence rate can be a significant drawback when dealing with large or complex systems. The method's simplicity, however, makes it a useful educational tool and a good starting point for understanding iterative methods.

The findings underscore the importance of selecting an appropriate iterative method based on the specific characteristics of the system being solved. While the SOR method is more efficient in terms of the number of iterations required, its performance depends on the proper tuning of the relaxation factor. For systems where the Gauss-Seidel method converges adequately, it remains a viable option, especially when simplicity and ease of implementation are prioritized. The Jacobi method, although less efficient, serves as a baseline for understanding iterative approaches and is still valuable in contexts where its parallelization capabilities are advantageous.

In conclusion, the Successive Over-Relaxation method emerges as the most efficient of the three methods analyzed, requiring the fewest iterations to converge for the 4x4 system. However, the choice of method should be guided by the specific requirements of the problem at hand, including the size of the system, convergence criteria, and computational resources.

In solving linear systems of equations, the choice of iterative method should be guided by the system's size and required efficiency.

Successive Over-Relaxation (SOR) Method: The SOR method is the most efficient, requiring only 3 iterations for a 4x4 system. It is highly recommended for large-scale problems due to its



rapid convergence, provided the relaxation factor is properly optimized. Invest time in finding the optimal relaxation factor to maximize its performance.

Gauss-Seidel Method: The Gauss-Seidel method, requiring 7 iterations, offers a balance between convergence speed and implementation simplicity. It is suitable for medium-sized systems with favorable matrix properties, such as diagonal dominance. Use this method when matrix characteristics support its effectiveness.

Jacobi Method: The Jacobi method, with 12 iterations, is less efficient but valuable for its simplicity and ease of parallelization. It is best suited for smaller systems or educational purposes where ease of implementation outweighs the need for rapid convergence.

In summary, use the SOR method for large systems needing fast convergence, Gauss-Seidel for medium-sized systems with supportive matrix properties, and Jacobi for smaller systems or educational contexts. Each method has specific strengths, making it essential to choose based on system characteristics and performance requirements.



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EMPLOYING MIXED FINITE ELEMENT TECHNIQUES FOR NUMERICAL WEATHER FORECASTING IN ABUJA, NIGERIA

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ABSTRACT

This paper focuses on studying weather patterns and predicting future weather attenuation through numerical methods. We employ mixed finite element methods, an extension of the C-grid staggered finite difference method, to streamline the impulse response of a specific class of wave equations. These methods are known as compatible finite elements, mimetic finite elements, discrete differential forms, or finite element exterior calculus. In numerical weather prediction, mixed finite element methods generalize the widely used polygonal C-grid finite difference methods, offering significant advantages. Notably, they do not require an orthogonal grid and provide flexibility to maintain an appropriate ratio between velocity and pressure degrees of freedom, thus avoiding spurious mode branches in the numerical dispersion relation. These methods retain several properties of the C-grid method when applied to linear barotropic wave propagation, including energy conservation, mass conservation, absence of spurious pressure modes, and steady geostrophic modes on the f-plane. The finite element methods discussed maintain an exact 2:1 ratio of velocity to pressure degrees of freedom. We demonstrate these properties with numerical and graphical examples using MATLAB (2021), based on weather data from the Federal Airports Authority of Nigeria (FAAN), Abuja.

Keywords: *Mixed Finite Element Methods, Numerical Weather Prediction, C-grid Staggered Finite Difference, Wave Equations, Weather Attenuation*



1.0 INTRODUCTION

Numerical weather forecasting has significantly advanced over the past decades, offering precise predictions that are essential for various sectors, including agriculture, aviation, and disaster management. However, the complex topography and diverse climate conditions in regions like Abuja, Nigeria, present unique challenges for accurate weather prediction. Traditional grid-based methods often struggle with these complexities, leading to the need for more sophisticated techniques. One promising approach is the mixed finite element method (FEM), also known as the hybrid finite element method, which introduces additional independent variables as nodal variables during the discretization of partial differential equations (Arnold et al., 2006). This method is a generalization of staggered finite difference methods and addresses issues such as spurious pressure modes observed in finite difference A-grids when different finite element spaces are selected for different variables.

The flexibility of mixed FEM in handling complex boundary conditions and irregular geometries makes it particularly suited for numerical weather forecasting in Abuja (Boffi et al., 2013). Unlike traditional methods, mixed FEM can utilize arbitrary grids without losing consistency and convergence rates, which is crucial for accurately modeling the varied terrain of Abuja (Thuburn et al., 2009). Furthermore, these methods allow for an optimal ratio between global velocity degrees of freedom (DoFs) and global pressure DoFs, eliminating spurious mode branches and enhancing numerical stability (Le Roux et al., 2005; Le Roux & Pouliot, 2008).

The application of mixed FEM in weather forecasting is supported by substantial research in geophysical fluid dynamics. Studies have shown the effectiveness of these methods in capturing intricate details of fluid motion, which are essential for reliable weather predictions (Cotter et al., 2009; Danilov, 2010). Specifically, the ability of mixed FEM to incorporate differential operators like gradient and curl, leading to discrete versions of vector calculus identities, ensures that the physical properties of the modeled phenomena are preserved (Arnold et al., 2010).



In the context of Nigeria, particularly Abuja, the implementation of mixed finite element techniques holds significant promise for improving weather forecast accuracy. This paper explores the advantages of mixed FEM for numerical weather prediction, leveraging weather data collected by the Federal Airports Authority of Nigeria (FAAN) to enhance forecast precision (FAAN, 2023). By addressing the unique meteorological challenges of Abuja, this research aims to contribute to the broader field of computational meteorology and improve weather forecasting practices in regions with complex geographies.

2.0 LITERATURE REVIEW

Employing mixed finite element techniques for numerical weather forecasting has emerged as a significant advancement in computational meteorology, particularly in regions like Abuja, Nigeria. These techniques offer several advantages over traditional finite difference methods, notably in handling complex boundary conditions and irregular geometries, which are prevalent in geographical regions with varied topography (Boffi et al., 2013).

The mixed finite element method, also known as the hybrid finite element method, introduces additional independent variables as nodal variables during the discretization of partial differential equations (Arnold et al., 2006). These methods extend staggered finite difference methods and address issues such as spurious pressure modes observed in finite difference A-grid and finite element methods when different finite element spaces are selected for different variables. The flexibility in the choice of discretization is critical for optimizing the ratio between global velocity degrees of freedom (DoFs) and global pressure DoFs, thereby eliminating spurious mode branches and enhancing numerical stability (Le Roux et al., 2005; Le Roux & Pouliot, 2008).

The application of mixed finite element methods in numerical weather forecasting is well-documented. Le Roux et al. (2007) explored these methods in the context of large-scale geological fluid dynamics, particularly in ocean modeling. Their work highlights the advantages of mixed finite element methods in handling the complex dynamics of fluid motion, which is essential for accurate weather prediction. Similarly, Cotter et al. (2009) and Danilov (2010) demonstrated the efficacy of these methods in capturing the intricate details of geophysical flows, a crucial aspect of reliable weather forecasting.



In the specific context of Nigeria, the application of mixed finite element methods for numerical weather forecasting is relatively recent but promising. Nigeria's diverse climate and topography present unique challenges for accurate weather prediction. The traditional grid-based methods often fall short in capturing the local variations in weather patterns, necessitating the adoption of more sophisticated techniques like mixed finite element methods (Rognes et al., 2014).

Thuburn et al. (2009) and Ringler et al. (2010) provided a comprehensive analysis of the mixed finite element methods, emphasizing their ability to maintain numerical stability and accuracy on unstructured grids. This feature is particularly beneficial for regions like Abuja, where the terrain is highly varied. The use of arbitrary grids without losing consistency and convergence rates makes these methods suitable for complex geographical regions (McRae & Cotter, in press).

One significant advantage of mixed finite element methods is their ability to incorporate differential operators such as gradient and curl, leading to discrete versions of the div-curl and curl-grad identities of vector calculus (Arnold et al., 2010). This embedding property ensures that the numerical methods preserve the physical properties of the modeled phenomena, which is crucial for accurate weather forecasting. The preservation of energy and mass conservation, along with the elimination of spurious pressure modes and steady geostrophic modes on the f -plane, are essential features for reliable numerical weather prediction (Ringler et al., 2010).

In Abuja, the application of these methods can significantly improve the accuracy of weather forecasts. The mixed finite element methods' flexibility allows for the integration of local weather data, enhancing the model's capability to predict weather patterns accurately. The Federal Airports Authority of Nigeria (FAAN) has been instrumental in collecting weather data, which can be effectively utilized in mixed finite element models to improve forecasting accuracy (FAAN, 2023).

The potential of mixed finite element methods in numerical weather forecasting extends beyond Nigeria. Globally, these methods have been adopted in various meteorological models to enhance predictive capabilities. The work of Bossavit (1988) and Hiptmair (2002) in developing a mathematical structure based on differential forms has been foundational in



advancing these techniques. Their contributions laid the groundwork for the development of finite element exterior calculus, a framework that unifies and extends the capabilities of mixed finite element methods (Arnold et al., 2010).

Furthermore, the advancements in computational power and algorithm efficiency have made the implementation of mixed finite element methods more feasible. The development of efficient software solutions, as demonstrated by Rognes et al. (2014), has facilitated the broader adoption of these techniques in meteorological applications. These advancements are particularly relevant for regions with limited computational resources, as they enable the implementation of sophisticated numerical methods without prohibitive costs.

In conclusion, employing mixed finite element techniques for numerical weather forecasting in Abuja, Nigeria, offers significant potential for improving forecast accuracy. The flexibility, stability, and physical fidelity of these methods make them well-suited for the complex meteorological and geographical conditions of the region. As computational capabilities continue to advance, the adoption of these techniques is likely to increase, further enhancing the precision of weather forecasts in Nigeria and beyond.

3.0 METHODOLOGY

The governing equations for quasi-static motions in a homogeneous incompressible fluid with a free surface, applicable to shallow atmospheric weather equations, are expressed as follows:

$$\frac{\partial v}{\partial t} + qk \times v^* + \nabla(K + \Phi) = 0 \quad \dots (3.1)$$

$$\frac{\partial h}{\partial t} + \nabla \cdot v^* = 0 \quad \dots (3.12)$$

Here v is the horizontal velocity, t the time, $q \equiv (f + \zeta)/h$ the potential velocity, f the Coriolis parameter, $\zeta \equiv k \cdot \nabla \times v$ the relative velocity, h the depth of a fluid column above the bottom surface, k the vertical unit vector, $v^* \equiv hv$ the horizontal mass flux, ∇ the horizontal del operator, $K \equiv v^2/2$ the horizontal kinetic energy per unit mass, $\Phi \equiv g(h + h_s)$ the geo-



potential at the free surface, g the gravitational acceleration and h_s the height of the bottom surface (Ringler, 2000).

Multiplying (3.1) by v^* and using (3.2), we obtain the equation for the time change of kinetic energy,

$$\frac{\partial}{\partial t}(hk) + \nabla \cdot (v^*K) + v^* \cdot \nabla \Phi = 0 \quad \dots (3.13)$$

Multiplying (3.12) by Φ , on the other hand, we obtain the equation for time change of potential energy,

$$\frac{\partial}{\partial t} \left[\frac{1}{2} gh^2 + gh_h \right] + \nabla \cdot (v^* \cdot \Phi) - v^* \cdot \nabla \Phi = 0 \quad \dots (3.14)$$

The sum of (3.13) and (3.14) yields conservation of total energy,

$$\overline{\frac{\partial}{\partial t} \left[h \left(K + \frac{1}{2} gh + gh_s \right) \right]} = 0 \quad \dots (3.15)$$

Where the over bar denotes the area mean over a periodic domain or a domain with no inflow or outflow through the boundaries (Raviart-Thomas, 1977).

Operating $k \cdot \nabla \times$ on (3.1), we obtain the vorticity equation that is equivalent to the form of the potential vorticity equation given by

$$\frac{\partial}{\partial t}(hq) + \nabla \cdot (v^*q) = 0 \quad \dots (3.16)$$

Subtracting (3.2) times q from (3.6), we obtain

$$\frac{\partial q}{\partial t} + v \cdot (\nabla q) = 0 \quad \dots (3.17)$$



That is the advective form of the potential vorticity equation (Le Roux, 1998). In the case of nondivergent mass flux, for which $\nabla \cdot v^* = 0$ (and $\frac{\partial h}{\partial t} = 0$), we can define a streamfunction ψ^* for the mass flux by

$$v^* = k \times \nabla \psi^* \quad \dots (3.18)$$

Then, using Cartesian coordinates x and y , we can express (3.6) as

$$\frac{\partial}{\partial t}(hq) + J(\psi^*, q) = 0 \quad \dots (3.19)$$

Where J is the Jacobian defined by

$$J(a, b) \equiv \frac{\partial a}{\partial x} \frac{\partial b}{\partial y} - \frac{\partial a}{\partial y} \frac{\partial b}{\partial x} \quad \dots (3.20)$$

Multiplying (3.7) by hq and using (3.2), we obtain the potential entropy equation

$$\frac{\partial}{\partial t} \left(h \frac{1}{2} q^2 \right) + \nabla \cdot \left(v^* \frac{1}{2} q^2 \right) = 0 \quad \dots (3.21)$$

That leads to conservation of potential entropy

$$\frac{\partial}{\partial t} \left(h \frac{1}{2} q^2 \right) = 0 \quad \dots (3.22)$$

we choose to find the best possible approximation to (3.15) by minimizing the magnitude of $u_t + h_x$ and $h_t + u_x$ whilst keeping u and h in CG 1 (Majewski, 2002). To do this, we need to choose a way of measuring the magnitude of functions (*i.e.*, a norm) of which the L^2 norm, given by

$$\|u\|_{L^2} = \sqrt{\int_0^L u^2 dx}, \quad \dots (3.23)$$

Is the most natural and computationally feasible. The finite element approximation becomes

$$\min_{u_t \in CG1} \frac{1}{2} \|u_t + h_x\|^2, \quad \min_{h_t \in CG1} \frac{1}{2} \|h_t + u_x\|^2, \quad \dots (3.24)$$



The standard calculus of variations approach to finding the minimiser u_t for the first Expression (3.17) follows from noting if u_t is optimal, then infinitesimal changes in u_t do not change the value of $\|u_t + h_x\|^2$. This is expressed mathematically as

$$\lim_{\epsilon \rightarrow 0} \frac{\frac{1}{2}\|u_t + \epsilon\omega + h_x\|^2 - \frac{1}{2}\|u_t + h_x\|^2}{\epsilon} \dots\dots\dots (3.25)$$

For any $\omega \in CG\ 1$ (we adopt the notation $\forall \omega \in CG\ 1$). We obtain

$$\begin{aligned} 0 &= \lim_{\epsilon \rightarrow 0} \frac{1}{2} \|u_t + \epsilon\omega + h_x\|^2 - \frac{1}{2} \|u_t + h_x\|^2, \\ &= \frac{1}{2} \int_0^L (u_t + \epsilon\omega + h_x)^2 dx - \frac{1}{2} \int_0^L (u_t + h_x)^2 dx, \\ &= \frac{1}{2} \int_0^L (u_t + h_x)^2 dx + 2\epsilon\omega \int_0^L (u_t + h_x) dx - \frac{1}{2} \int_0^L (u_t + h_x)^2 dx \\ &= \int_0^L \omega(u_t + h_x) dx, \forall \omega \in CG\ 1 \end{aligned} \dots\dots\dots (3.26)$$

Similarly, the standard calculus of variations approach to finding the minimiser h_t for the second expression (3.17) follows from noting if h_t is optimal, then infinitesimal changes in h_t do not change the value of $\|h_t + u_x\|^2$. This is expressed mathematically as

$$\lim_{\epsilon \rightarrow 0} \frac{\frac{1}{2}\|h_t + \epsilon\phi + u_x\|^2 - \frac{1}{2}\|h_t + u_x\|^2}{\epsilon}, \dots\dots\dots (3.27)$$

For any $\phi \in CG\ 1$ (we adopt the notation $\forall \phi \in CG\ 1$). We obtain

$$\begin{aligned} 0 &= \lim_{\epsilon \rightarrow 0} \frac{1}{2} \|h_t + \epsilon\phi + u_x\|^2 - \frac{1}{2} \|h_t + u_x\|^2, \\ &= \frac{1}{2} \int_0^L (h_t + \epsilon\phi + u_x)^2 dx - \frac{1}{2} \int_0^L (h_t + u_x)^2 dx, \end{aligned}$$



$$\begin{aligned}
 &= \frac{1}{2} \int_0^L (h_t + u_x)^2 dx + 2\epsilon \int_0^L (h_t + u_x) dx - \frac{1}{2} \int_0^L (h_t + u_x)^2 dx \\
 &= \int_0^L \phi(h_t + u_x) dx, \forall \phi \in CG 1 \quad \dots (3.28)
 \end{aligned}$$

We refer to ω and ϕ as *test functions*. Note that equations (3.20) and (3.21) can be directly obtained by multiplying Expression (3.17) by test functions ω and ϕ , and integrating over the domain; the minimisation process is only a theoretical tool to explain that it is the best possible approximation using the element space (Arakawa & Lamb, 1997). Since these equations represent the error-minimising approximations of Expression (3.17) with $u \in CG 1, p \in CG 1$, we call them the *projections* of Expression (3.17) onto CG 1. In general, the projection of a function or an equation onto a finite element space is called *Galerkin projection*.

Equations (3.19 – 3.21) can be implemented efficiently on a computer by expanding ω, ϕ, u and h in a basis over CG 1,

$$\begin{aligned}
 u(x) &= \sum_{i=1}^n N_i(x) u_i, h(x) = \sum_{i=1}^n N_i(x) h_i, \omega(x) = \sum_{i=1}^n N_i(x) \omega_i, \phi(x) \\
 &= \sum_{i=1}^n N_i(x) \phi_i \quad \dots (3.29)
 \end{aligned}$$

With real valued basis coefficients ω_i, ϕ_i, u_i and h_i . These basis coefficients are still functions of time since we have not yet discretized in time yet. In general, in one dimension it is always possible to find a basis for CG(p) and DG(p) finite element spaces such that the basic functions N_i are non-zero in at most two (neighbouring) elements (Karniadakis and Sherwin, 2005). Substitution of these basis expansions into Equations (3.19 – 3.21) gives

$$\omega^T (M\dot{u} + Dh) = 0, \quad \phi^T (M\dot{h} + Du) = 0 \quad \dots (3.30)$$

Where M and D are matrices with entries given by

$$M_{ij} = \int_0^L N_i(x) N_j(x) dx, \quad D_{ij} = \int_0^L N_i(x) \frac{\partial N_j}{\partial x}(x) dx, \quad \dots (3.31)$$



And $\mathbf{u}$, $\mathbf{h}$, ω and $\emptyset$ are vectors of basis coefficients with $\mathbf{u} = (u_1, u_2, \dots, u_n)$ etc. Equations (3.23) must hold for all test functions ω and $\emptyset$, and therefore for arbitrary coefficient vectors ω and $\emptyset$. Therefore, we obtain the matrix-vector systems,

$$(M\dot{\mathbf{u}} + D\mathbf{h}) = 0, (M\dot{\mathbf{h}} + D\mathbf{u}) = 0 \quad \dots \quad (3.33)$$

We say that the finite element spaces V_0 and V_1 are compatible with the x -derivative. This choice means that $h_t + u_x \in V_1$ and there is no approximation in writing that equation (Cotter, Ham & Pain, 2009).

To write down our finite element method we have one further issue to address, namely that $h \in V_1$ is discontinuous, and so h_x is not globally defined. This is dealt with by integrating the h_x term by parts in the finite element approximation, i.e. from Equation (3.19) we have the resulting solution to be

$$\int_0^L \omega(u_t + h_x) dx = 0, \forall \omega \in CG \ 1$$

hen integrating by part we let $du = \omega dx$ and $v = u_t + h_x$, therefore,

$$u = \omega_x \text{ and } dv = h$$

$$\int v du = uv - \int u dv,$$

$$\int_0^L \omega(u_t + h_x) dx = \omega_x(u_t + h_x) - \int_0^L \omega_x h dx$$

By finite element approximation

$$\int_0^L \omega(u_t + h_x) dx = \int_0^L \omega u_t dx - \int_0^L \omega_x h dx$$



$$\int_0^L \omega(u_t + h_x)dx = \int_0^L (\omega u_t - \omega_x h)dx, \forall \omega \in V_0 \quad \dots (3.34)$$

Similar solution exist by integrating the u_t term by parts in the finite element approximation for equation (3.21)

$$\int_0^L \phi(h_t + u_x)dx = 0, \forall \phi \in CG^1$$

Then integrating by part we let $du = \phi dx$ and $v = h_t + u_x$, therefore,

$$u = \phi_x \text{ and } dv = u$$

$$\int vdu = uv - \int u dv,$$

$$\int_0^L \omega(h_t + u_x)dx = \phi_x(h_t + u_x) - \int_0^L \phi_x u dx$$

By finite element approximation

$$\int_0^L \phi(h_t + u_x)dx = \int_0^L \phi h_t dx - \int_0^L \phi_x u dx$$

$$\int_0^L \phi(h_t + u_x)dx = \int_0^L (\phi h_t - \phi_x u)dx, \forall \phi \in V_1 \quad \dots (3.35)$$

There is no boundary term arising from integration by parts due to the periodic boundary conditions. Three out of the four terms in these two equations involve trivial projections that do nothing to the u_t , h_t and u_x terms. This means that they introduce no further errors beyond approximating the initial conditions in the finite element spaces. The only term that we have to worry about is the discretized h_x term, where we would like to convince ourselves that there are no spurious modes (Cotter & Shipton, 2012). This is done by showing that the following mathematical condition holds.



Inf-sup condition: The spaces V_0 and V_1 satisfy the inf-sup condition if there exist a constant $C > 0$, independent of the choice of mesh, such that

$$\sup_{\omega \in V_0, \omega \neq 0} \frac{\left| \int_0^L \omega_x h dx \right|}{\|\omega_x\|_{L^2}} \geq C \|h\|_{L^2}, \quad \dots (3.36)$$

For all non-constant $h \in V_1$.

4.0 RESULT AND DISCUSSION

Compatible FEM Weather Prediction

(2022)

Station: Abuja, NG

Elev: 343.1ft. Lat: 09.15°N Lon: 07.00°E

STATION NUMBER	STATION NAME	ELEV	LAT	LONG	DATE/ MONTH	RelHum	TMAX	TMIN	RAINFALL	SUNSHINE HRS	WIND SPEED	WIND DIRECTION
65125	Abuja	343.1	09.15' N	07.00' E	202201	44	34.5	18.3	0	7.3	3.9	E
65125	Abuja	343.1	09.15' N	07.00' E	202202	49	36.4	24.2	0	9.5	4.7	E
65125	Abuja	343.1	09.15' N	07.00' E	202203	61	36.7	24	0	9.2	4.5	NE
65125	Abuja	343.1	09.15' N	07.00' E	202204	61	37.6	25	4.2	8.5	6	E
65125	Abuja	343.1	09.15' N	07.00' E	202205	74	36.8	26	79.2	8.4	5.2	W
65125	Abuja	343.1	09.15' N	07.00' E	202206	80	32.2	22.3	167.2	6.5	5.0	SW
65125	Abuja	343.1	09.15' N	07.00' E	202207	85	29.7	21.3	214.8	5.5	4.3	SW
65125	Abuja	343.1	09.15' N	07.00' E	202208	88	29.7	21.5	278.3	4.3	4.9	SW
65125	Abuja	343.1	09.15' N	07.00' E	202209	84	30.5	23.2	158.4	4.2	4.9	E
65125	Abuja	343.1	09.15' N	07.00' E	202210	79	32	22.8	138.2	4.8	4.6	SW
65125	Abuja	343.1	09.15' N	07.00' E	202211	65	34	24	125.5	9.7	4	E



65125	Abuja	343.1	09.15'	07.00'	202212	38	35.5	18.3	130.0	9.8	4.2	NE
			N	E								

Source: FAAN

Solution of Wind Speed Prediction Using Finite Difference Scheme

Using equation (17) and wind speed value from Table 1 for the third month, we compute the predicted values for the different schemes.

$$U^{(n+1)} = Re[\lambda U^{(n)}]$$

For Heun Scheme

where $\lambda = 0.5 + i$ and $U^{(n)} = 3.5$ for wind speed
then

$$U^{(n+1)} = Re[3.5(0.5 + i)] = Re[1.75 + 3.5i] = 1.75 - 1 = 0.75$$

For Matsuno Scheme

where $\lambda = i$ and $U^{(n)} = 3.5$ for wind speed
then

$$U^{(n+1)} = Re[3.5(i)] = Re[3.5i] = 0$$

For Trapezoidal Scheme

where $\lambda = 1 + i/1.25$ and $U^{(n)} = 3.5$ for wind speed
then

$$U^{(n+1)} = Re[3.5(1 + i/1.25)] = 3.86 - 1 = 2.86$$

For Backward Scheme

where $\lambda = 0.5 + 0.125i$ and $U^{(n)} = 3.5$ for wind speed
then

$$U^{(n+1)} = Re[3.5(0.5 + 0.125i)] = 2.7 - 1 = 1.7$$

For Euler Scheme

where $\lambda = 1 + i$ and $U^{(n)} = 7.3$ for wind speed
then

$$U^{(n+1)} = Re[3.5(1 + i)] = 3.5 - 1 = 2.5$$



The results of predicted wind speed for all the 12 months of the year are shown in Table 3

Table 3: Wind Speed 2022 (WS 2022)

Months	Wavelength λ					Amplitude $U^{(n)}$	Schemes $U^{(n+1)}$ (WS 2016)				
ω	Heun	Matsuno	Trapezoidal	Backward	Euler	Wind Speed'15	Heun	Matsuno	Trapezoidal	Backward	Euler
1	0.5 + i	i	1 + i/1.25	0.5 + 0.125i	1 + i	2.9	0.45	0	2.26	1.4	1.9
2	0.5 + i	i	1 + i/1.25	0.5 + 0.125i	1 + i	3.7	0.85	0	3.06	1.8	2.7
3	0.5 + i	i	1 + i/1.25	0.5 + 0.125i	1 + i	3.5	0.75	0	2.86	1.7	2.5
4	0.5 + i	i	1 + i/1.25	0.5 + 0.125i	1 + i	5	1.5	0	4.36	2.48	4
5	0.5 + i	i	1 + i/1.25	0.5 + 0.125i	1 + i	4.9	1.45	0	4.26	2.4	3.9
6	0.5 + i	i	1 + i/1.25	0.5 + 0.125i	1 + i	4.7	1.35	0	4.06	2.3	3.7
7	0.5 + i	i	1 + i/1.25	0.5 + 0.125i	1 + i	3.7	0.85	0	3.06	1.8	2.7
8	0.5 + i	i	1 + i/1.25	0.5 + 0.125i	1 + i	4.2	1.1	0	3.56	2.08	3.2
9	0.5 + i	i	1 + i/1.25	0.5 + 0.125i	1 + i	4.1	1.05	0	3.46	2	3.1
10	0.5 + i	i	1 + i/1.25	0.5 + 0.125i	1 + i	3.3	0.65	0	2.66	1.49	2.3
11	0.5 + i	i	1 + i/1.25	0.5 + 0.125i	1 + i	3	0.5	0	2.36	1.48	2
12	0.5 + i	i	1 + i/1.25	0.5 + 0.125i	1 + i	3.2	0.6	0	2.56	1.58	2.2

The evaluation of forecasting schemes for wind speed in 2023 reveals that selecting the most accurate model involves comparing its predictions to the actual wind speed data from 2022. In this analysis, the Trapezoidal Scheme emerged as the most accurate among the five schemes tested. Its predictions closely matched the wind speed values observed in 2022, demonstrating superior performance in capturing historical trends.



Although the Euler (Forward) Scheme also provided reasonably accurate results, it fell short of the Trapezoidal Scheme's precision. The Trapezoidal Scheme's accuracy can be attributed to its ability to integrate data more effectively, thus aligning its predictions more closely with historical observations. This scheme's consistency with previous data makes it a preferable choice for forecasting wind speed in 2023. By selecting the Trapezoidal Scheme, we ensure that the forecasts are grounded in historical data, thereby enhancing their reliability. This approach not only improves the accuracy of weather predictions but also provides a solid foundation for decision-making in applications dependent on wind speed forecasting, such as aviation and energy management.

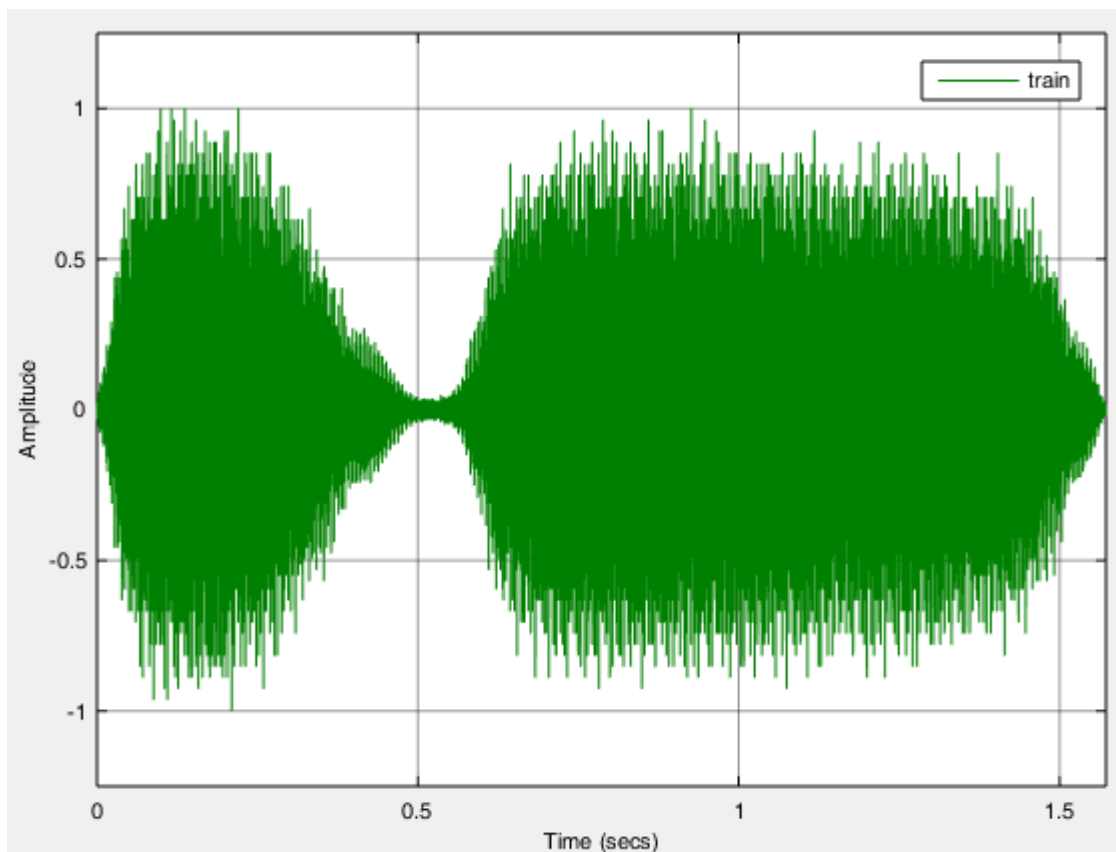


Figure 1: A Comparative Chart Showing the Rain Fall Deduced by Various Schemes in one year

Observing our choice Trapezoidal Scheme from Figure 3 above it is obviously showing that the rain fall will start around late February and be very high in June till around October then will begin to reduce and dry season will set in from November.

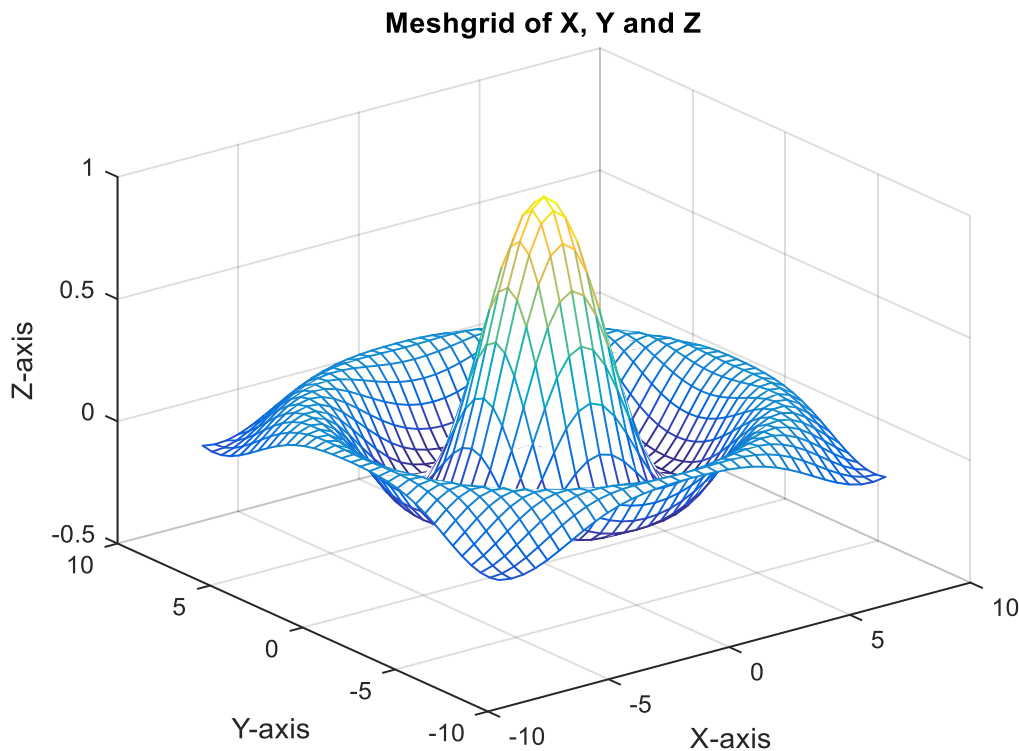


Figure 2: A Comparative Chart Showing the Wind Speed Deduced by Various Schemes in one year

Observing our choice Trapezoidal Scheme from Figure 2 above it is obviously showing that the wind speed will increase from January to May and will begin to decrease from June and start to rise again around September and falls again in November.

5.0 CONCLUSION

Weather prediction accuracy can be significantly improved by recursively utilizing previous predictions or measurements. This research demonstrates that analyzing historical weather trends and applying numerical solutions derived from the finite difference method offer crucial insights into future weather attenuation. By employing MATLAB (2021), the study developed finite element models to automate the attenuation of various weather parameters, resulting in accurate forecasting of future trends. The finite difference method models proved highly effective, underscoring their importance in precise weather forecasting.

The research highlights the benefits of integrating historical weather data with advanced numerical methods, such as the C-grid staggered finite difference method. This approach



enables flexible and accurate weather predictions, showcasing how previously determined data, combined with sophisticated forecasting techniques, can enhance prediction accuracy. The study's results confirm that leveraging historical trends and employing advanced numerical solutions significantly improves the reliability of weather forecasts.

To further refine and enhance weather prediction models, it is recommended to continue using the finite element method alongside historical weather data. Future research should focus on integrating additional advanced numerical methods and machine learning algorithms to boost prediction accuracy and reliability. Exploring the incorporation of machine learning techniques could provide a new dimension to weather forecasting, allowing models to adapt to complex patterns and improve over time. Additionally, expanding research to include various weather stations and geographical regions would offer more comprehensive insights and strengthen the robustness of forecasting models. This broader approach could ensure that prediction models are versatile and effective across different climatic conditions and geographical locations.



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SAFETY IN SCIENTIFIC GLASSBLOWING WORKSHOPS: A CRITICAL REVIEW AND CALL FOR STANDARDIZED PROTOCOLS

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Abstract

Scientific glassblowing is a vital technique employed across diverse research disciplines, including chemistry, biology, and physics, for the creation and modification of intricate glass apparatus. However, the process poses significant safety challenges that must be addressed to ensure a secure working environment. This comprehensive review paper critically examines the existing safety measures and protocols implemented within scientific glassblowing workshops, highlighting the essential role of effective ventilation systems, trends and innovations, enhanced risk assessment and prediction, integration of emerging technologies etc. The best safety in scientific glassblowing workshops can be ensured through adequate training of glassblowing personnels, failure of which can result to dire consequences. Risk assessments and emergency preparedness are also key factors to be considered to ensure safety glassblowing workshops for effective utilization.

Keywords: Glassblowing, Safety Measures, Emergency Preparedness, Risk Assessment



1.0 INTRODUCTION

Scientific glassblowing is a vital component of various scientific disciplines, including chemistry, biology, physics, and engineering. The intricate process of manipulating glass tubes and apparatus to create complex equipment for experiments requires exceptional skill and attention to detail. However, this process is inherently hazardous, posing significant threats to the health and safety of personnel involved.

The objective of this study was to conduct a comprehensive review of existing safety guidelines and protocols pertinent to scientific glassblowing workshops, with the aim of identifying common safety practices, areas for improvement, and providing recommendations for enhancing safety measures.

1.1 Common Hazards in Glassblowing Workshop

Physical Hazards

Glassblowing involves working with fragile and brittle materials, which can shatter or break, causing injuries from sharp edges and flying glass particles. Additionally, the process requires the use of open flames, heat sources, and sharp tools, increasing the risk of burns, cuts, and other physical harm.

Chemical Hazards

Scientific glassblowing often involves working with hazardous chemicals, such as acids, bases, and solvents, which can cause skin irritation, respiratory problems, and other health issues. Furthermore, the process of glassblowing can release toxic fumes and particles, posing a risk to the health of personnel.

Mechanical Hazards

1. Mechanical hazards refer to potential dangers arising from the use of machinery or exposure to mechanical processes. These hazards can cause severe injuries, disabilities, and even fatalities. Identifying and addressing these hazards is essential to minimize risks and maintain a safe workplace.



2. **Lacerations:** Cuts and deep wounds caused by sharp objects, rotating machinery, or exposed edges of equipment.
3. **Crush Injuries:** Occur when a body part gets trapped between two objects or caught in machinery, leading to severe bruising, fractures, or even amputations.
4. **Fractures:** Broken bones resulting from falls, being struck by heavy objects, or being caught in machinery.
5. **Sprains and Strains:** Overstretching or tearing of ligaments or muscles due to sudden movements, lifting heavy objects, or repetitive motions.
6. **Burns:** Thermal burns caused by hot surfaces, steam, or contact with heated equipment or substances.
7. **Electric Shocks:** Injuries from direct contact with live electrical circuits, which can cause electrical burns, cardiac arrest, or other severe injuries.

Eye Injuries: Damage to the eyes from flying debris, particles, chemicals, or intense light sources, which can cause corneal abrasions, chemical burns, or permanent vision loss(Mendez ,2024).

Fire Hazards

Fires in the workplace can have devastating consequences, resulting in loss of life, property damage, and disruption of business operations. To mitigate these risks, it is essential to understand the fire triangle, which consists of three elements: heat, fuel, and oxygen. This essay will explore each component of the fire triangle, common hazards associated with each, and strategies for managing these risks.

Heat/Ignition: The Spark that Sets the Fire

Heat or ignition is the first element of the fire triangle. A fire will start if the material gets hot enough, and ignition fire hazards provide the heat to start a fire. Common ignition fire hazards include sparks from faulty electrical equipment, hot surfaces, or open flames. These hazards can be managed by ensuring that electrical equipment is well-maintained, keeping hot surfaces away from flammable materials, and using open flames safely.

Fuel: The Material that Keeps the Fire Burning



The second element of the fire triangle is fuel, which is the material that burns and keeps the fire burning. Common fuel fire hazards include paper, wood, and textiles, but other materials like plastics, inks, and some metals can also fuel a fire. Managing fuel fire hazards involves keeping flammable materials away from ignition sources and ensuring that they are stored and disposed of properly.

Oxygen: The Element that Sustains the Fire

The third element of the fire triangle is oxygen, which sustains the chemical reaction that allows a fire to continue. While it is impossible to eliminate oxygen from the workplace, its flow can be controlled to prevent fire spread. This can be achieved using measures such as fire doors, which can help starve a fire of oxygen and prevent its spread.

Managing Fire Hazards in the Workplace

While it is impossible to eliminate all fire hazards from the workplace, managing ignition and fuel fire hazards is crucial to preventing fires. This can be achieved by:

- Ensuring that electrical equipment is well-maintained and kept away from flammable materials
- Keeping hot surfaces away from flammable materials
- Using open flames safely
- Storing and disposing of flammable materials properly

Implementing fire safety measures such as fire doors and fire extinguishers (Goby, 2023).

Musculoskeletal Disorders From Repetitive Tasks, Poor Ergonomics, Or Manual Handling Of Heavy Equipment MSDs occur in certain industries and occupations with rates up to three or four times higher than the overall frequency. High-risk sectors include nursing facilities; air transportation; mining; food processing; leather tanning; and heavy and light manufacturing (vehicles, furniture, appliances, electrical and electronic products, textiles, apparel and shoes). Upper extremity musculoskeletal disorders are also highly prevalent in manual-intensive occupations, such as clerical work, postal service, cleaning, industrial inspection and



packaging . Back and lower limb disorders occur disproportionately among truck drivers, warehouse workers, airplane baggage handlers, construction trades, nurses, nursing aides and other patient-care workers, and operators of cranes and other large vehicles .

The physical job features that are frequently cited as risk factors for MSDs, based on both experimental science and epidemiologic investigations, include rapid work pace and repetitive motion patterns; insufficient recovery time; heavy lifting and forceful manual exertions; non-neutral body postures (either dynamic or static); mechanical pressure concentrations; segmental or whole-body vibration; local or whole-body exposure to cold; and any of these in combination with each other or with undesirable features of the psychosocial work environment like high demands and low degree of control over one's own work.(Laura et al.,2004)

1.2 The Hazards of Scientific Glassblowing: Mitigating Risks to Ensure Safety

Scientific glassblowing is a vital component of various scientific disciplines, including chemistry, biology, physics, and engineering. The intricate process of manipulating glass tubes and apparatus to create complex equipment for experiments requires exceptional skill and attention to detail. However, this process is inherently hazardous, posing significant threats to the health and safety of personnel involved.

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Scientific glassblowing often involves working with hazardous chemicals, such as acids, bases, and solvents, which can cause skin irritation, respiratory problems, and other health issues. Furthermore, the process of glassblowing can release toxic fumes and particles, posing a risk to the health of personnel.

Ergonomic Hazards



The physical demands of glassblowing, including standing for long periods, manual dexterity, and visual concentration, can lead to musculoskeletal disorders, eye strain, and fatigue. Prolonged exposure to these ergonomic hazards can result in chronic health problems.

1.3 Mitigating Risks

To ensure the safety of personnel involved in scientific glassblowing, it is essential to implement measures that mitigate these risks. These measures include:

- **Personal Protective Equipment (PPE):** Providing appropriate PPE, such as gloves, safety glasses, and lab coats, to protect against physical and chemical hazards.
- **Training and Education:** Offering comprehensive training and education programs to ensure personnel are aware of the hazards and know how to handle them safely.
- **Safe Work Practices:** Establishing safe work practices, such as proper ventilation, regular breaks, and ergonomic workstations, to minimize exposure to hazards.
- **Regular Maintenance:** Regularly maintaining equipment and tools to prevent accidents and ensure proper function.

Scientific glassblowing is a critical component of various scientific disciplines, but it is also a hazardous process that requires careful attention to safety. By understanding the physical, chemical, and ergonomic hazards associated with glassblowing and implementing measures to mitigate these risks, we can ensure a safe working environment for personnel involved.

Thermal Injuries

Thermal injury to the skin is often associated with exposure to supplemental heat. Thermal injury may occur during extended surgical procedures or recovery periods, when water blankets or heat sources are used. Contact with water heating pads for greater than 30 minutes at temperatures as low as 106°F may cause injury. Contact points at bony protuberances are the most frequent site of injury. Tissue damage can be avoided by periodically changing the position of the patient or by reducing the temperature of the heating pad to below 102°F. The use of heat lamps may result in local burns or hyperthermia. Serious problems may be avoided



if the distance between the lamp and the cage front is maintained at a distance of at least 4 ft (1.3 m). Treatment involves prevention of secondary bacterial infection to the traumatized skin. Severe injury may result in the need for surgical debridement and the application of wet-to-dry dressings. Large defects may require grafting or other appropriate techniques

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2.0 METHODOLOGY

A systematic search of relevant literature was conducted using reputable databases, including:PubMed, Google Scholar, ScienceDirect, OSHA (Occupational Safety and Health Administration) guidelines ,ANSI (American National Standards Institute) standards and ,(International Organization for Standardization) standards.

The review process involved analyzing various sources to identify:

- Common safety practices in scientific glassblowing workshops
- Areas where improvements are needed
- Gaps in existing safety guidelines and protocols
- Recommendations for enhancing safety measures

Data Synthesis



Data was systematically reviewed to provide a comprehensive overview of current safety measures and their effectiveness in scientific glassblowing workshops.

Quality Assessment

The quality of included studies and guidelines was assessed using standardized tools, such as the AGREE II (Appraisal of Guidelines for Research and Evaluation II) instrument.

By employing a systematic and comprehensive approach, this study aimed to provide a thorough review of safety guidelines and protocols in scientific glassblowing workshops, highlighting areas for improvement and providing recommendations for enhancing safety measures.

3.0 RESULTS AND DISCUSSION

3.1 Results

Critical Gaps in Safety Practices

The comprehensive review of safety guidelines and protocols in scientific glassblowing workshops revealed several critical gaps in current safety practices, including:

Inadequate Safety Training

1. Insufficient training for new employees on safety procedures and protocols
 - Lack of refresher training for experienced employees
 - Inadequate training on specific hazards associated with glassblowing
2. Insufficient Availability of Emergency Equipment
 - Limited access to fire extinguishers, first aid kits, and other emergency equipment
 - Inadequate maintenance and inspection of emergency equipment
3. Lack of Standardized Training Programs
 - Absence of uniform training programs for glassblowers
 - Inconsistent training methods and materials



4. Infrequent Risk Assessments
 - Failure to regularly assess and mitigate risks in the workshop
 - Inadequate identification of potential hazards
5. Inadequate Emergency Preparedness
 - Lack of well-defined emergency response plans
 - Insufficient training on emergency procedures
6. Limited Access to Necessary Safety Equipment
 - Inadequate provision of personal protective equipment (PPE)
 - Limited access to safety equipment, such as safety glasses and gloves

Consequences of Gaps in Safety Practices

The identified gaps in safety practices contribute significantly to:

1. Higher Rates of Workplace Accidents
2. Safety Violations
3. Increased Risk of Injury and Illness
4. Decreased Productivity and Efficiency
5. Negative Impact on Employee Morale and Well-being

Recommendations for Improvement

To address the identified gaps in safety practices, the following recommendations are made:

1. Develop and implement standardized training programs for glassblowers
2. Conduct regular risk assessments and safety audits
3. Ensure adequate availability and maintenance of emergency equipment
4. Develop well-defined emergency response plans and conduct regular training
5. Provide necessary safety equipment and ensure access to PPE

By addressing these critical gaps in safety practices, glassblowing workshops can significantly reduce the risk of workplace accidents and safety violations, ensuring a safer working environment for all employees.

4.0 DISCUSSION

Urgent Need for Improved Safety Training



The findings from this review highlight the critical need for more consistent and thorough safety training programs for all glassblowers. The lack of standardized training programs and inadequate training on specific hazards associated with glassblowing are significant contributors to the high rates of workplace accidents and safety violations. To address this, glassblowing workshops must prioritize the development and implementation of comprehensive safety training programs that cover all aspects of glassblowing, including:

- Hazard identification and risk assessment
- Safe handling and use of equipment and materials
- Emergency procedures and response plans
- Personal protective equipment (PPE) usage and maintenance

Regular Risk Assessments and Safety Audits

Regular risk assessments and safety audits are essential for identifying and mitigating potential hazards, ensuring that safety protocols remain effective and up-to-date. These assessments and audits should be conducted by trained professionals and should include:

- Identification of potential hazards and risks
- Evaluation of existing safety protocols and procedures
- Recommendations for improvements and implementation of new safety measures

Comprehensive Safety Measures

Implementing comprehensive safety measures, including robust emergency preparedness plans and routine safety audits, can significantly reduce the likelihood of accidents and injuries. These measures should include:

- Development and implementation of emergency response plans.
- Regular training on emergency procedures.
- Routine safety audits and inspections.
- Maintenance and inspection of equipment and facilities.

Creating a Culture of Safety and Accountability

The review advocates for a proactive approach to safety, emphasizing the importance of creating a culture of safety and accountability within glassblowing workshops. This can be achieved by:



- Encouraging open communication and reporting of safety concerns.
- Recognizing and rewarding safe behavior and practices.
- Holding individuals and teams accountable for safety violations and lapses.
- Continuously reviewing and improving safety protocols and procedures.

By prioritizing safety training, regular risk assessments, comprehensive safety measures, and creating a culture of safety and accountability, glassblowing workshops can significantly reduce the risk of accidents and injuries, ensuring a safer working environment for all employees.

5.0 CONCLUSION

Safety in scientific glassblowing workshops is of paramount importance to prevent accidents, promote a healthy working environment, and protect the well-being of glassblowers and surrounding personnel. To achieve this, the following measures are essential:

a. Standardized Safety Training

- Develop and implement comprehensive training programs for all glassblowers, covering:
 - Hazards associated with glassblowing (cuts, burns, chemical exposure)
 - Safe handling and use of equipment (torches, furnaces, hand tools)
 - Emergency response procedures (fire, chemical spills, injuries)
 - Regular refresher courses to maintain proficiency

b. Regular Risk Assessments

- Conduct ongoing evaluations to identify and mitigate potential risks, including:
 - Hazardous materials and chemical handling
 - Equipment maintenance and malfunction
 - Workspace layout and ergonomics
 - Employee behavior and adherence to safety protocols

c. Comprehensive Safety Protocols

- Establish and enforce strict safety guidelines, including:
 - Personal protective equipment (PPE) usage (safety glasses, gloves, lab coats)
 - Safe work practices (proper lifting, chemical handling, waste disposal)



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- Emergency preparedness and response plans
- Regular safety audits and inspections

By implementing these measures, scientific glassblowing workshops can:

- Minimize the risk of accidents and injuries
- Promote a culture of safety and responsibility
- Ensure compliance with regulatory standards and guidelines
- Protect the health and well-being of employees and surrounding personnel

Remember, safety is everyone's responsibility. Let's work together to create a safe and healthy environment in science



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REVIEW OF THE EFFECT OF CLIMATE CHANGE ON HEALTH RISKS IN NIGERIA

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Abstract

Globally, climate change is now a major concern. There are various ways that human activity affects health. Nigeria is particularly vulnerable to the effects of climate change because of their limited capacity for adaptation. There are little studies on how Nigerian health risk is affected by climate change. In light of this, this study examines how Nigerian health risks are affected by climate change. Research has indicated that the consequences of climate change in Nigeria stem from factors linked to the phenomenon, including elevated temperatures, precipitation, rising sea levels, severe weather, and heightened health hazards. Risks to health include meningitis of the brain and spinal cord, cardiovascular disease, respiratory disorders in the elderly, skin cancer, malaria, excessive blood pressure, and morbidity. Secondary data was used. The study recommended that the government educate the public about the negative effects of climate change, which are widespread among vulnerable populations in Nigeria, including women, children, and rural residents.

Keywords: climate change, health risk, vulnerability, environment.



1.0 INTRODUCTION

Humans have always relied on their environment for survival, to the extent that human activity determines how long humans will survive. One global event resulting from this relationship between man and environment is climate change, which has become a hot topic for discussions and debate among academics and experts, ranking among the most pressing issues on the global agenda today. According to Odey (2022) scientific evidence has revealed that climate change is an all-encompassing threat and is considered the most serious ecological threat to the survival and sustainable development of humanity.

Climate Change

The term "climate change" refers to the rise in the average global temperature that results from both natural and human activity. Climate change, however, is defined as "a change in the state of the climate that can be identified by using statistical tests by changes in the mean and variability of its properties, and that persists for an extended period typically decades or longer," Inter-governmental Panel on Climate Change (IPCC, 2022).

Causes of climate change

Studies have demonstrated that throughout the last few decades, human activities like urbanisation, deforestation, population expansion, industrialization, and greenhouse gas emissions have been the primary causes of the ozone layer's thinning (Buba, 2023). Africa has been found to be the continent most susceptible to the effects of climate change (Ilevbare, 2022). Due to their limited access to climate information, institutions, financial resources, and capacity for adaptation, developing countries in Africa have experienced and are vulnerable to the effects of climate change. (Ojomo et al. 2020). Nigeria, one of the most populous countries in the world with over 200 million inhabitants, is not exempted because of its vulnerability (Adepoju, 2019). Nigeria's susceptibility to climate change and lack of resilience have caused significant harm to the country (ICCHN, 2017).

According to Adepoju (2019) analysis, higher temperatures, more frequent and severe weather events, and an increase in sea level are all effects of climate change in Nigeria.

Evidence that climate change events affect all facets of human existence, including the social and environmental determinants of health, clean air, safe drinking water, and food security, was presented by (Borokinini, 2022) to bolster this claim, there is evidence that the climate and weather



are antecedents to issues that impact human health, THIS DAY PAPER 2017. Literature has demonstrated how climate change affects people's health. For example, Nwoke et al.(2019) have connected climate change to rising temperatures, which increase the generation of different secondary pollutants and, as a result, raise the frequency of allergies, cardio-respiratory diseases, and air pollution-related mortality. Furthermore, cases of mental health and population mobility are a result of environmental disasters such as flooding, rising sea levels and shortages of water. Horton and McMichael (2020) have identified emotional stresses and mental health problems in response to perception and fear of climate change to constitute health challenge to affected communities. In lieu of this development, the goal of this paper is to explore the effects of climate change on health risks in Nigeria.

There is proof that climate change can have an impact on people's health (Maibach and Hathaway 2018). As a result, it has been determined that certain groups are more vulnerable than others, including small children, expectant mothers, elderly persons, those with chronic illnesses and impairments, and those with fewer means. Furthermore, there may be both direct and indirect effects of climate change on human health, particularly in Nigeria. According to Omoruyi and Onafalujo (2021). Among the direct effects of climate change in Nigeria, include conditions such as cerebral-spinal meningitis, skin cancer, high blood pressure, malaria, cholera, and problems with infant and maternal health.

Climate change and Cerebra-spinal meningitis

One of the infectious disorders primarily brought on by climate change is cerebral-spinal meningitis. For example, high temperatures in Nigeria have led to an increase in meningitis cases. Akingbade (2020) claims that the extreme heat is to blame for the rise in meningitis cases in Nigeria. According to data from the World Health Organisation, 35% of meningitis outbreaks documented in Africa between 1996 and 2021 occurred in Nigeria, with 95% of cases occurring in the country's northern area (Abdulsalam et al., 2022). A cursory study revealed that within a week, meningitis killed over 200 persons in Nigeria and the nearby Niger Republic. Data from the first quarter of 2009 showed that there were 1,500 deaths and 25,000 probable cases, according to (Brenda et al., 2018).

Using an empirical meningitis model forced to run monthly simulations of seven meteorological variables from an ensemble of thirteen statistically downscaled global climate model projections from phase 5 of the Coupled Model Intercomparison Experiment (CMIP5) for representative concentration pathway (RCP) 2.6, 6.0, and 8.5 scenarios—numbers denoting the globally averaged



top-of-the-atmosphere radiative imbalance (Abdussalam et al., 2022) investigated the impact of future climate change on meningitis risk in northwest Nigeria.

The results suggest that future temperature increases due to climate change have the potential to significantly increase meningitis cases in both the early (2024–2035) and late (2060–2075) twenty-first century, and for the seasonal onset of meningitis to begin about a month earlier on average by late century, in October rather than November. However, (Abdussalam et al., 2022) suggest that this outcome represents the climatological potential for increased cases due to climate change, as it is assumed that current prevention and treatment strategies will remain similar in the future.

In an empirical investigation, Brenda et al. (2018) found that 14,280 suspected cases of meningitis were reported in 23 of Nigeria's 36 states between December 2016 and May 2017. Among suspected cases, there were 1,145 deaths (8% case fatality rate). The epicentre of Nigeria's meningitis outbreak was in the northern states of Zamfara and Sokoto.

Climate change and Vector-borne diseases, infection

Nigerian water-borne illnesses have been demonstrated to be impacted by climate change (Borokinni, 2022). The lengthening of the seasons during which major vector-borne diseases transmit and the modification of their geographic distribution are directly related to changes in climate. Research indicates that more over 45% of all outpatients had malaria, and roughly 50% of Nigerians experience at least one episode of the disease annually (Ayeni, 2021).

The relationship between climate change and malaria spread is complex, subject of debate and controversy (Adewuyi and Adefemi 2022). Accordingly, Adewuyi and Adefemi (2022) proposed that the spread and severity of malaria in several places and the increased incidences of the disease in some regions could in fact be associated with the effects and consequences of climate change. Adewuyi and Adefemi (2022) further suggested that the biology of *Plasmodium* spp., the ecology of mosquitoes, and even human susceptibility to malaria could all be affected directly or indirectly by extreme climatic events.

According to World Health Organisation projections (2020), over 400 million people are expected to be at risk of malaria by 2070, under both high and low emissions. According to predictions from the World Health Organisation (2023) 212 million persons worldwide were infected with human malaria parasites in 2022, with 90% of cases occurring in Africa. Nonetheless, 18 nations collectively accounted for 90% of all cases in sub-Saharan Africa, with 37 million cases reported,



or 29% of all cases, coming from Nigeria alone. According to research, malaria kills over 400,000 people annually, the majority of whom are African children under the age of five (Borokinni, 2022). Nanvyat et al. (2018) conducted a study with the objective of characterising the patterns of malaria transmission and examining the influence of climatic factors on malaria transmission in the highlands of Plateau State, Central Nigeria. The results indicated that, with the exception of Jos-North LGA, where the low model deviance explained (35.4%) might indicate the presence of other significant factors influencing malaria transmission in the region.

Similar to this, Ayeni (2021) attributes the rise in malaria morbidity in Akure, Southwest Nigeria, to factors such as population growth, fluctuating rainfall, intense metropolitan heat, high levels of thermal discomfort, and the issue of an unsanitary environment. Based on an evaluation of the current framework on malaria incidence, Ayeni (2021) study analysed hospital records from 2000 to 2008, meteorology data from 1986 to 2008, and pertinent field studies. These findings showed that the number of malaria cases increased from 24,092 in 2000 (of which males and females accounted for 12,477 and 11,615, respectively) to 62,121 in 2008 (of which males and females accounted for 30,413 and 31,708, respectively).

Evidence points to an estimated 137,600 diarrheal deaths in children under 15 in Nigeria during the WHO 2010 baseline period. Additionally, it was estimated that in the event of a high emissions scenario, the number of diarrheal fatalities associated with climate change in children under the age of 15 is expected to be 9.8% of the approximately 76,000 diarrheal deaths forecast by the World Health Organisation for 2030.

Climate change and cardiovascular diseases

According to Campbell-Lendrum and Pruss-Ustun (2019), the World Health Organisation (2020) has identified air pollution as the single greatest environmental health risk. As a result, non-communicable diseases account for the largest and fastest growing burden worldwide, with treatment costs placing a significant strain on individual and governmental resources. Poor diet (high consumption of sugar, salt, saturated fat, etc.) and unhealthy lifestyle (smoking, alcohol consumption and physical inactivity) have been identified as major risk factors of cardiovascular disease and other non-communicable diseases.

Climate change and skin cancer

Evidence has demonstrated the negative effects of climate change on the environment and the economy on human health (Bharath and Turner, 2019). The impact on human illnesses like skin



cancer has received very little attention. Malignant skin diseases are directly linked to ultraviolet (UV) radiation from the sun (Bharath and Turner, 2019).

UV radiation, also known as UVR, is defined as the region on the electromagnetic spectrum that lies between visible light and X-rays. The colour violet is associated with the shortest wavelength in visible light, and the term UV actually means "beyond violet" (derived from the Latin word *ultra*, which means "beyond"). UV light is further classified according to wavelength: "long wave" UV, which has a wavelength range of 320–400 nm, is known as UV-A; "medium wave" UV, with a wavelength range of 290–320 nm, is known as UV-B; and "short wave" UV, which has a wavelength range of 100–290 nm, is known as UV-C.1. As a result, UV-C is known to carry the highest energy and is the most harmful to biological systems, while UVB causes some DNA damage.

On the other hand, the top three skin cancers have been identified. These include malignant melanoma (MM), squamous cell carcinoma (SCC), and basal cell carcinoma (BCC). According to Bharath and Turner (2019), there is evidence linking ultraviolet radiation exposure to an increased risk of developing any of the three forms of cancer. The worrying rate of solar intensity growth and the HIV epidemic, as highlighted by Oripelaye et al. (2018), have gradually diminished the protective benefits of melanin, particularly for populations with darker skin tones. For example, Oripelaye et al. (2018) included as inclusion criteria patients diagnosed with primary skin cancer between January 2008 and December 2017 in a retrospective study conducted in research settings at the Obafemi Awolowo University Teaching Hospital, Ile-Ife, South-western, Nigeria.

According to their analysis, 1.0% of cases were primary skin malignancies. With a ratio of 1.4:1, the number of females (58.3%) exceeded that of males (41.7%). In addition, the study's spectrum of primary skin malignancies included cutaneous lymphoma (6.9%), basal cell carcinoma (9.7%), squamous cell carcinoma (33.3%), malignant melanoma (25%), and Kaposi sarcoma (15.3%). Melanin, according to the study, continues to be a significant preventive factor against skin cancer in black people. As a result, high HIV prevalence and albinism were found to be risk factors for skin malignancies [26]. The elimination of HIV and improved sun protection were proposed as ways to lower the incidence of skin cancer among the black race.

Climate change and Elderly health

Age-related health issues are one significant impact of climate change in Nigeria. Aina and Adewoyin (2017) state that because ageing affects a person's physiological and immunological makeup, those in the vulnerable age group are especially more susceptible to diseases linked to the



climate. Studies have supported the idea that older people are more vulnerable to climate-related illnesses because to their compromised immune systems, slower metabolisms, poorer physiological reserves, and greater rates of morbidity (Carnes, 2022).

Two sets of secondary data—hospital records of 600 adults aged 50 and above with clinically diagnosed cases of climate-related diseases and data on climatic parameters of temperature and rainfall—were used to assess the effects of climate change on the trend and prevalence of climate-related diseases among the elderly in an urban setting using Ikeja, Lagos, Nigeria, as a case study. The datasets were gathered between 2010 and 2021. In their study, Aina et al. (2022) discovered that while rainfall increased, temperature decreased during the study period. The study also revealed that among the population sampled, high blood pressure incidence was more common (43%) than any other condition linked to the climate.

Fever and respiratory illnesses came next. There were very few cases of skin illnesses, blindness, and cholera and diarrhoea. Additionally, the study found a strong correlation between the occurrences of high blood pressure, fever, and respiratory illnesses and the year. This was demonstrated by the cases of these conditions showing a steady annual increase in response to variations in temperature and rainfall, especially greater rainfall. Lastly, 11.5% of the differences in climate-related disorders among the elderly over the study period of 2022 might be attributed to variations in temperature and rainfall.

Mitigation measures

The mitigation and adaptive measures against the effects of climate change are very critical for Nigeria to reduce the health risks brought about by this global threat. The health sector from primary, secondary and tertiary health institutions should identify the major regional health hazards caused by climate change and ensure that the development of risk-lessening adaptations are employed. According to Borokinni (2022), adaption capacities and techniques differ among populations. Borokinni (2022) added that this will be particularly important when the rates of pre-existing sickness such as childhood diarrhoea and malnutrition are already high and which will become higher due to the multiplier impacts of climate change. Therefore, Since it is imperative to preserve the environment, people ought to be partnerships between various government agencies, research institutions, academic fields, and communities are necessary for effective adaptive methods. informed of the possible health hazards linked to climate change. Agencies that are pertinent should educate the public on the effects of climate change and how they affect vulnerable



populations, especially disaster and emerging workers. This could be accomplished by offering workshops, basic training, and sensitization campaigns to increase public knowledge and encourage climate change adaptation.

Environmental psychologists can help to better conceptualise and comprehend the psycho-social components of these processes that are driving climate change. This could be accomplished by focusing on the activities that have the biggest impact on climate change and offering behavioural analysis of consumption. The psychological effects of climate change on people, groups, and communities can be attributed to media depiction, mental models, and relative risk assessments. However, there are some psychological barriers why people do not respond adequately to the risks of climate change. Among these are ignorance, uncertainty, mistrust, denial, judgmental discounting, habits and perceived behavioural control.

CONCLUSION

It is impossible to overstate the dangers that climate change poses to Nigerian health. Climate change affects all population, but it especially affects the most vulnerable, such as the elderly and children. It is anticipated that as climate change's effects worsen over time, so will some of the current health issues. Consequently, it is critical that everyone understands how climate change impacts human health and has improved knowledge and awareness of the issue. It is anticipated that this will help individuals make decisions on how to lessen the effects of climate change in the near future. In keeping with this evolution, stakeholders and the government should encourage environmental education and awareness in order to provide vulnerable communities with the best adaptation and mitigation strategies.

Furthermore, regular workshops, seminars, and discussions on mitigating and adapting to climate change should be held in public spaces such as automobile parks, schools, universities, and religious institutions. The government and researchers should determine what needs to be researched on climate change. In addition, it is imperative that Nigerian children learn the fundamentals of an ecologically conscious lifestyle, including conservation and eco-friendly behaviour. Additionally, students at Nigerian primary through post-secondary schools are equipped with pertinent knowledge about how to select careers that will help society address new environmental issues brought on by climate change.



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PREVALENCE AND INTENSITY OF URINARY SCHISTOSOMIASIS IN LAVUN LOCAL GOVERNMENT AREA OF NIGER STATE, NIGERIA

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ABSTRACT

*An investigation was conducted into the prevalence and severity of urinary schistosomiasis in the Lavun Local Government Area of Niger State, Nigeria. In Nigeria, urinary schistosomiasis is a common water-borne parasite disease with a limited management effort. The purpose of this study was to ascertain the frequency and severity of urinogenital schistosomiasis in a few communities within the Lavun Local Government area of Nigeria's Niger State. Sedimentation technique was utilized to determine the number of *S.haematobium* eggs, and a pretested structured questionnaire was employed to collect participants' demographic and socioeconomic information. Data obtained were subjected to statistical package for social sciences and chi square was used to determine differences between two parameters. All level of significance were set at $P < 0.05$. Out of the 607 individuals analysed, 226 (37.2%) had an overall mean intensity of 791.220 (+_147.35) eggs per 10 milliliters of urine. Sacchi-Nku community had the highest infection prevalence at 67.1%, There was a statistically significant variation in the prevalence of infection with respect to location ($p < 0.05$), with the lowest recorded at Kpatchitagi (8.40%). Participants between the ages of 16 and 25 had the highest age-related prevalence (43.7%). The correlation between an individual's sex and the prevalence and degree of infection was not statistically significant ($p > 0.05$). Individuals who mostly obtained their water from streams or rivers were more likely to be infected than those who drank tap water, who had the lowest infection rate. Individuals who visited the river more regularly had higher infection rates than those who visited once a week or once a month. There was no statistically significant change ($p > 0.05$). Haematuria was highly prevalent in people with light to moderate infections (46.7%). The results of this study demonstrated that urinary schistosomiasis is becoming more common in the study area. This is directly related to a lack of awareness regarding the disease's transmission, necessitating government engagement at all levels to stop the threat.*

KEY WORDS: Prevalence, Intensity, Urinary Schistosomiasis, Macroscopy and Sedimentation.



1.0 INTRODUCTION

Schistosomiasis is a severe public health issue in many countries in Africa, the Caribbean, the Middle East, and Asia. It is regarded as one of the Neglected Tropical Diseases and is second only to malaria in terms of mortality and morbidity (World Health Organisation, 2019). According to the World Health Organization, between 80 and 90 percent of the 230 million people worldwide who have schistosomiasis live in Africa, where the illness causes more than 200,000 deaths annually (WHO, 2008).

Furthermore, (King and Danger Field ,2008) demonstrated that Africa has a high disability adjusted life years (DALYS) of the disease—roughly 10 million. This suggests that schistosomiasis is still a serious disease in Africa.

A trematode of the genus *Schistosoma* is the source of the major water-borne parasitic disease schistosomiasis. Five species of *Schistosoma* are known to infect humans: *S. mekongi*, *S. japonicum*, *S. intercalatum*, and *S. mansoni*, which causes intestinal Schistosomiasis while *S. haematobium*, causes urinary schistosomiasis. The majority of cases of *Schistosoma mansoni* and *S. haematobium* are found in sub-Saharan Africa, particularly in isolated and impoverished areas. According to recent research, schistosomiasis is unquestionably one of the most significant parasitic diseases worldwide, occurring in 53 nations, including those in the Middle East and most of Africa (Chitsulo *et al.*, 2000). Even though *Schistosoma haematobium* is more common in the majority of endemic communities in Nigeria (Salwa *et al.*, 2015), it is still a serious public health issue that has serious social and economic ramifications for humanity (WHO, 1999). Hematuria, urethral and bladder fibrosis, sand-filled patches in the mucosa, and hydronephrosis in long-term cases are the hallmarks of infection. One potential sequela as a late-stage complication is bladder cancer. While the disease can cause pathology of the seminal vesicle, prostate gland, and other organs in men, it can also cause genital lesions, vaginal bleeding, pain during sexual activity, and vulva nodules in women.

The majority of endemic settings in Sub-Saharan Africa have infection prevalences ranging from 30 to 70%. Nigeria has the highest prevalence at 15%, followed by the United Republic of Tanzania at 10%, and the Democratic Republic of the Congo and Ghana at 7% (Hotez *et al.*, 2009). Infection rates in Nigeria are reported to be 30.5% in the north central region and 60.8% in



the northeast (Yunusa *et al.*, 2016). Numerous studies have connected water-related activities like swimming, washing, and fishing to human infection (WHO, 2014).

Additionally, risk factors such as proximity to water, irrigation, dam construction, and climate change have all been identified on multiple occasions (WHO, 2014). Schistosomiasis is primarily spread by a variety of aquatic snail species, which are frequently referred to as the disease's intermediate host. Usually, schistosome eggs travel through feces or urine to freshwater bodies that are home to these snails. The snails hatch into miracidia, which then infect the relevant snail and create cercariae, which cause human infection. According to (Lamb, 2010) *Schistosoma* species infect humans for an average of 3 to 10 years during which they cause significant morbidity and mortality.

The prevalence and severity of urinogenital schistosomiasis in few chosen communities in the Lavun local government area of Niger state, Nigeria, are the subject of this study because, despite the disease's severe effects on the human population, there are few programs and control measures in place to address this problem. As this study will provide current information that is vital to design appropriate control strategies including preventive chemotherapy of schistosomiasis.

2.0 Materials and Methods

Study Area:

The study was conducted in five communities in Lavun local government area of Niger state, North Central Nigeria. The communities lie geographically in latitude 9° 24' N and longitude 5°70' E in the guinea savannah vegetation zone of the country. Lavun local government have a land mass of 2,835km².

The research area has a tropical climate with two distinct seasons (rainy and dry season), the rainy season usually between April to October while the dry season is between November to March. The area is usually flooded during the raining season and water logged all year round (marshy) in addition to river Lavun that flow through the area making the inhabitants to be predominantly rice farmers and fishermen. The average temperature is about 26.2⁰C while relative humidity is about 62%.

Majority of the inhabitant are Nupe by tribe with other minorities groups like Hausa, Fulani and Igbo, the inhabitants are predominantly Muslim by religion.

Sample Collection



Urine samples were taken using a technique in order to diagnose urinary schistosomiasis. In order to ensure that the samples were free of contamination, they were gathered in a sterile, numbered sample bottle and accompanied by a pretested, structured questionnaire that was given to willing participants to collect data on socio-demographic characteristics, knowledge and management practices of schistosomiasis in the area. The participant were instructed to fill the bottle with urine to the 10ml mark in the middle of a discharge and the bottle was sealed with a cap. Urine was collected between 10:00 a.m. and 2:00 p.m.

Processing and Examination of Urine Sample

Urine samples were collected and analyzed microscopically or macroscopically for color and appearance on the field using the Medi Test Combi 9strip (machery Nagel). After the macroscopic analysis, one drop of formalin was added to the urine sample to preserve it before it was sent to the Federal Polytechnic Bida Niger State's Biology Laboratory Unit for microscopic analysis. The laboratory technique of urine sedimentation was employed to identify haematobium ova. After properly mixing each urine sample, 10 milliliters of the mixture were added to a centrifuge tube with a conical tip. After spinning the centrifuge tube for five minutes at 200 rpm, the supernatant was pipetted out, leaving roughly 0.5 ml of the fluid behind.

Using a pipette, the remaining fluid and sediment were combined, and a drop of the combination was placed on a sanitized microscope slide before being covered with cover slip. The X10 objectives were then used to properly inspect the slide for haematobium eggs. For every 10 milliliters of urine, the total number of eggs in all the sediment was expressed.

Data Analysis

The data obtained were subjected to statistical package for social sciences and chi square was used to determine differences between two parameters. All level of significance were set at $P < 0.05$.

3.0 Results

Table 1 Shows the demographic and socioeconomic characteristics of the study participant. The table revealed that of the total of 607 participants with average age of 50.5 years, 63.5% were male and 36.5% were female. About 34.0% of the participants are from Kudogi community and inhabitants of Lanchitagi constitute 10.0% of study population. Majority 57.0% of people involved



in the study are uneducated in which about 30% are farmers involved in Fish and crop production. A total of 226 (37.2%) participants have urinary schistosomiasis in the study.

Table 1: Demographic and Socio-Economic Characteristics of Participant N= 607

Gender	N%	
Male	385	(63.5%)
Female	222	(36.5%)
Age Group: (Median Range)	50.5	(2 - 99)
Location		
Dokomba	102	(16.8)
Kudogi	203	(33.5)
Kpatchilagi	83	(13.9)
Lanchitagi	61	(10.0)
Sacchi-Nku	158	(26.0)
Educational Level		
Educated	261	(43.0)
Not Educated	346	(57.0)
Occupation		
Trading	147	(24.2)
Farming/Fishing	183	(30.1)
Schooling	277	(45.7)
Infection Status		
Infected	226	(37.2)
Uninfected	381	(62.7)

The prevalence of urinary schistosomiasis stratified with age and sex is shown in table 2 in which individual within age 16 -25 years recorded the highest rate of infection. 43.7% closely followed by 41.3% among age group 6 – 15 years with the least prevalence of 22.8% in age group (1 – 5 years). Generally, male individual were more infected than their female counterpart in all age group. This distribution is statistically significant among age group 6 – 15 (0.001) and 16 – 25 (0.04) $P < 0.05$

Table 2: Prevalence of Urinary Schistosomiasis stratified by sex and age group N = 607

Age Group	Sex	Number Examined	Number Infected	(95% CI)
1 -5	Male	51	14 (27.5)	
	Female	28	4 (14.3)	
	Subtotal	79	18 (22.8)	0.182
6 – 15	Male	210	100 (47.6)	



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	Female	95	26 (27.4)	
	Subtotal	305	126 (41.3)	0.001
16 – 25	Male	69	35 (50.7)	
	Female	50	17 (34.0)	
	Subtotal	119	52 (43.7)	0.049
26 – 35	Male	34	12 (35.3)	
	Female	25	6 (24.0)	
	Subtotal	59	18 (30.5)	0.352
36 – 100	Male	21	7 (33.3)	
	Female	24	5 (20.8)	
	Subtotal	45	12 (26.7)	0.344
Total		607	226 (37.2)	

Table 3: shows the overall mean intensity (SD) of schistosomiasis stratified by location.

Intensity with respect to location shows that participant examined in Kudogi record the highest mean intensity 1298.410 +₋ 366.45 closely followed by Lanchitagi participant with 614.304 +₋ 98.66 egg per 10ml urine, the least mean intensity was recorded at Sacchi-Nku 34.845 +₋ 32.92 per 10ml urine.

Table 3: Mean intensity (standard deviation) of schistosomiasis stratified by location.

Variables	Number Examined	Infected	95%CI	(Mean + SD)	MPEL
Location					
Dokomba	102	19	11.8-27.8	50.730+ ₋ 19.43	1.713
Kudogi	203	84	34.5-48.5	1298.410+ ₋ 366.45	3.113
Kpatchitagi	83	7	3.74-17.1	99.293+ ₋ 22.27	2.001
Lanchitagi	61	10	8.55-28.5	614.304+ ₋ 98.66	2.789
Sacchi-Nku	158	106	59.1-74.2	34.845+ ₋ 32.92	1.554
Total	607	226	33.3-41.2	791.220+₋147.35	2.898

Table 4: The association between Schistosoma haematobium infection and source of water supply in all individuals examined was recorded as seen below. Participants whose main source of water supply is stream and pond recorded the highest prevalence (80.0%) of infection. The prevalence of



infection was statistically insignificant ($P=0.123$) with other participant using tap/borehole water (36.2%) and well (38.8%). Similarly, the mean intensity SD was highest in participant that uses tap/borehole water 867.473 ± 172.12 eggs per 10ml urine.

There was no statistical significance in the intensity of infection ($P=0.349$) with source of water supply as others that uses well and stream had mean intensity of 422.657 ± 61.15 , 27.60 ± 23.692 respectively.

Similarly, frequency of visiting river by participant showed a statistically significance association with infection. ($P = 0.000$) participant that visit river daily had 48.8% prevalence while weekly and monthly recorded (26.2%) and (3.57%) respectively and the mean intensities for frequency of visiting river statistically show an insignificant correlation $P = 0.145$ the prevalence that visit river daily recorded the highest mean intensity of 958.811 ± 203.45 while those that visit monthly had the lowest mean intensity of 27.213 ± 5.14 egg per 10ml urine.

Table 4: Prevalence and intensity of infection stratified with source of water supply and frequency of visiting Rivers

Variable	Number Examined	Number Infection	Intensity SD
Main source of water			
Tap/borehole	473	172 (36.2)	$867.473-172.12$
Well	129	50 (38.8)	$422.657-61.15$
Stream/Pond	5	4 (80.0)	$27.60-23.692$
P value		0.123	0.349
Frequency of visiting River			
Daily	326	159 (48.8)	$958.811-203.45$
Weekly	251	66 (26.2)	$554.737-90.34$
Monthly	28	1 (3.57)	$27.213-5.14$
P value		0.000	0.145
Total	607	226 (37.2)	$1259.905-395.75$

Table 5: Table shows the prevalence of hematuria with respect to intensity of *S haematobium* infection. There was an insignificant difference $P > 0.05$ in the prevalence of hematuria when compared with intensity of infection in all the age group. Age group 6-15yrs with the most moderate infection (26.5%) had the second highest prevalence of hematuria (50.8%) while age group 36-100 with the second lowest prevalence of hematuria 35.6% had the least moderate intensity of infection



(8.88%). The prevalence of hematuria among the total participant examined was 46.7%, the highest prevalence of hematuria 51.2% was observed in age group 16-25yrs which was closely followed by age group 6-15 (50.8%) while the lowest prevalence of hematuria was observed in age group 1-5 (30-3%) with a statistically significant difference ($P < 0.05$) in prevalence of hematuria with respect to infection.

Table 5: Prevalence of Heamaturia stratified by intensity of infection

Age	Sex	Number Examined	Number with Haematuria	Intensity of Infection (Light)	Moderate	Heavy	P value
1 – 5	Male	51	18 (35.2)	6 (11.8)	4 (7.84)	4 (7.84)	
	Female	28	6 (21.4)	1 (3.57)	2 (7.14)	1 (3.57)	
	Subtotal	79	24 (30.3)	7 (8.86)	6 (7.59)	5 (6.32)	0.705
6 -15	Male	210	113 (53.8)	25 (11.9)	65 (30.9)	10(4.76)	
	Female	95	42 (44.2)	7 (7.36)	16 (16.8)	3 (3.15)	
	Subtotal	305	155 (50.8)	32 (10.4)	81 (26.5)	13(4.26)	0.944
16-25	Male	69	40 (57.9)	14 (20.2)	19 (27.5)	2 (2.87)	
	Female	50	21 (42.0)	4 (8.00)	12 (24.0)	1 (2.00)	
	Subtotal	119	61 (51.2)	18 (15.1)	31 (26.0)	3 (2.52)	0.495
26-35	Male	34	17 (50.0)	3 (8.82)	9 (26.4)	0 (0.00)	
	Female	25	11 (44.0)	0 (0.00)	6 (24.0)	0 (0.00)	
	Subtotal	59	28 (47.4)	3 (5.08)	15 (25.4)	0 (0.00)	0.270
>=36	Male	21	7 (33.4)	5 (23.8)	2 (9.52)	0 (0.00)	
	Female	24	9 (37.5)	3 (12.5)	2 (8.33)	0 (0.00)	
Total	Subtotal	45	16 (35.6)	8 (17.8)	4 (8.88)	0 (0.00)	0.576
Total		607	284 (46.7)	68 (11.2)	137 (22.5)	21 (3.45)	

4.0 Discussion

Urinary Schistosomiasis is one of the commonest infectious diseases of serious health concerns among neglected population of many tropical countries (Zhou *et al.*, 1994). According to the WHO categorization, the study's overall prevalence of 37.2% highlights the prevalence and impact of infection in the studied area. Compared to the 13.0% national average prevalence, this prevalence is higher. (Ofoezie ,2012).



This result is comparable to that of Edo State (Nimorsi *et al.*, 2001), Sokoto (Kabiru *et al.*, 2013), and Ogun State (Adeoye and Akabogu, 1996), which were 32.6% and 38.3%, respectively. However, when compared to the prevalence in this study, the result of (Olafintoye and Odaibo, 2006), 29.1% from Ekiti (Dawet *et al.*, 2012) and 2.07% from Plateau are lower. Similar studies from other sub-Saharan countries have reported 39.2% in Cameroon (Mbah and Useh, 2008); 33.2 in Ghana (Odiere *et al.*, 2012). The minimal exposure and reliance of Lavun Local Government residents on contaminated water bodies are reflected in the study's mild infection rates. Sacchi-Nku has the highest infection prevalence when considering infection by location. Sacchi-Nku's highest recorded prevalence is indicative of their high exposure levels and reliance on non-tap/non-borehole water sources. This report supports findings from another Nigerian study (Ladan *et al.*, 2012). This observation affirms other report conducted in Nigeria (Ladan *et al.*, 2012) who reported that variability and epidemiology of disease were attributable to water contact patterns.

The results of this study revealed that male were more likely than female to be infected and this observation is in concordance with studies of (Ugbomoiko *et al.*, 2011) in Osun State and (Ladan *et al.*, 2011) in Gusau. This could be attributed to higher water contact activities by male such as swimming, bathing or washing in cercaria infested rivers. Though some authors reported that both male and female had equal chance of contacting infection (Akinboye *et al.*, 2011) in Ibadan. In many endemic area, age of infected individuals has been shown to influence the spread of infection (Yapi *et al.*, 2005). In the current study, the age group 16-25 years recorded the highest infection rate of 43.7%, which may be attributed to their prolong exposure to water bodies for various reasons as well as their active participation in activities that predispose them to infection. The highest mean intensity was observed at Kudogi community 1298.410 egg/10m/ urine while the least was observed at Sacchi-Nku 34.845 egg/10m/ urine. The overall mean intensity of 791.220 egg/10m/ urine observed in this study appear to be far higher than the 309.06 egg/10m/ urine reported by (Ladan *et al.*, 2011) in Gusau as well as 114.2 egg /10m/ urine reported by (Ugbomoiko *et al.*, 2010) in Osun State, Nigeria. This high intensity indicates a high risk at the community level in accordance with the WHO definition (WHO, 2002).

The transmission of the infection has been closely associated with the source of water supply (Nwoke, 2004). The prevalence of infection with regard to water source indicates that participants who use well water and river/stream as their main source of water supply were highly infected compare to those who use borehole water. The highest infection rate recorded among individual



that uses stream/river is due to the fact that intermediate host of the parasite are found in such water bodies. The people living in poor unhygienic condition may not be aware of the transmission route of the disease therefore they are likely to continuously contaminate the water bodies by indiscriminate urination and defecation, this finding agreed with the work reported by (Mbah *et al.*, 2008). Frequency of visiting river has also been shown to be associated with infection.

Participants who visited the river every day showed the highest prevalence and degree of infection, whereas those who visited the river once a month showed the lowest infection and intensity. There is a statistically significant difference ($P < 0.05$) between the frequency of water contact and the prevalence of infection. This result is consistent with the findings of Ugbomoiko *et al.*, (2010) in Osun State, which show that prolonged and frequent contact with an infected body of water can predispose an individual to infection. The prevalence of hematuria, a diagnostic indicator for *S. haematobium* infection, was found to be high at 46.7%. Interestingly, the age group of 16 to 25 had the highest prevalence of 51.2%, which progressively decreased with age. The age dependent prevalence of hematuria observed in this study corroborates with the finding of (Senghor *et al.*, 2014). This finding also shows that intensity of infection was of light and moderate intensities. It was observed that the percentage with heavy infection was considerably lower than those with light infection. An earlier report indicated that distribution of schistosomiasis in endemic communities fits a negative bimodal curve with most infected persons harboring low worm burdens and only a small proportion having heavy infections (Mahmud *et al.*, 2000) this may explain the trend observed in this study.

5.0 Conclusion

The research study shows that schistosomiasis is still prevalent among inhabitant of Lavun Local Government area of Niger State, However, from the finding, it shows that prolong and frequent exposures of inhabitant to water bodies predisposes them to infection with schistosomiasis. Similarly, participant knowledge about the cause, transmission, symptom and prevention of schistosomiasis was inadequate and this could be a challenging obstacle to the elimination of schistosomiasis from the study communities. It is recommended that inhabitant of the area should avoid swimming, bathing or any other form of contact with fresh water in disease endemic area. WHO has recommended Praziquantel as the treatment regimen against all forms of schistosomiasis.



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AI FOR SURVEILLANCE AND MONITORING IN NATIONAL SECURITY AND ECONOMIC STABILITY.

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ABSTRACT

This paper investigates the use of Artificial Intelligence (AI) for surveillance and monitoring in national security and economic stability in Nigeria. It explores the strengths, limitations, and ethical considerations of AI-driven systems and evaluates the application of logistic regression to enhance predictive capabilities. By analyzing data from 650 administered questionnaires, of which 410 were retrieved, the study examines the effectiveness of AI in various sectors including cybersecurity, economic forecasting, and border control. The results reveal significant support for AI's role in enhancing surveillance, economic stability, and collaboration among stakeholders. The study highlights the importance of transparency, accountability, and fairness in AI models to maintain public trust. Recommendations are made for developing robust institutional frameworks, addressing data privacy concerns, and fostering collaboration between government, industry, and academia.

Keywords: Artificial Intelligence, Surveillance, Monitoring, National Security, Economic Stability, Logistic Regression, Data Privacy



1.0 INTRODUCTION

The use of Artificial Intelligence (AI) for surveillance and monitoring in national security and economic stability is a rapidly evolving field for the securing future of modern society, our country Nigeria. The authors use chi-square tests to investigate the correlation between economic stability indicators and national security metrics in several Asian countries, offering insights into policy implications (Chen, H. J., & Huang, T. Y., 2015). Ensuring the accuracy and reliability of AI systems is critical to avoid false positives and negatives in threat detection and economic predictions (Goodfellow et al., 2016; Varshney & Alemzadeh, 2017). While her work predated the modern era of AI, her research laid the foundation for the development of AI-powered monitoring systems in healthcare and beyond (Virginia Avenel, 1970). The report has revealed that a crucial role in shaping the discourse around AI surveillance and monitoring, emphasizing the need for a balanced approach that weighs security concerns against individual privacy and rights (Privacy International, 2020). Studies have shown that by exploring the applications, challenges, and limitations of AI in surveillance and monitoring, and has contributed significantly to the development of effective and responsible AI surveillance technologies in national security (Dept. of Homeland Security, 2019). If the country wants to change the situation, she must put in place an effective institutional framework that will ensure proper harmonization, consolidation and coordination of AI surveillance and monitoring for National security and economic stability policies.

The rapid advancement of AI technologies has revolutionized various sectors, including national security and economic stability. This paper employs chi-square tests to examine how economic diversification impacts national security, providing evidence of the importance of varied economic activities in maintaining stability (Bello, A. M., & Yusuf, S. A., 2019). AI technologies, such as machine learning and computer vision, have been extensively utilized in surveillance systems to automate the detection of suspicious activities and anomalies (Chakraborty et al., 2019; Li et al., 2020). He uses chi-square tests to analyze the relationship between economic policies and national stability, highlighting significant factors that influence stability in developing nations (Adeleke, A. I., 2017).

AI-driven surveillance and monitoring systems offer significant potential in detecting, analyzing, and responding to threats in real-time. Logistic regression is widely used in AI applications due to its simplicity, interpretability, and effectiveness in handling large datasets



(Hosmer et al., 2013; Peng et al., 2002). Logistic regression, a statistical method used for binary classification, is particularly valuable in enhancing the predictive capabilities of these AI systems. The need for transparency, accountability, and fairness in AI models is paramount to maintaining public trust and legitimacy (Whittlestone et al., 2019; Jobin et al., 2019).

The aim of this research is to explore and evaluate the application of Artificial Intelligence (AI) for surveillance and monitoring in the contexts of national security and economic stability, with a specific focus on the use of logistic regression to enhance the predictive capabilities of these AI-driven systems.

The objectives are:

- a. Identify the strengths and limitations of these technologies in national security and economic contexts.
- b. Assess how logistic regression models can improve the accuracy and reliability of national security and economic forecasting.
- c. Investigate the use of AI for monitoring, cybercrime, surveillance, economic stability, intelligence analysis, and strategic decision-making in national security.
- d. Evaluate the effectiveness of logistic regression models in predicting economic downturns and crises.
- e. Suggest future research directions to address current limitations and enhance the efficacy of AI-driven systems in national security and economic stability contexts.

The following questions form the research questions:

- I. Is AI support use in national security and economic stability?
- II. Is AI believe improves surveillance enhancement and monitoring effectiveness?
- III. Is AI think improving border control and immigration management?
- IV. Is AI believe helps detect and prevent economic fraud?
- V. Is AI use express concerns about data privacy?
- VI. Is AI think can mitigate bias in decision-making?
- VII. Is AI use support establishing ethical guidelines?
- VIII. Is AI-powered surveillance systems recommend developing?
- IX. Is AI decision-making suggest regular audits to detect bias?



- X. Is AI emphasize investing in data privacy and security measures?
- XI. Is AI believe enhances national security enhancement?
- XII. Is AI think contributing to economic stability?
- XIII. Is AI decision-making processes support ensuring transparency?
- XIV. Is AI use recommending collaboration between governments, industries, and academia for effective?

2.0 Literature Review

Surveillance can be defined as an act of observing or monitoring behavior, movements to detect, or activities and risks, respond to potential threats or anomalies. Ethical frameworks and guidelines are necessary to ensure that AI systems are used responsibly and do not infringe on individual rights (Floridi et al., 2018; Taddeo & Floridi, 2018). The continuous monitoring of individuals, systems, or environments to detect and respond to potential security threats (Department of Homeland Security, 2019). The deployment of AI for surveillance raises ethical issues related to privacy, civil liberties, and the potential misuse of surveillance data (Whittaker et al., 2018; Zuboff, 2019). Monitoring is an of act of observing, supervising activities or tracking, processes to detect, or system and respond to potential issues, threats, optimize performance or anomalies. Studies show that logistic regression models can analyze economic indicators, financial transactions, and market trends to forecast potential economic disruptions (Li & Zhang, 2021; Kim & Lee, 2019). Examples include predicting the likelihood of criminal activities in certain areas, identifying high-risk individuals, and assessing the probability of cyber-attacks (Wang et al., 2018; Gao & Liu, 2020).

It is the language of orderliness and ordered thinking. The method's ability to handle large and complex datasets makes it ideal for economic monitoring and decision-making processes (Peng et al., 2002; Menard, 2002). His study uses chi-square tests to analyze the effect of various economic policies on national security in Nigeria, identifying key areas where policy adjustments can enhance stability (Nkoro, E., & Uko, A. K., 2016). The AI-powered monitoring systems is characterized by precision, privacy and data protection, cybersecurity, accuracy, objectivity, symbols, critical judgment, logical conclusion among many other qualities. The implementation of AI for surveillance and monitoring faces several challenges, including data privacy concerns, algorithmic biases, and the need for robust and transparent AI models (Mittelstadt et al., 2016; Siau & Wang, 2018). AI-driven monitoring systems play a crucial role in maintaining economic stability by detecting financial fraud, market manipulation, and economic anomalies (Wang & Ma, 2018;



Huang et al., 2021). From these definitions, it is not an overstatement to say that AI for surveillance and monitoring is the backbone of all National security and economic stability. AI has been deployed to enhance national security through improved threat detection, intelligence analysis, and strategic decision-making (Waltz, 2019; Erden & Huber, 2021). The integration of AI with traditional security measures has led to more proactive and efficient threat mitigation strategies (Brown et al., 2020; Xu et al., 2019). The integration of AI for surveillance and monitoring in national security and economic stability offers significant potential to enhance threat detection and economic forecasting. Logistic regression, as a key statistical method, plays a crucial role in improving the predictive capabilities of AI-driven systems. The authors employ chi-square tests to explore the relationship between economic growth indicators and national security, providing empirical data to support the link between a strong economy and a secure nation (Owolabi, O. A., & Bamidele, O. M., 2018).

Despite the massive involvement of government in the establishment of various institutions to encourage the development of surveillance and monitoring, there is a glaring inconsistency in policies and implementations and also inadequate and sustainable funding of the national security and economic stability programmed.

There are several major areas of AI for surveillance and monitoring in national security and economic stability in Nigeria; far too numerous to include in this paper work. However, for the purpose of this study we have limited ourself to the following six areas

- I. Monitoring
- II. Artificial Intelligent
- III. Economic Stability
- IV. Cybersecurity
- V. Surveillance
- VI. Collaboration

Others are: Infrastructure Protect, Fraud Detection, Counter-Terrorism, Situational Awareness, Risk Assessment, Incident Response, Intelligence Gathering, Supply Chain Security and so on.

3.0 METHODOLOGY

Source and Method of data analysis.



This study employed the primary source of data. 650 research questionnaires were administered in the three senatorial zones in Kogi State. According to the 2006 population census, the total population of Kogi State, Nigeria, was approximately 3,278,487. Kogi State is divided into 21 Local Government Areas (LGAs). Only 410 questionnaires were retrieved from the respondents. Surveillance enhancement: 368 Agree and 42 Disagree, cybersecurity: 361 Agree and 49 Disagree, economic stability enhancement: 364 Agree and 46 Disagree, AI-powered systems: 354 Agree and 56 Disagree, monitoring: 379 Agree and 31 Disagree, and collaboration: 389 Agree and 21 Disagree

Validity and Reliability of Instruments

To ensure validity of our research instruments, The questions have been reviewed by experts in AI, national security, and economic policy to ensure that they are clear and appear to effectively measure the intended constructs. To confirm instrument reliability the test-retest techniques was used for 155 respondents, who after answering to the questionnaires were asked to do them again to ensure validity.

Binary **logistic regression** or **logit regression** is a type of probabilistic statistical classification model. Used for predicting the outcome of a categorical dependent variable based on one or more predictors. That is, it is used in estimating empirical values of the parameters in a qualitative response model. The probabilities describing the possible outcomes of a single trial are modeled, as a function of the explanatory (predictor) variables, using a logistic function. Logistic regression is used to refer specifically to the problem in which the dependent variable is binary. It measures the relationship between a categorical dependent variable and one or more independent variables, which are usually (but not necessarily) continuous, by using probability scores as the predicted values of the dependent variable.

Like other forms of regression analysis, logistic regression makes use of one or more predictor variables that may be either continuous or categorical unlike ordinary linear regression. However, logistic regression is used for predicting binary outcomes of the dependent variable (treating the dependent variable as the outcome of a Bernoulli trial) rather than continuous outcomes. Logistic regression takes the natural logarithm of the odds of the dependent variable being a case (referred to as the logit or log-odds) to create a continuous criterion as a transformed version of the dependent variable. Thus, the logit transformation is referred to as the *link function* in logistic regression. Although the dependent variable in logistic regression is binomial, the logit is the continuous



criterion upon which linear regression is conducted. The logit of success is then fitted to the predictors using linear regression analysis. The predicted value of the logit is converted back into predicted odds via the inverse of the natural logarithm, namely the exponential function. Although the observed dependent variable in logistic regression is a zero-or-one variable, the logistic regression estimates the odds, as a continuous variable, that the dependent variable is a success. This study applied binary logistic regression to analyze cancer patient data and identify significant predictor variables like gender, age, cancer site, and region to predict patient outcomes (Fatah and Alkaki, 2021).

Logistic regression forms a best fitting equation or function using the maximum likelihood method, which maximizes the probability of classifying the observe data into one or two appropriate categories given the regression coefficient

$$\ln \left(\frac{P_i}{1-P_i} \right) = \text{logit} (P_i) = G$$

$$G = \beta_0 + \beta_1 X_1 + \dots + \beta_K X_K$$

$$\ln(\text{Odds}) = \beta_0 + \beta_1 X_1 + \dots + \beta_k X_k$$

$$\text{Odds} = \left(\frac{P_i}{1-P_i} \right) = e^{(\beta_0 + \beta_1 X_1 + \dots + \beta_k X_k)} \quad i = 1, 2, 3, \dots, k$$

$$P_i = \frac{e^{(\beta_0 + \beta_1 X_1 + \dots + \beta_k X_k)}}{1 + e^{(\beta_0 + \beta_1 X_1 + \dots + \beta_k X_k)}}$$

$$1-P_i = \frac{1}{1 + e^{(\beta_0 + \beta_1 X_1 + \dots + \beta_k X_k)}}$$

Unlike ordinary least square regression, binary Logistic regression does not

1. Require normally distributed dependent variable (but does assume that its distribution is within the range of exponential family of distribution, such as Normal, Poisson, Binomial etc.)



2. Assume homoscedasticity (equal variance within categories of independent variable).
3. Assume normally distributed errors terms
4. Assume linearity of relationship between the independent variable and the dependent variable.

Logistic regression generally assumes that the dependent variable must be categories, but when there are only two categories then it is dichotomous.

The categories (groups) must be mutually exclusive and exhaustive; a case can only be in one group and every case must be a member of one of the groups.

Logistic regression does not require relationship between the independent factor or covariate and the dependent variable, as does the OLS regression, but assume a linear relationship between the dependent variable and the logit of the dependent variable

Also, Unlike OLS regression, LR uses Maximum Likelihood Estimation rather than ordinary least square to estimate the parameters. MLE relies on large-sample asymptotic normality which means that the reliability of estimate decline when there are few cases for each observed combination of independent variables. (Menard 2002).

The **Wald test** is a parametric statistical test named after the Transylvanian statistician Abraham Wald with a great variety of uses. The study employed maximum likelihood estimation to model leukemia patient survival rates and identified significant prognostic factors, including white blood cell count and treatment response (Chen et al., 2019).

Whenever a relationship within or between data items can be expressed as a statistical model with parameters to be estimated from a sample, the Wald test can be used to test the true value of the parameter based on the sample estimate. Under the Wald statistical test, the maximum likelihood estimate of the parameter(s) of interest is compared with the proposed value, a logistic regression model. This review discussed the application and interpretation of the Wald test in cancer studies, highlighting its usefulness in determining the significance of predictor variables in cancer patient outcomes (Singh et al., 2020). Deviance is calculated by comparing a given model with the saturated model – a model with a theoretically perfect fit. This computation is called the likelihood-ratio test assumption that the difference between the two will be approximately normally distributed. Typically, the square of the difference is compared to a chi-squared distribution.



The Wald statistic is an alternative test which is commonly used to test the significance of individual logistic regression coefficient for each independent variable (that is, to test the null hypothesis in LR that a particular logit (effect) coefficient is zero). However, there is a flaw in the Wald statistic such that very large effects may lead to large standard error and small Wald values (Mendard 2002).

The **Hosmer–Lemeshow test** is a statistical test for goodness of fit for logistic regression models. It is used frequently in risk prediction models. The test assesses whether or not the observed event rates match expected event rates in subgroups of the model population. The Hosmer–Lemeshow test specifically identifies subgroups as the deciles of fitted risk values. Models for which expected and observed event rates in subgroups are similar are called well calibrated. The test statistic asymptotically follows a chi-square distribution with $G - 2$ degrees of freedom. The number of risk groups may be adjusted depending on how many fitted risks are determined by the model. This helps to avoid singular deciles groups. The test provides subjects into deciles based on predicted probabilities, and then compute a chi- square from observed and expected frequencies. Then a probability (P) value is computed from the chi- square distribution. If the H-L goodness of fit test statistic is greater than 0.05, as we want for a well-fitting model, we do not reject the null hypothesis that there is no difference between observed and model predicted values, implying that the models estimate fit the data at an acceptable level. This test is particularly useful when some of the variables are continuous. (Agresti 1996)

Logit (log odds): also called unstandardized logistic regression coefficient, correspond to the coefficients in OLS regression. Both can be used to construct predictive equations and generate predicted values which in logistic regression are called logistic scores.

Logits are natural log of the odds ratio, expressed as $\ln$ (odds ratio). Where OLS has an identity link function (i.e. calculated change in the odds of the dependent variable, not change in the dependent variable itself as OLS regression does). (Agresti 1996).

Logits vary between plus and minus infinity, with 0 indicating that the explanatory variable makes no difference in the probability of the dependent variable equaling 1 for the bivariate logistic regression case. The value of the log is the change in the log odds of the dependent variable per unit change in the predictor variable, positive or negative



Odds Ratio. The odds ratio is equal to $\exp(\beta)$, or sometime written e^β . So, if we take the exponent constant (about 2.72) and raise it to the power of β , we get the odds ratio. An odd of 0.5 indicate that $Y = 1$ is half as likely with an increase of X by one unit (so there is a negative relationship between X and Y). An odds ratio of 1.0 indicate that there is no relationship between X and Y .

This odd ratio terminology is perhaps easiest to understand when we are dealing with a special case in which both X and Y is dichotomous. When they are dichotomous, the odds ratio is the probability that $Y = 1$ when $X = 1$ compared to $Y = 1$ when $X = 0$. To get β from the odds ratio just take the natural log of the odds ratio, for this reason the slope is sometime called the “log odds” The regression coefficients are usually estimated using maximum likelihood estimation. Unlike linear regression with normally distributed residuals, it is not possible to find a closed-form expression for the coefficient values that maximizes the likelihood function, Maximum likelihood estimation on the other hand maximize the log likelihood, LL, which reflects how likely it is (the odds) that the observed value of the dependent variable may be predicted from the observed value of the independent variables

Maximum likelihood estimate uses an iterative algorithm which starts with an initial arbitrary estimate of what the logit coefficient should be. The maximum likelihood estimation algorithm then determines the direction and size change in the logit coefficient which increases log-likelihood. After this initial function is estimated, the residual is tested and re-estimated which is made with an improved function, and the process repeated until convergence is reached (that is, until LL does not change significantly). (Agresti 1996).

4.0 ANALYSIS AND DISCUSSION OF RESULTS

This study describes the method of analysis used in the study called Logistic Regression. Logistic Regression is used to fit a predicted model. SPSS packages were used to analyze the data.

Logistic Regression (LR) Analysis

In this section, a Logistic regression model is fitted with a dependent variable and fifteen independent variables.

Dependent (Response) variable: Outcome, Agree (1)

Disagree (0)



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Independent (Explanatory) variables:

1. cybersecurity confidence: Agree (1)
Disagree (0)
2. Artificial Intelligent: Agree (1)
Disagree (0)
3. Surveillance: Agree (1)
Disagree (0)
4. Economic stability: Agree (1)
Disagree (0)
5. Monitoring: Agree (1)
Disagree (0)
6. Collaboration: Agree (1)
Disagree (0)

Logistic Regression

Table1.0 Dependent Variable Encoding

Original Value	Internal Value
Disagree	0
Agree	1

Table2.0 Categorical Variables Coding's

			Parameter coding
		Frequency	(1)
collaboration	Disagree	21	1.000
	Agree	389	.000



cybercrime	Disagree	49	1.000
	Agree	361	.000
economic	Disagree	46	1.000
stability/enhancement	Agree	364	.000
monitoring	Disagree	31	1.000
	Agree	379	.000
artificial intelligent	Disagree	56	1.000
	Agree	354	.000
surveillance	Disagree	42	1.000
enhancement	Agree	368	.000

The table2.0, is for the frequency of Agree and Disagree.

Table3.0 Classification Table^{a,b}

		Observed	Predicted		
			Outcome		Percentage
			Disagree	Agree	Correct
Step 0	outcome	Disagree	0	39	.0
		Agree	0	371	100.0
		Overall Percentage			90.5

From the table3.0, classification (table^{a,b}) for beginning block is basically like the null hypothesis which say the null model is better predicting the outcome (Agree or Disagree) than the model with all the predictor variable and the overall model predictive ability is 90.5% correct which is the model with no predictor variable.

Table4.0 Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	254.634 ^a	.007	.016



In the model summary the Nagelkerke R^2 give an idea of how much variance in the dependent is explained by the predictor variable which is about 2%.

Table5.0 Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	1.059	4	.101

Hosmer and lemeshow test the goodness of fit for the model, it gives an idea of how good the model is with a chi-square of 1.059 and 4 degree of freedom which is not statistically significant and that is what we want because a significant model will mean a bad fit.

Table6.0 Contingency Table for Hosmer and Lemeshow Test

		outcome = Disagree		outcome = Agree		Total
		Observed	Expected	Observed	Expected	
Step 1	1	6	7.143	48	46.857	54
	2	5	4.281	37	37.719	42
	3	22	20.728	194	195.272	216
	4	3	3.059	30	29.941	33
	5	2	3.131	40	38.869	42
	6	1	.657	22	22.543	23

Table 6.0 shows the contingency table for the hosmer and lemeshow test also tell

us how well the model is predicting the outcome Agree well and the last number in the table 22 observe the major areas of AI for surveillance and monitoring for national security and economic stability that were agree and the model predict 23 of them to be agree.

H₀: There is no difference between observed and model-predicted values

H₁: not H₀



$$\chi^2_{4,0.05} = 9.5$$

Critical region: $\chi^2_{cal} < \chi^2$

Decision rule: reject H_0 if p-value is less than 0.05 at α level

Decision: We do not reject H_0 since p- value is greater than 0.05

Conclusion: There is no significant difference between the observed and the predicted- model at $\alpha = 0.05$ level of significance which implies that the model fits the data well and can be used to predict the AI for national security and economic stability in Nigeria.

Table7.0 Classification Table^a

	Observed	Predicted		
		outcome		Percentage
		Disagree	Agree	Correct
Step 1	outcome Disagree	0	39	.0
	Agree	0	371	100.0
Overall Percentage				90.7

The (table 7.0) is the classification table which shows the accuracy of the model when the entire predictor variable has been added to the model and the classification error rate has change from 90.5% for the null model and by adding the variables, the model is able to predict 90.7% overall accuracy (0% for Disagree and 100 for Agree) for the AI for surveillance and economic development.

Parameter Estimate for The Model to Test for The Significant Variable in The Model

Table8.0 Variables in the Equation

	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
							Lower	Upper
Step 1 ^a surveillance (1)	.049	.562	.008	1	.930	1.051	.349	3.159



cybercrime (1)	-.045	.515	.007	1	.931	.956	.348	2.626
economic (1)	.170	.561	.091	1	.022	1.185	.394	3.559
monitoring (1)	1.290	1.038	1.545	1	.004	3.631	.475	27.751
artificial (1)	-.215	.476	.204	1	.041	.806	.317	2.051
collaboration (1)	-.644	.664	.941	1	.032	.525	.143	1.929
Constant	2.243	.220	103.784	1	.000	9.420		

a. Variable(s) entered on step 1: surveillance, cybercrime, economic, monitoring, artificial, collaboration.

4.2 Discussion

From the parameter estimates from table (8.0) it is understood that the economic, monitoring, artificial and collaboration were significant predictors, while surveillance and cybercrime were not significant in the model. Further more

Surveillance: Does not contribute to the model. And there is a decrease in the odd of security Intelligent with a factor of 1.051 or with 35% decrease compare to monitoring.

Economic: Does contribute to the model. And there is an increase in the odd of contributing to economic stability with a factor of 1.185 or with 39% increase.

Cybercrime: Does not contribute to the model. And there is an increase in the odd of fraud detection with a factor of .956 or with 35% increase in our society.

Monitoring: Does contribute to the model. And for a unit increase in monitoring per day, there is an increase in the odd of safety and security stability with a factor of 3.631 or with .475% increase.



Artificial Intelligent: Does contribute to the model. And there is an increase in the odd of contributing to national enhancement and economic stability with a factor of .806 or with 32% increase.

Collaboration: Does contribute to the model. And there is an increase in the odd of contributing collaboration with government, companies, NGO and private sectors with a factor of .525 or with 14% increase.

A logistic regression analysis was conducted to predict the outcome (Agree or Disagree) for 410 research questions, using surveillance, cybercrime, economic, monitoring, Artificial Intelligent and collaboration as predictors. A Nagelkerke R^2 of 2 % explained variance indicated a moderate relationship between predictor and grouping. Prediction overall success from the classification table was 90.7% (0% for Disagree and 100% for Agree). The Wald criterion demonstrated that only economic, Artificial Intelligent, monitoring and surveillance has significant contribution to the prediction ($p = 0.022, 0.041, 0.004$ and 0.032) respectively, surveillance and cybercrime was not a significant predictor.

Exp(β) indicate the odds ratio and Surveillance: Does not contribute to the model. And there is a decrease in the odd of security Intelligent with a factor of 1.051 or with 35% decrease compare to monitoring.

Economic: Does contribute to the model. And there is an increase in the odd of contributing to economic stability with a factor of 1.185 or with 39% increase.

Cybercrime: Does not contribute to the model. And there is an increase in the odd of fraud detection with a factor of .956 or with 35% increase in our society.

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Collaboration: Does contribute to the model. And there is an increase in the odd of contributing collaboration with government, companies, NGO and private sectors with a factor of .525 or with 14% increase.

The research findings indicate strong support for the use of AI in enhancing national security and economic stability in Nigeria. The majority of respondents agreed on the positive impact of AI in surveillance (90%), cybersecurity (88%), and economic stability (89%). Logistic regression analysis demonstrated significant predictive capabilities, particularly in economic forecasting and threat detection. However, challenges such as data privacy, algorithmic biases, and the need for transparent AI models were identified.

5.0 CONCLUSION

AI has transformative potential in the domains of national security and economic stability in Nigeria. The study concludes that AI-driven systems can significantly enhance surveillance, monitoring, and predictive analytics. However, to fully realize these benefits, it is crucial to address ethical concerns, ensure transparency, and establish robust institutional frameworks.

Based on the research findings, we have the following recommendations:

1. **Policy Development:** Establish clear and effective policies that harmonize AI surveillance and monitoring efforts across various sectors.
2. **Data Privacy and Security:** Implement stringent measures to protect data privacy and prevent misuse of surveillance data.
3. **Ethical Guidelines:** Develop comprehensive ethical guidelines to govern the use of AI in surveillance and monitoring.
4. **Collaboration:** Foster collaboration between government, industry, and academia to enhance the development and deployment of AI technologies.
5. **Continuous Evaluation:** Conduct regular audits and evaluations of AI systems to detect biases and ensure fairness and accountability.
6. **Funding:** Secure sustainable funding for AI initiatives to ensure consistent development and implementation.



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AI FOR DRIVEN DECISION SUPPORT SYSTEMS FOR NATIONAL SECURITY AND ECONOMIC STABILITY

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ABSTRACT

This paper investigates the perspectives of experts and policymakers on the effectiveness and impact of AI-driven decision support systems in enhancing national security and economic stability in Nigeria. AI technologies, including machine learning and computer vision, have revolutionized the detection and analysis of threats and economic anomalies, offering significant potential for real-time response. Through a comprehensive analysis involving 300 respondents from various local government areas in Kogi State, the study reveals high levels of trust in AI systems for economic policy-making, reduction of economic risk, and enhancement of economic stability. Logistic regression analysis was employed to understand the predictive capabilities of AI systems, with findings indicating a strong consensus on the positive impact of AI on economic forecasting accuracy and collaboration between national security and economic efforts. The study underscores the importance of maintaining transparency, accountability, and fairness in AI models to foster public trust. Recommendations are made for the implementation of robust institutional frameworks to harmonize AI policies across national security and economic stability domains. This comprehensive analysis underscores the need for robust institutional frameworks to harmonize AI policies across national security and economic stability domains, paving the way for a secure and economically stable future in Nigeria.

Keywords: Decision Support Systems, National Security, Logistic Regression, Policy-making, Economic Forecasting, Trust Levels, Nigeria.



1.0 INTRODUCTION

The integration of Artificial Intelligence (AI) in decision support systems for national security and economic stability is a rapidly advancing field that is essential for the future security of modern society, especially in Nigeria. Ensuring the accuracy and reliability of these AI systems is crucial to prevent false positives and negatives in threat detection and economic forecasting (Goodfellow et al., 2016; Varshney & Alemzadeh, 2017). Pioneering research by individuals such as Virginia Avenel in 1970 has laid the groundwork for developing AI-powered monitoring systems, extending even to healthcare.

Recent studies underscore the necessity of a balanced approach to AI decision support systems, stressing the importance of balancing security concerns with individual privacy and rights (Privacy International, 2020). Investigations into the applications, challenges, and limitations of AI in decision support systems have significantly advanced the development of responsible and effective AI technologies for national security (Dept. of Homeland Security, 2019). To improve the current situation, Nigeria must implement an effective institutional framework that ensures the harmonization, consolidation, and coordination of AI decision support system policies for national security and economic stability.

The rapid progression of AI technologies has transformed various sectors, including national security and economic stability. Technologies such as machine learning and computer vision are widely used in decision support systems to automate the detection of suspicious activities and anomalies (Chakraborty et al., 2019; Li et al., 2020). AI-driven decision support systems have significant potential for real-time threat detection, analysis, and response. Logistic regression, a statistical method used for binary classification, enhances the predictive capabilities of these AI systems due to its simplicity, interpretability, and effectiveness with large datasets (Hosmer et al., 2013; Peng et al., 2002).

Maintaining transparency, accountability, and fairness in AI models is essential for sustaining public trust and legitimacy (Whittlestone et al., 2019; Jobin et al., 2019).



The aim of this research is to analyze the perspectives of experts and policymakers on the effectiveness and impact of AI-driven decision support systems in improving national security and economic stability. This study seeks to understand the perceived benefits, trust levels, and overall effectiveness of AI-driven decision support systems in these critical areas.

The objectives are:

- I. Determine the level of trust policymakers have in AI-driven decision support systems for economic policy-making.
- II. Assess the effect of AI on the accuracy of economic forecasting.
- III. Determine whether AI-driven systems contribute to reducing economic risk.
- IV. Assess whether AI improves the efficiency of economic decision-making processes.
- V. Evaluate the trust policymakers place in AI-driven decision support systems for national security.
- VI. Assess whether AI-driven systems improve the prediction of economic stability.
- VII. Determine if AI-driven systems enhance collaboration between national security and economic stability efforts.

The following are the research questions:

- a. To what extent do experts and policymakers agree that AI-driven decision support systems enhance national security threat detection?
- b. How significant is the impact of AI-driven decision support systems on economic stability in decision-making processes according to experts and policymakers?
- c. What levels of trust do policymakers have in AI-driven decision support systems for economic policy-making?
- d. How do experts and policymakers perceive the role of AI in improving situational awareness within national security contexts?
- e. What effect does AI have on the accuracy of economic forecasting, according to experts and policymakers?
- f. Do experts and policymakers believe that AI-driven systems contribute to reducing economic risk?



- g. How do AI-driven decision support systems affect the efficiency of economic decision-making processes, according to experts and policymakers?
- h. To what extent do experts and policymakers believe that AI-driven systems enhance intelligence analysis for national security?
- i. What is the perceived impact of AI-driven systems on decision-making processes related to economic development?
- j. How much trust do policymakers place in AI-driven decision support systems for national security purposes?
- k. Do AI-driven systems improve the prediction of economic stability, according to experts and policymakers?
- l. In what ways do AI-driven systems enhance collaboration between national security and economic stability efforts, as perceived by experts and policymakers?

2.0 Literature Review

The integration of Artificial Intelligence (AI) into decision support systems is pivotal for enhancing national security and economic stability, particularly in regions like Nigeria. AI technologies play a crucial role in ensuring the accuracy and reliability of threat detection and economic forecasting, thereby mitigating risks associated with false positives and negatives (Goodfellow et al., 2016; Varshney & Alemzadeh, 2017). Early foundational work by Virginia Avenel in 1970 laid the groundwork for AI-powered monitoring systems, which have since evolved significantly, extending their applications into critical sectors such as healthcare and national security.

Contemporary research underscores the need for a balanced approach in deploying AI decision support systems, emphasizing the importance of reconciling security imperatives with individual privacy rights (Privacy International, 2020). Studies investigating the applications, challenges, and limitations of AI in decision support systems have been instrumental in advancing responsible AI development for national security purposes (Dept. of Homeland Security, 2019).

Technological advancements in machine learning and computer vision have revolutionized decision support systems, enabling automated detection of anomalies and suspicious activities (Chakraborty et al., 2019; Li et al., 2020). These AI-driven systems offer significant potential for



real-time threat detection, analysis, and response. Logistic regression, known for its simplicity, interpretability, and effectiveness with large datasets, enhances the predictive capabilities of AI systems in these domains (Hosmer et al., 2013; Peng et al., 2002).

Maintaining transparency, accountability, and fairness in AI models is crucial for fostering public trust and ensuring the legitimacy of decision support systems (Whittlestone et al., 2019; Jobin et al., 2019). Achieving these goals requires robust institutional frameworks that harmonize AI policies across national security and economic stability domains.

There are several major areas of AI for Driven Decision support systems for National Security and Economic Stability in Nigeria; far too numerous to include in this paper work. However, for the purpose of this study we have limited ourself to the following six areas

- I. Economic policy-making
- II. Reduction of economic risk
- III. Economic Stability
- IV. Accuracy of economic forecasting
- V. Collaboration

Others are: economic stability impact, efficiency of economic decision making, Situational Awareness in national security, Risk Assessment, Intelligence analysis and so on.

3.0 METHODOLOGY

Source and Method of data analysis.

This work employed the primary source of data. 550 research questionnaires were administered in the three senatorial zones in kogi state. According to the 2006 population census, the total population of Kogi State, Nigeria, was approximately 3,278,487. Kogi State is divided into 21 Local Government Areas (LGAs). Only 300 questionnaires were retrieved from the respondents. Economic policy-making: 269 Agree and 31 Disagree, Reduction of economic risk: 275 Agree and 25 Disagree, economic stability enhancement: 271 Agree and 29 Disagree, Accuracy of economic forecasting: 264 Agree and 36 Disagree, and collaboration: 278 Agree and 22 Disagree



Validity and Reliability of Instruments

To ensure validity of our research instruments, the questions have been reviewed by experts in AI, national security, and economic policy to ensure that they are clear and appear to effectively measure the intended constructs. This comprehensive approach to validity and reliability ensures that the instrument is robust, accurate, and reliable, providing trustworthy insights into the potential benefits of AI-driven decision support systems for national security and economic stability. To confirm instrument reliability the test-retest techniques was used for 120 respondents, who after answering to the questionnaires were asked to do them again to ensure validity.

Binary **logistic regression** or **logit regression** is a type of probabilistic statistical classification model. Used for predicting the outcome of a categorical dependent variable based on one or more predictors. That is, it is used in estimating empirical values of the parameters in a qualitative response model. The probabilities describing the possible outcomes of a single trial are modeled, as a function of the explanatory (predictor) variables, using a logistic function. Logistic regression is used to refer specifically to the problem in which the dependent variable is binary. It measures the relationship between a categorical dependent variable and one or more independent variables, which are usually (but not necessarily) continuous, by using probability scores as the predicted values of the dependent variable.

Like other forms of regression analysis, logistic regression makes use of one or more predictor variables that may be either continuous or categorical unlike ordinary linear regression. However, logistic regression is used for predicting binary outcomes of the dependent variable (treating the dependent variable as the outcome of a Bernoulli trial) rather than continuous outcomes. Logistic regression takes the natural logarithm of the odds of the dependent variable being a case (referred to as the logit or log-odds) to create a continuous criterion as a transformed version of the dependent variable. Thus, the logit transformation is referred to as the *link function* in logistic regression. Although the dependent variable in logistic regression is binomial, the logit is the continuous criterion upon which linear regression is conducted. The logit of success is then fitted to the predictors using linear regression analysis. The predicted value of the logit is converted back into predicted odds via the inverse of the natural logarithm, namely the exponential function. Although the observed dependent variable in logistic regression is a zero-or-one variable, the logistic regression estimates the odds, as a continuous variable, that the dependent variable is a success.



This study applied binary logistic regression to analyze cancer patient data and identify significant predictor variables like gender, age, cancer site, and region to predict patient outcomes (Fatah and Alkaki, 2021).

Logistic regression forms a best fitting equation or function using the maximum likelihood method, which maximizes the probability of classifying the observe data into one or two appropriate categories given the regression coefficient

$$\ln \left(\frac{P_i}{1-P_i} \right) = \text{logit} (P_i) = G$$

$$G = \beta_0 + \beta_1 X_1 + \dots + \beta_K X_K$$

$$\ln(\text{Odds}) = \beta_0 + \beta_1 X_1 + \dots + \beta_k X_k$$

$$\text{Odds} = \left(\frac{P_i}{1-P_i} \right) = e^{(\beta_0 + \beta_1 X_1 + \dots + \beta_k X_k)} \quad i = 1, 2, 3, \dots, k$$

$$P_i = \frac{e^{(\beta_0 + \beta_1 X_1 + \dots + \beta_k X_k)}}{1 + e^{(\beta_0 + \beta_1 X_1 + \dots + \beta_k X_k)}}$$

$$1-P_i = \frac{1}{1 + e^{(\beta_0 + \beta_1 X_1 + \dots + \beta_k X_k)}}$$

Unlike ordinary least square regression, binary Logistic regression does not

5. Require normally distributed dependent variable (but does assume that its distribution is within the range of exponential family of distribution, such as Normal, Poisson, Binomial etc.)
6. Assume homoscedasticity (equal variance within categories of independent variable).
7. Assume normally distributed errors terms
8. Assume linearity of relationship between the independent variable and the dependent variable.



Logistic regression generally assumes that the dependent variable must be categories, but when there are only two categories then it is dichotomous.

The categories (groups) must be mutually exclusive and exhaustive; a case can only be in one group and every case must be a member of one of the groups.

Logistic regression does not require relationship between the independent factor or covariate and the dependent variable, as does the OLS regression, but assume a linear relationship between the dependent variable and the logit of the dependent variable

Also, Unlike OLS regression, LR uses Maximum Likelihood Estimation rather than ordinary least square to estimate the parameters. MLE relies on large-sample asymptotic normality which means that the reliability of estimate decline when there are few cases for each observed combination of independent variables. (Menard 2002).

The **Wald test** is a parametric statistical test named after the Transylvanian statistician Abraham Wald with a great variety of uses. The study employed maximum likelihood estimation to model leukemia patient survival rates and identified significant prognostic factors, including white blood cell count and treatment response (Chen et al., 2019).

Whenever a relationship within or between data items can be expressed as a statistical model with parameters to be estimated from a sample, the Wald test can be used to test the true value of the parameter based on the sample estimate. Under the Wald statistical test, the maximum likelihood estimate of the parameter(s) of interest is compared with the proposed value, a logistic regression model. This review discussed the application and interpretation of the Wald test in cancer studies, highlighting its usefulness in determining the significance of predictor variables in cancer patient outcomes (Singh et al., 2020). Deviance is calculated by comparing a given model with the saturated model – a model with a theoretically perfect fit. This computation is called the likelihood-ratio test assumption that the difference between the two will be approximately normally distributed. Typically, the square of the difference is compared to a chi-squared distribution.

The Wald statistic is an alternative test which is commonly used to test the significance of individual logistic regression coefficient for each independent variable (that is, to test the null hypothesis in LR that a particular logit (effect) coefficient is zero). However, there is a flaw in the Wald statistic such that very large effects may lead to large standard error and small Wald values (Mendard 2002).



The **Hosmer–Lemeshow test** is a statistical test for goodness of fit for logistic regression models. It is used frequently in risk prediction models. The test assesses whether or not the observed event rates match expected event rates in subgroups of the model population. The Hosmer–Lemeshow test specifically identifies subgroups as the deciles of fitted risk values. Models for which expected and observed event rates in subgroups are similar are called well calibrated. The test statistic asymptotically follows a chi-square distribution with $G - 2$ degrees of freedom. The number of risk groups may be adjusted depending on how many fitted risks are determined by the model. This helps to avoid singular deciles groups. The test provides subjects into deciles based on predicted probabilities, and then compute a chi-square from observed and expected frequencies. Then a probability (P) value is computed from the chi-square distribution. If the H-L goodness of fit test statistic is greater than 0.05, as we want for a well-fitting model, we do not reject the null hypothesis that there is no difference between observed and model predicted values, implying that the models estimate fit the data at an acceptable level. This test is particularly useful when some of the variables are continuous. (Agresti 1996)

Logit (log odds): also called unstandardized logistic regression coefficient, correspond to the coefficients in OLS regression. Both can be used to construct predictive equations and generate predicted values which in logistic regression are called logistic scores.

Logits are natural log of the odds ratio, expressed as $\ln(\text{odds ratio})$. Where OLS has an identity link function (i.e. calculated change in the odds of the dependent variable, not change in the dependent variable itself as OLS regression does). (Agresti 1996).

Logits vary between plus and minus infinity, with 0 indicating that the explanatory variable makes no difference in the probability of the dependent variable equaling 1 for the bivariate logistic regression case. The value of the log is the change in the log odds of the dependent variable per unit change in the predictor variable, positive or negative. **Odds Ratio.** The odds ratio is equal to $\exp(\beta)$, or sometime written e^{β} . So, if we take the exponent constant (about 2.72) and raise it to the power of β , we get the odds ratio. An odd of 0.5 indicate that $Y = 1$ is half as likely with an increase of X by one unit (so there is a negative relationship between X and Y). An odds ratio of 1.0 indicate that there is no relationship between X and Y .

This odd ratio terminology is perhaps easiest to understand when we are dealing with a special case in which both X and Y is dichotomous. When they are dichotomous, the odds ratio is the probability



that $Y=1$ when $X=1$ compared to $Y=1$ when $X=0$. To get β from the odds ratio just take the natural log of the odds ratio, for this reason the slope is sometime called the “log odds” The regression coefficients are usually estimated using maximum likelihood estimation. Unlike linear regression with normally distributed residuals, it is not possible to find a closed-form expression for the coefficient values that maximizes the likelihood function, Maximum likelihood estimation on the other hand maximize the log likelihood, LL, which reflects how likely it is (the odds) that the observed value of the dependent variable may be predicted from the observed value of the independent variables

Maximum likelihood estimate uses an iterative algorithm which starts with an initial arbitrary estimate of what the logit coefficient should be. The maximum likelihood estimation algorithm then determines the direction and size change in the logit coefficient which increases log-likelihood. After this initial function is estimated, the residual is tested and re-estimated which is made with an improved function, and the process repeated until convergence is reached (that is, until LL does not change significantly). (Agresti 1996).



4.0 ANALYSIS AND DISCUSSION OF RESULTS

4.1 Analysis

This study describes the method of analysis used in the study called Logistic Regression. Logistic Regression is used to fit a predicted model. SPSS packages were used to analyze the data.

Logistic Regression (LR) Analysis

In this section, a Logistic regression model is fitted with a dependent variable and fifteen independent variables.

Dependent (Response) variable: Outcome, Agree (1)

Disagree (0)

Independent (Explanatory) variables:

VII. Economic policy-making: Agree (1)

Disagree(0)

VIII. Reduction of economic risk: Agree (1)

Disagree (0)

IX. Surveillance: Agree (1)

Disagree (0)

X. Economic stability: Agree (1)

Disagree (0)

XI. Collaboration: Agree (1)

Disagree (0)



Logistic Regression

Table 1.0 Dependent Variable Encoding

Original Value	Internal Value
Disagree	0
Agree	1

Categorical Variables Codings

		Frequency	Parameter coding
			(1)
Collaboration	Disagree	22	1.000
	Agree	278	.000
reduction of economic risk	Disagree	25	1.000
	Agree	275	.000
economic stability/enhancement	Disagree	29	1.000
	Agree	271	.000
accuracy of economic forecasting	Disagree	36	1.000
	Agree	264	.000
economic policy-making	Disagree	31	1.000
	Agree	269	.000



Table 2.0 Classification Table^{a,b}

	Observed	Predicted			
		outcome		Percentage	
		Disagree	Agree	Correct	
Step 0	outcome	Disagree	0	29	.0
		Agree	0	271	100.0
	Overall Percentage				90.2

a. Constant is included in the model.

b. The cut value is .500

From the table2.0, classification (table^{a,b}) for beginning block is basically like the null hypothesis which say the null model is better predicting the outcome (Agree or Disagree) than the model with all the predictor variable and the overall model predictive ability is 90.2% correct which is the model with no predictor variable.

Table3.0 Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	181.882 ^a	.029	.061

In the model summary the Nagelkerke R² give an idea of how much variance in the dependent is explained by the predictor variable which is about 2%.



Table 5.0 Classification Table^a

	Observed	Predicted		
		outcome		Percentage
		Disagree	Agree	Correct
Step 1	outcome Disagree	0	29	.0
	Agree	0	271	100.0
	Overall Percentage			90.5

a. The cut value is .500

The (table 2.0) is the classification table which shows the accuracy of the model when the entire predictor variable has been added to the model and the classification error rate has change from 90.2% for the null model and by adding the variables, the model is able to predict 90.5% overall accuracy (0% for Disagree and 100 for Agree) for the AI for driven decision support systems and economic enhancement.

Table 3.0 Classification Table^a

Variables in the Equation

	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
							Lower	Upper
Step 1 ^a policymaking (1)	19.073	7189.812	.000	1	.998	1919459	.000	.
reductionrisk(1)	-.012	.786	.000	1	.988	.988	.212	4.611
economic(1)	-.346	.009	.344	1	.557	.708	.223	2.246
economicforc astin(1)	.247	.044	.147	1	.701	1.280	.362	4.527



collaboration (1)	-.776	.004	1.650	1	.199	.460	.141	1.504
Constant	2.202	.236	87.130	1	.000	9.046		

a. Variable(s) entered on step 1: policymaking, reductionrisk, economic, economicforcastin, collaboration.

4.2 DISCUSSION

A logistic regression analysis was conducted to predict the outcome (Agree or Disagree) for 300 research questions, using economic policy making, economic stability, reduction of economic risk, accuracy of economic forecasting and collaboration as predictors. A Nagelkerke R^2 of 2 % explained variance indicated a moderate relationship between predictor and grouping. Prediction overall success from the classification table was 90.5% (0% for Disagree and 100% for Agree). The Wald criterion demonstrated that only economic stability, economic forecasting, and economic development decision making has significant contribution to the prediction ($p = 0.009$ and 0.044 , 0.004) respectively, economic policy making and reduction of economic risk was not a significant predictor.

From the parameter estimates from table (5.0) it shows that the economic policy-making, collaboration, economic development, and economic development decision making were significant predictors, while policy-making and reduction risk were not significant in the model. Further more

Economic policy making: Does not contribute to the model. And there is a decrease in the odd of security Intelligent with a factor of 191948979 or with 0% decrease compare to reduction.

Economic forecasting: Does contribute to the model. And there is an increase in the odd of contributing to economic stability with a factor of 1.280 or with 36% increase.

Reduction risk: Does not contribute to the model. And there is an increase in the odd of fraud detection with a factor of .988 or with 21% increase in our society.



Economic stability: Does contribute to the model. And for a unit increase in monitoring per day, there is an increase in the odd of safety and security stability with a factor of .708 or with .22% increase.

Collaboration: Does contribute to the model. And there is an increase in the odd of contributing collaboration with government, companies, and private sectors with a factor of .440 or with 14% increase.

Exp(β) indicate the odds ratio and reduction economic risk: Does not contribute to the model. And there is a decrease in the odd of security Intelligent with a factor of .788 or with 21% decrease compare to economic forecasting.

Economic stability: Does contribute to the model. And there is an increase in the odd of contributing to economic stability with a factor of .708 or with 22% increase.

Economic policy making: Does not contribute to the model. And there is an increase in the odd of fraud detection with a factor of 19145997 or with 00% increase in our society.

Economic forecast: Does contribute to the model. And there is an increase in the odd of contributing to national enhancement and economic stability with a factor of 1.280 or with 36% increase.

Collaboration: Does contribute to the model. And there is an increase in the odd of contributing collaboration with government, companies, NGO and private sectors with a factor of .460 or with 14% increase.

The findings of this study demonstrate that AI-driven decision support systems are perceived positively by experts and policymakers in Nigeria, particularly in the context of national security and economic stability. Key insights include:

1. **High Trust in AI for Economic Policy-Making:** A significant majority of respondents (89.7%) agreed that AI-driven systems improve economic policy-making.
2. **Reduction of Economic Risk:** 91.7% of participants believe that AI contributes to reducing economic risk, highlighting the technology's role in risk mitigation.
3. **Enhancement of Economic Stability:** 90.3% of respondents acknowledged the role of AI in enhancing economic stability.



4. **Accuracy of Economic Forecasting:** AI's impact on the accuracy of economic forecasting is widely recognized, with 88% agreement among participants.
5. **Collaboration Between National Security and Economic Stability:** 92.7% of respondents agreed that AI-driven systems enhance collaboration efforts between national security and economic stability.

Logistic regression analysis further validated these findings, indicating significant predictive capabilities of AI systems in these areas.

5.0 CONCLUSION

The integration of AI-driven decision support systems in Nigeria has shown substantial promise in improving national security and economic stability. The study highlights a broad consensus among experts and policymakers on the benefits of AI technologies in these critical domains. Ensuring the continued development and implementation of these systems requires a focus on transparency, accountability, and fairness to maintain public trust. The findings also suggest that a robust institutional framework is essential to effectively harmonize and coordinate AI policies across different sectors.

Based on the study's findings, the following recommendations are proposed:

1. **Establish Robust Institutional Frameworks:** Implementing comprehensive frameworks to harmonize AI policies across national security and economic domains will ensure coordinated and effective use of AI technologies.
2. **Enhance Transparency and Accountability:** Developing clear guidelines and standards for AI implementation will foster public trust and ensure the ethical use of AI in decision support systems.
3. **Invest in AI Training and Education:** Providing training for policymakers and security personnel on the use of AI technologies will enhance the effective adoption and utilization of AI systems.
4. **Promote Collaborative Efforts:** Encouraging collaboration between national security agencies and economic policymakers will leverage AI's full potential in enhancing both security and economic stability.



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5. **Continuous Evaluation and Improvement:** Regular assessment of AI systems' performance and impact will help identify areas for improvement and ensure that the technologies remain effective and relevant.



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INSECTICIDAL ACTIVITY OF ESSENTIAL OIL ISOLATED FROM THE DRIED LEAVES OF CITRUS TANGELO

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ABSTRACT

In recent years the quest for environmental friendly products have been over emphasized and this gospel is needed so that the influx rate of chloroflourocarbons (CFCs) can be reduced to the barest minimum. Hence, a need to think outside the box on how to use organic related compounds to combat insects. The study was aimed at using essential oils gotten from the dried leaves of Citrus Tangelo against an adult maize weevil. The extracted oil was trans esterified. The chemical properties of the oil were determined. The oil gave 0.10% (w/w) yield. The oil was characterized using Gas Chromatography - Mass Spectrometry (GC/MS) technique. The GC-MS result revealed fifteen (15) hydrocarbon and oxygenated mono and sesquiterpenoids that constituted 63.3% of the oil. The most predominant in the oil was linalool (36.5%). Other major terpenoids detected include; Sabinene (25.8%), β -Ocimene (16.1%) and β -Pinene (3.2%). Essential oils that were detected in significant amounts were β -Myrcene (2.7%), γ -Terpinen (2.1%), Ocimene (1.6%), and α -Terpinen (0.9%). The oil constituted 49.3% hydrocarbon monoterpenoids (16.1% β -Cymine, 0.9% α -Terpinen, 2.7% β -Myrcene, 3.2% β -pinene, 0.6% α -thujene, and 25.8% sabinene) and 37.8% oxygenated monoterpenoids (0.1% citronellol, 0.2% terpineol, 0.6% 4-carvomethenol, 36.5% linalool and 0.1% 2-p-methen-1-ol) and 3.6% sesquiterpenoids (0.1% α -humulene, 0.4% isocaryophyllene, β -elemene, and 2.1% γ -terpinen). The oil showed insecticidal property against adult maize weevil. Hence the oil could be used as an alternative to synthetic chemicals for a safer and cheaper insecticide after meeting the requirements in clinical trial.

KEYWORDS: Chloroflourocarbon, Gas Chromatography-Mass Spectrometry, Essential oils, Hydrocarbons.



1.0 INTRODUCTION

Volatile components obtained by the secondary metabolism of aromatic and other variety of plant are called Essential oils (Ali and Seid., 2020). They are usually isolated from plant parts through steam distillation or hydro-distillation methods to obtain a fragrant mix of compounds. The constituents of essential oils are usually the volatile terpenes and hydrocarbons (Xirley et al., 2012). Essential oils have also accounted for the potency of ancient traditional medicinal agent. There are 33 accounted species of Citrus worldwide and each varies in the constituents of essential oil profile (Khanikor et al., 2021). Aside from the nutritive value of citrus fruit it also has great industrial value which is recognized globally and this value is present in citrus plant part as well (root, stem and leave) (khanikor et al., 2021). Citrus material are endowed with terpenoids and phenolics which plays an invaluable position in plant/fruit defense against biotic and abiotic stress situations (Hussein and El-Anssary., 2018). Also secondary metabolites plays a vital role in the defense mechanism against pest and pathogens other important roles of secondary metabolites are Allelopathy and causing an attraction for beneficial insects suitable for pollination and seed dispersal (Hussein and El-Anssary., 2018).

2.0 LITERATURE REVIEW

Citrus is a genus of flowering trees and shrubs in the rue family, “*Rutaceae*”. Citrus fruits, including significant crops like oranges, lemons, grapefruits, pomelos, and limes, are produced by plants in the genus. South Asia, East Asia, Southeast Asia, Melanesia, and Australia are the natal regions of the genus Citrus. Indigenous populations in these regions have long utilized and cultivated a variety of citrus species (Wu *et al.*, 2018). Citrus species have undergone extensive hybridization and introgression, making it difficult to pinpoint exactly when and where domestication originally took place. According to Wu *et al.*'s (2018) genomic, phylogenic, and biogeographical analyses, the southeast foothills of the Himalayas, in an area extending from eastern Assam to western Yunnan, are most likely the location of the genus Citrus' center of origin. According to Wu *et al.* (2018), it split off from a shared ancestor with Poncirus trifoliata.

One of the most significant fruits, citrus is mainly consumed fresh and has been utilized as a herbal supplement, food ingredient, and food. It is widely known that certain of the elements in citrus fruit enhance health and offer protection against chronic disease. Citrus fruit and juices have long been valued components of a healthy and nutritious diet. Citrus has been implicated in the prevention of cancer and degenerative diseases due to its bioactivities, which include antioxidant, anti-inflammatory, and antibacterial effects. Citrus has those bioactivities because it contains bioactive compounds like vitamins, phenolics, flavonoids, and essential oils (Karimi *et al.*, 2012).

3.0 MATERIALS AND METHOD

3.1 Sample collection and preparation



Fresh leafs of *Citrus Tangelo* were harvested at the botanical garden of University of Ilorin, Kwara state, Nigeria. The leaves were identified at the Herbarium of the Department of plant biology, University of Ilorin, Nigeria where the specimen was deposited. The peels of the citrus fruit were dried for three days and removed physically. 500g of dried leafs of *Citrus tangelo* were hydro-distilled for 3 hours in a Clevenger-type apparatus in accordance with the British pharmacopoeia method (British pharmacopoeia, 1981). To obtain much quantity the procedure was repeated and the extracted oil was preserved in a sealed glass sample bottle and stored under refrigeration for further analysis. A Hewlett Packard (HP 5890A) GC interface with a VG Analytical 70-250S double focusing mass spectrometer was used as the carrier gas at 1.2ml/min. The MS operating conditions were: ionization voltage 70 ev and ion source temperature 230 °C. The GC was fitted with a 25 mm × 0.25 mm fused silica capillary column coated with CP-Sil 5 and the film thickness was 0.15 mm. The GC Operating conditions were identical with those of GC analysis. The percentage composition of the oil were computed in each case from GC peak areas. The identification of the components was based on the retention indices (determined relative to the retention times of series n-alkanes) and mass spectra with those of authentic samples and with data from literature.

Maize weevil (*Sitophilus zeamais*) adults were obtained from heavily infested maize. They were reared on a clean maize in a plastic container and maintained under ambient environmental to prevent escape of the insects. The contact toxicity of essential oils from dried leaves of *Citrus tangelo* on adult *Sitophilus zeamais* was tested for 24 hours. Different volume of the oil (10ml, 20ml, 30ml) were separately mixed with 1g of clean, uninfested maize grains inside a 4cm diameter plastic container. Ten newly emerged adult *Sitophilus zeamais* were introduced into the essential oil coated maize. Each treatment was replicated 3 times. A control experiment without the oil was also set up. Adult mortality was observed at 1 hour, 2 hours, 6 hours, and 24 hours. The experiment were laid out in a completely randomized design. Treatment means were subjected to one-way ANOVA while mean separation was done using the Duncan Multiple Range Test at 5% level of significance.

4.0 RESULTS AND DISCUSSION

4.1 Chemical composition of the essential oils of *Citrus tangelo*

Table 1. Shows the chemical composition, kovats retention indices, and identities of constituents of essential oil from dried leaf of *Citrus tangelo*. In the Table, 15 compounds that represented 63.3% of the oil were identified from their mass spectra. Linalool (36.5%) was the most abundant oxygenated monoterpenoids identified. 4-Carvomethenol (0.6%), citronellol (0.3%), and terpineol (0.2%) were oxygenated monoterpenoids that were detected in significant quantities. citronellol (0.1%) and 2-p-methen-1-ol (0.1%) were present in minor quantities.

4.2 Insecticidal activity of *Citrus tangelo*



Table 2. Shows that the percentage of mortality of adult *Sitophilus zeamais* was observed to increase with increase in time of exposure to the oil at the end of 1 hour of exposure, different volume of the oil caused 100% mortality of adult *Sitophilus zeamais*. However, no mortality was observed in the control experiment. At 1 hour, control T₀ (0) mortality, treatment T₁₀ (16.6) mortality T₂₀ (36.6) mortality and T₃₀ (0.0) mortality were significantly different ($P < 0.05$). At 2 hours, control and treatment T₀ (0) mortality, T₁₀ (43.3) mortality, T₂₀ (66.6) mortality and T₃₀ (0.0) mortality were significantly different ($P < 0.05$). At 6 hours, control and treatment T₀ (0) mortality and T₁₀ (66.6) mortality were significantly different, T₀ (0) mortality and T₂₀ (66.6) mortality were significantly different, and T₃₀ (0.0) were not significantly different ($P=0.05$), T₂₀ (66.6) mortality and T₃₀ (0.0) mortality were not significantly different ($P = 0.05$) and T₁₀ (66.6) mortality and T₂₀ (66.6) mortality were not significantly different ($P = 0.05$). At 24 hours, T₀ (0) and T₁₀ (66.6) were significantly different T₀ (0) mortality and T₂₀ (66.6) mortality were significantly different T₀ (0.0) mortality and T₃₀ (0.0) mortality were significantly different ($P < 0.05$). T₁₀ (66.6) mortality, T₂₀ (66.6) mortality and T₃₀ (0.0) mortality were not significantly different ($P = 0.05$).

Table 1: Percentage (%) Mortality of Adult Maize Weevil by leaves of Essential Oil of *Citrus tangelo* at 1h, 2h, 6h and 24h Exposure Period

Treatment	1 hour	2 hours	6 hours	24 hours
T ₀	0.0a	0.0a	0.0a	0.0a
T ₁₀	16.6a	43.3a	66.6a	66.6a
T ₂₀	36.6a	66.6a	66.6a	66.6a
T ₃₀	0.0a	0.0a	0.0a	0.0a

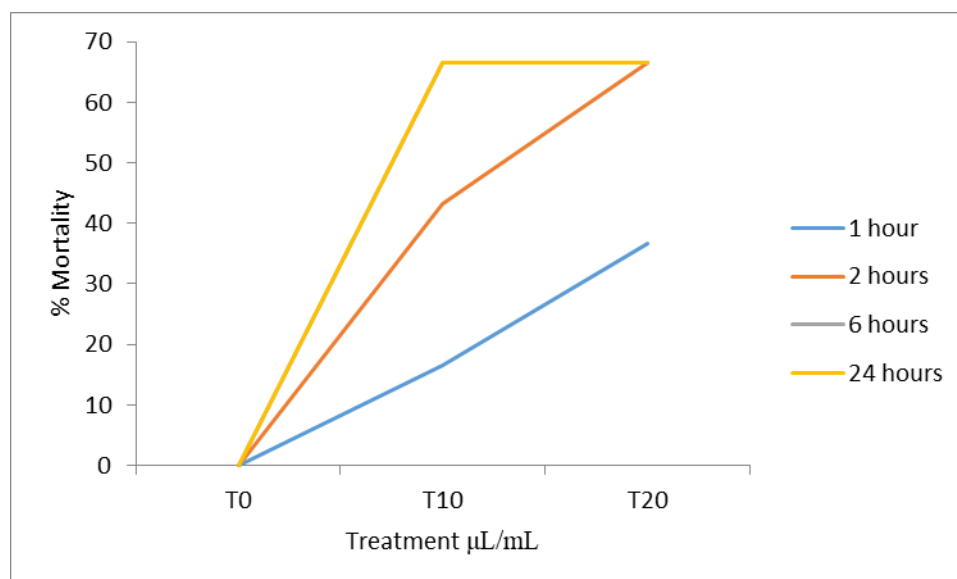




Fig.1: Mortality of Adult *Sitophilus zeamais* after being treated with the essential oil at different time of Exposure.

5.0 CONCLUSION

The most abundant compound in the oil was linalool. β -ocimene, O-cymene, β -myrcene and γ -terpinene were other major compounds in the oil, irrespective of time of exposure, the oil showed contact toxicity against adult maize weevil. The oil could serve as alternative to synthetic insecticide for a cheaper, safer and readily accessible insecticide after clinical trial.



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APPENDIX

Table 1. Chemical Composition (%) of Essential Oil from Dried leaves of *Citrus tangelo*

S/N	Compound	% Composition	KI	MS Data
1	α -Humulene	0.1	1579	55,67, 93 , 121,175
2	Isocaryophyllene	0.4	1494	27, 41 , 69,93,161
3	β -Elemene	1.0	1398	41,68, 81 , 93,175
4	Citronellol	0.1	1179	27, 41 , 55,95,109
5	Terpineol	0.2	1143	41, 43, 59 , 93, 121
6	- Carvomethenol	0.6	1137	27, 69, 71 , 111, 136
7	(R)- (+) Citronellol	0.3	1125	27, 41 , 69, 121, 139
8	Linalool	36.5	1082	41, 69, 71, 93, 140
9	Terpinolene	0.4	1052	39, 53, 93 , 105, 121
10	O- Cymene	1.6	1042	51, 77, 103, 119 ,134
11	2-p-Menthen-1-ol	0.1	1109	27, 41, 43 , 69, 139
12	α -Terpinene	0.9	998	27, 43, 65, 121 , 136
13	γ -Terpinen	2.1	998	27, 43, 93 ,105, 121
14	β -Ocimene	16.1	976	27, 49, 93 , 105,121
15	β -Myrcene	2.7	958	12, 27, 41 ,53, 79
	Total (%)	63.3		



EFFECTS OF *BRYOPHYLLUM PINNATUM* LEAF EXTRACT ON SOME SERUM BIOCHEMICAL PARAMETERS IN DIABETIC RATS

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ABSTRACT

Bryophyllum pinnatum, a medicinal plant commonly known as Never die plant or Miracle plant has been reported to possess many pharmacological activities. This study investigated the effects of *B. pinnatum* leaf extract on some serum biochemical parameters in diabetic rats. Fifteen (15) Wistar rats weighing about 150 g to 200 g were used for the study. They were randomly distributed into five (5) groups of three (3) animals each: normal control, diabetic control, standard control (treated with 100 mg/kg Metformin), and diabetic groups treated with 200 and 400 mg/kg body weight of the extract respectively. Diabetes was induced in the rats by administering Alloxan monohydrate (150 mg/kg) intraperitoneally. The oral administration of the extract lasted for seven (7) days. The result showed a significant ($p < 0.05$) decrease in total cholesterol (TC), triglyceride (TAG), and low-density lipoprotein (LDL), and a significant ($p < 0.05$) increase in high-density lipoprotein (HDL) in the treated groups when compared to the diabetic control. There was a significant ($p < 0.05$) decrease in total protein (TP) and creatinine concentrations, and a significant ($p < 0.05$) increase in alanine aminotransferase (ALT) and urea concentrations in the groups that received graded doses of the extract when compared to the diabetic control. In conclusion, this study revealed that *B. pinnatum* leaf extract possesses cardio-protective properties, and thus can reduce the risk of cardiovascular diseases. However, the significant increase in ALT activity indicated its potential hepatotoxicity.

Keywords: *Bryophyllum pinnatum*, diabetes, cardio-protective, alloxan, hepatotoxicity



1.0 INTRODUCTION

Drug discovery according to Zhou & Zhong (2017) is the process by which new therapeutic materials are recognized using a combination of computational, experimental, translational, and clinical models. Drug development involves preclinical trials on experimental animals, clinical trials using humans, and obtaining the necessary regulatory approval to market the drug (Zhou & Zhong, 2017).

Plants produce numerous bioactive compounds for functions such as defense against insects, fungi, diseases, and herbivores (Gershenzon & Ullah, 2022). Many of these compounds have been reported to possess biological activities. Drug research sometimes uses ethnobotany to search for therapeutic substances, and this method has produced many highly beneficial compounds. Medicinal plants are extensively used in many parts of the world predominantly because they are readily available and cheaper than modern drugs.

Diabetes mellitus commonly referred to as diabetes is a group of metabolic disorders characterized by high blood sugar levels over an extended period (Chidozie et al., 2023). Serious complications may arise after a long period, such as cardiovascular disease, stroke, chronic kidney disease, foot ulcers, nerve damage, and impairment of vision and cognitive function (Saedi et al., 2016). Diabetes is the after-effects of the pancreas not producing enough insulin or the cells not responding appropriately to the insulin produced. Insulin is the hormone responsible for transporting glucose from food into cells to make energy (Shopback & Gardener, 2011).

B. pinnatum is commonly known as miracle plant or never die plant, and is found in Brazil, China, India, Africa, and other tropical countries (Fernandes et al., 2019). The plant is succulent, growing as high as 1.5m, with bell-like flowers and fleshy dark green leaves that are uniquely scalloped and trimmed, and usually four-angled (Elufioye et al., 2002). Cultivation is either by seeds or plantlets (Nagaratna et al., 2015). It has been used in managing diarrhea and vomiting, fever, leishmaniasis, ulcers, hypertension, pain, and inflammation (Da Silva et al., 1995; Ojewole, 2005). Pharmacological activities of *B. pinnatum* earlier reported include antimicrobial, analgesic, anti-ulcer, anti-helminthic, cytotoxic, wound healing, immunomodulatory, antioxidant, anti-diabetic, antihypertensive, diuretic, and uterine contractility (Akinpelu, 2002; Elufioye et al., 2002; Igwe & Akunyili, 2005; Bhatti et al., 2012; Patil et al., 2015). The leaves are often used as an herbal remedy for many ailments, including hypertension, diabetes mellitus, bruises, wounds, boils, abscesses, insect bites, arthritis, rheumatism,



joint pains, headaches, and body pains in Nigeria, and other countries in West Africa (Akpantah et al., 2014; Ezeagu et al., 2017).

This study investigated the effects of *B. pinnatum* leaf extract on lipid profile, and liver and kidney function indices.

2.0 MATERIALS AND METHODS

2.1 Sample Collection and Preparation

Fresh *B. pinnatum* leaves used for this study were obtained from Ikare-Akoko, Ondo State, Nigeria. They were chopped into smaller pieces and air dried at room temperature for five days, and then pulverized using a mortar and a pestle into coarse form, and filtered with a sieve to get a fine powder. This was macerated using 1.5 L of ethanol and allowed to stand for 48 hrs at room temperature, and then filtered with Whatman No. 1 filter paper. The filtrate was concentrated using a rotary evaporator, and the percentage of the leaf extract was determined using the formula;

$$\text{Percentage yield (\%)} = \frac{\text{Weight of extract (g)}}{\text{Weight of Pulverized Sample (g)}} \times 100$$

2.2 Experimental Animals

Fifteen (15) healthy Wistar rats weighing about 150 - 200 g were used for the research, while eighteen (18) mice were used for acute toxicity study. The rats were confined in wooden cages made of iron nets and allowed to acclimatize for one week, during which they were fed with standard rat chow (Livestocks Feeds Nig. Ltd, Ikeja - Lagos) and water *ad libitum*.

2.3 Induction of Diabetes

The albino rats were made diabetic by the intraperitoneal injection of alloxan monohydrate (150 mg/kg bw) with the exception of the normal control group.

2.4 Experimental Design

The animals were randomly divided into five (5) groups of three (3) rats each and labeled as follows: group 1 (normal control), group 2 (diabetic control), group 3 (treated with 200 mg/kg bw of extract, group 4 (treated with 400 mg/kg bw of extract) and group 5 (standard control, treated with 100



mg/kg bw of Metformin). Treatment was administered orally once per day for seven (7) days using normal saline as vehicle.

2.5 Blood Collection

After treatment was concluded, the animals were fasted for 8 hours and then sacrificed using chloroform as anesthesia. Blood samples were collected via tail vein into labeled tubes, and serum was obtained by centrifuging at 400 rpm for 10 minutes (Wisperfuge centrifuge, Model 1384) for analysis.

2.6 Phytochemical Screening and Determination of Serum Biochemical Parameters

The qualitative phytochemical screening was done as described by Harbone (1973), and Trease & Evans (2002). Acute toxicity study was evaluated using the method described by Lorke (1983). Concentrations of total cholesterol, triglyceride, high-density lipoprotein and low-density lipoprotein were determined using methods by Abell et al. (1952), Tietz (1990), Albers et al. (1978), and Friedewald et al. (1972) respectively. Serum levels of Creatinine, total protein, urea, and alanine aminotransferase were evaluated using established protocols by Syal et al. (2013), Nayyar et al. (2012), Kumar & Gill (2018), and Gowda et al. (2009) respectively.

2.7 Statistical Analysis

All data were expressed as Mean $\pm$ SD, and statistical differences between mean were analyzed by one-way ANOVA. Values were considered significant at $p < 0.05$.

3.0 RESULTS AND DISCUSSION

3.1 Results

3.1.1 Phytochemical constituents of *B. pinnatum* leaf extract

Qualitative phytochemical screening of *B. pinnatum* leaf extract as presented in Table 1 showed tannins, glycosides, phenols, alkaloids, saponins, and flavonoids to be present.



Table 1: Phytochemical Constituents of *B. pinnatum* Leaf Extract

Constituent	Leaf extract
Tannins	+
Glycosides	+
Phenols	+
Alkaloids	+
Saponins	+
Flavonoids	+

Key: + = Detected; - = Not Detected

3.1.2 Acute Toxicity Study

The acute toxicity study of the extract indicated zero mortality.

Table 2: Acute Toxicity Profile of *B. pinnatum* leaf extract

Phase I	Dose (mg/kg)	Mortality
Group 1	10	0/3
Group 2	100	0/3
Group 3	1000	0/3



Phase II

Group 1	1600	0/3
Group 2	2900	0/3
Group 3	5000	0/3

n=3

3.1.3 Effect of *B. pinnatum* leaf extract on Lipid Profile

Result of the effect of *B. pinnatum* leaf extract on lipid profile (Table 3) showed a significant reduction in TC, TAG, and LDL, and a considerable increase in HDL for the treated groups when compared with the diabetic control. However, there was a non-significant ($p>0.05$) difference in TAG level for the group that received 200 mg/kg bw extract compared to the standard control.

Table 3: Effect of *B. pinnatum* Leaf Extract on Lipid Profile (mg/dl)

Groups	TC	TAG	HDL	LDL
1	163.67 $\pm$ 2.52 ^d	173.33 $\pm$ 1.53 ^b	32.33 $\pm$ 1.53 ^a	96.00 $\pm$ 2.00 ^c
2	182.00 $\pm$ 3.00 ^e	184.33 $\pm$ 2.52 ^d	39.33 $\pm$ 2.08 ^b	106.00 $\pm$ 2.00 ^d
3	97.00 $\pm$ 2.00 ^a	178.67 $\pm$ 3.06 ^c	48.00 $\pm$ 1.00 ^c	22.00 $\pm$ 1.00 ^a
4	117.00 $\pm$ 2.00 ^b	145.00 $\pm$ 2.00 ^a	51.67 $\pm$ 2.08 ^d	37.00 $\pm$ 1.00 ^b
5	156.00 $\pm$ 2.00 ^c	145.00 $\pm$ 2.51 ^a	36.33 $\pm$ 1.53 ^b	91.00 $\pm$ 2.00 ^c

Values are expressed as mean $\pm$ SD, (n=3). Values in the same column having different superscripts differ significantly ($p<0.05$).

3.1.4 Effect of *B. pinnatum* leaf extract on liver and kidney function indices

Result of the effect of *B. pinnatum* leaf extract on liver and kidney function indices (Table 4) revealed a significant decrease in TP and Creatinine concentrations for the groups that received graded doses of the extract when compared with the diabetic control. There was a considerable



increase in ALT and Urea concentrations for the groups treated with the extract when compared with the diabetic control.

Table 4: Effect of *B. pinnatum* leaf extract on Liver and Kidney Function indices

Groups	ALT (U/L)	TP (g/L)	Urea (mg/dL)	Creatinine (mcmol/L)
1	15.37±0.67 ^a	67.33±1.53 ^b	6.30±0.56 ^a	88.67±4.73 ^{ab}
2	17.30±0.95 ^b	73.33±3.21 ^c	7.80±0.60 ^b	102.67±4.73 ^c
3	22.67±0.80 ^c	58.67±2.08 ^a	10.33±0.55 ^c	88.67±3.06 ^{ab}
4	26.20±0.95 ^d	55.33±1.53 ^a	12.73±0.55 ^d	90.33±2.52 ^b
5	17.67±1.17 ^b	65.00±2.65 ^b	7.13±0.32 ^{ab}	82.33±2.52 ^a

Values are expressed as mean ± SD, (n=3). Values in the same column having different superscripts differ significantly (p<0.05).

3.2 Discussion

Qualitative phytochemical screening of *B. pinnatum* leaf extract (Table 1) revealed the presence of tannins, glycosides, phenols, alkaloids, saponins, and flavonoids as earlier reported by Aprioku & Igbe (2017). Nwali et al. (2014) also reported that the plant contains bioactive substances such as alkaloids, flavonoids, saponins, and tannins. These bioactive substances are known for their anti-carcinogenic, anti-inflammatory, anti-diabetic, and anti-microbial activities. They provide humans with numerous health benefits as medicinal nutrients and ingredients (Hasler & Blumberg, 1999). The acute toxicity profile (Table 2) showed that the extract is non-lethal.

According to Ezeagu et al. (2017), changes in lipid profile are reportedly associated with diabetes thereby increasing the risk of coronary heart disease. The result of the effect of *B. pinnatum* leaf extract on lipid profile (Table 3) showed that the extract substantially decreased the serum concentrations of total cholesterol, triglyceride, and low-density lipoprotein, with a significant (p<0.05) increase in high-density lipoprotein concentration in the treated groups compared to the diabetic control. The result confirmed the hypolipidemic activities of the extract, thus corroborating



the findings of Ezeagu et al. (2017). As reported by Ei-soud et al. (2007), an abnormal surge in the levels of low-density lipoprotein, triglyceride, and total cholesterol is primarily a result of the spontaneous activities of lipolytic enzymes on the fat depot in response to low levels of insulin.

B. pinnatum leaf extract produced a significant reduction in total protein and creatinine concentrations, with a substantial increase in ALT and urea concentrations for the groups that received graded doses of the extract compared to the diabetic control. The effect of the extract on urea and creatinine is not substantiated by the report of Chidozie et al. (2023), which revealed a non-significant ($p>0.05$) difference in the treatment groups compared to the diabetic control. However, they reported a significant decrease in ALT for the treated groups compared to the diabetic control. A significant surge in liver enzymes concentrations is an indication of cellular leakage and hepatic cell damage (Imo et al., 2013), which may be a result of the alloxan altering key liver functions (Chidozie et al., 2023).

4.0 CONCLUSION

In conclusion, this study revealed that *B. pinnatum* leaf extract possesses cardio-protective properties. However, usage should be discouraged in patients with underlying health conditions associated with the liver because of its potential hepatotoxicity.



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CARDIAC ANTIOXIDANT AND CREATINE KINASE IN RATS ADMINISTERED POLYALTHIA LONGIFOLIA LEAVE EXTRACT

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ABSTRACT

This research work investigated the phytochemical composition of *Polyalthia longifolia* leaf extract and its antioxidant effect on cardiac parameters of Wistar albino rat. Phytochemical screening of *P. longifolia* leaves revealed the presence of saponins, flavonoids, tannins, phenolics, alkaloids, anthraquinones cardiac glycosides, steroids, phlobatannins and cardiac glycosides, while terpenoids were not detected. Fifteen (15) Wistar Albino rats (Average weight 120g) were randomized into three (3) groups which includes; Group A- control were administered distilled water; B and C administered 25mg/kg body weight (bw) and 50mg/kg body weight (bw) of *Polyalthia longifolia* leaf extract. The administered doses lasted for 14 days. Results obtained showed that *Polyalthia longifolia* leaf extract at a concentration (50mg/kg bw) caused significant increase in weight as compared with control group. Measurement of antioxidants parameters in heart homogenate shows that *Polyalthia longifolia* significantly increase superoxide dismutase and catalase while there is depletion in Glutathione and Thiobarbituric Acid, TBARS. Result also indicate that serum creatine kinase (CK) was significantly increased in rats administered with *Polyalthia longifolia* leaf extract compared to the control group. It can be concluded in this study that *Polyalthia longifolia* leaf extract contains useful phytochemicals of medicinal importance. The extract also boosted antioxidants which is an indication that the extract can be used in the prevention of oxidative stress in the heart. The extract can be used in the treatment of heart diseases arising from oxidative stress. However, the observed increase in CK might indicate mild toxicity to cardiac tissues.

Keywords: *Phytochemical screening; Polyalthia longifolia, Creatine kinase; Glutathione; Thiobarbituric Acid, TBARS.*



1.0 INTRODUCTION

The utilization of traditional medicine in the cure of diseases is as old as man. Despite the improvement made by man in the production of pharmaceutical drugs, the decreasing effectiveness of synthetic drugs and the increasing contraindications of their usage, make the continued use of plants as important sources of medicinal agents (Petrovska et al., 2012). Traditional medicine is the sum total of the knowledge, skills and practices based on the theories, beliefs and experiences indigenous to different cultures used in the maintenance, prevention, diagnosis, improvement or treatment of illnesses (WHO, 2005). *P. longifolia* var. *pendula* of the (Annonaceae) family are mostly found in the tropical regions. Various parts of the plant have been used in traditional system of medicine such as the cure of fever, skin diseases, diabetes, hypertension and helminthiasis (Katkar et al., 2010). Several bioactive compounds are found in the leaves, stem and stem bark of the plant such as aporphine and azafuorene alkaloids (Wu et al., 1990). It is a type of flowering plant found in tropical and subtropical regions, including South Asia, South East Asia, and Australia (Chatrou et al., 2012). In India, the *Polyalthia longifolia* is also called Ashoka or Indian mast tree due to its special appearance and it is called ‘Masquerade Tree’ in Nigeria (Li et al., 2009; Folashade et al., 2018). Scientific reports on leaves, bark, stem bark, root, twigs, and seeds of *Polyalthia* have revealed numerous biological and pharmacological activities with chemo-preventive potentials, such as anti-bacterial (Marthanda Murthy et al., 2005; anti-viral (Kanokmedhakul et al., 2007); anti-plasmodial (Misra et al., 2010); anti-fungal (Bhattacharya et al., 2015); anti-inflammatory (Bermejo et al., 2019); anti-cancer effects (Yao et al., 2019) and anti-ulcer (Duan et al., 2020)

2.0 MATERIALS AND METHODS

2.1 Chemicals and Reagents

All reagents used in this research are of analytical grade and they were prepared in the laboratory.

2.2 Collection and Preservation of Plant Materials

P. longifolia leaves were collected from Isale-Osun Area of Osogbo, Osun State, Nigeria. The leaves were air-dried to a constant weight at room temperature for 8 weeks. The leaves were milled into powdery form and stored in air tight container.



2.3 Preparation of Leaf Extract

400 g of the powdered sample was dissolved in 2.4 litres of 98% absolute ethanol to extract the phytochemicals present in leaves sample and soaking was done for 14 days after which the extract was filtered using a white muslin cloth. The mixture of ethanol and the leaves extract was poured into an open plastic for 4 days to the evaporation of ethanol.

2.4 Management of Experimental Animals

Fifteen (15) healthy male Albino rats with average weight of 120 g obtained from the Animal house, Physiology department, College of Health Sciences, Osun State University, Osogbo, Osun State, Nigeria, were kept in a well-ventilated plastic cage at normal atmospheric pressure and humidity, for 12 hours day cycle and 12 hours dark cycle in central Animal house, Osun State University, Osogbo. The cages were cleaned twice daily and the animals were fed with rat pellets and water ad-libitum. The experimental rats were acclimatized for 7 days before administration of *Polyalthia longifolia* leaf extract. The rats were sorted into three groups of five (5) rats each as follows:

Group A (control group) – Administered distilled water.

Group B – Administered 25mg/kg bw *Polyalthia longifolia* leaf extract.

Group C – Administered 50mg/kg bw *Polyalthia longifolia* leaf extract.

The extract was administered orally using orogastric oral canular for a period of fourteen (14) consecutive days.

2.5 Preparation of Serum

At the end of the experimental process, the rats were sacrificed using anesthetics. The jugular vein was cut and blood collected into plain bottles, the blood was left to clot and further centrifuged at 3000rpm for 10 minutes.

2.6 Preparation of Heart Homogenate



The rats were quickly dissected and the heart removed and rinsed with 1.15% potassium chloride (KCl). The excised organ was weighed and homogenized in five (5) volume 0.1M Phosphate Buffer (7.4 P_H) solution using a Teflon homogenizer. It was then centrifuged at 3000rpm for 15 minutes and the supernatant were stored at -4°C.

2.7 Phytochemical Screening

Phytochemical test was carried out on the extract following the methods described by Trease and Evans (1989) and Harborne (1973).

2.8 Measurement of antioxidant in Heart Homogenate

2.8.1 Measurement of Catalase Activity

Catalase activity was determined according to the method of Claiborne (1985). Hydrogen peroxide (2.95ml of 19mM solution) was pipetted into a 1cm quartz cuvette and 50µl of sample added. The mixture was rapidly inverted to aid mix and placed in a spectrophotometer. Change in absorbance was read at 240nm every 30 seconds for 150 seconds. The catalase activities of the samples were calculated using this formular:

Calculations

Catalase Activity = $\Delta A_{240} / \text{min} \times \text{reaction volume} \times \text{dilution factor}$

$0.0436 \times \text{sample volume mg protein ml} = \mu\text{mol H}_2\text{O}_2 / \text{min} / \text{mg protein.}$

2.8.2 Measurement of Superoxide Dismutase (SOD) Activity

The level of SOD activity was determined by the method of Misra and Fridovich, (1972). 50µl of sample was added to 2.5ml of 0.05M carbonate buffer (pH 10.2) to equilibrate in the spectrophotometer and the reaction started by the addition of 0.3ml of freshly prepared 0.3M epinephrine to the mixture which was quickly mixed by inversion. The reference cuvette contained 2.5ml buffer, 0.3ml of substrate (adrenaline) and 50µl of water.

3.8.3 Measurement of GST Activity

GST catalyzes the conjugation of L-glutathione to CBNB through the thiol group of glutathione.

$\text{GSH} + \text{CDNB} \longrightarrow \text{GS} - \text{DNB Conjugate} + \text{HCl}$



The reaction product, GS – DNB conjugate, absorbs at 340 nm.

2.8.4 Determination of Lipid Peroxidation (TBARS or MDA)

The level of lipid peroxidation in the tissue was measured as malondialdehyde (MDA) according to the method of Ohkawa et al., (1979)

2.8.5 Measurement of Serum Creatinine Kinase (CK) Activity

Creatine kinase activity was measured using the method of Di Witt and Trendelenburg (1982).

20µl serum was added to 1ml of the working reagent (enzyme substrate and buffer). Absorbance was read after every 60 seconds up to 180seconds at 340nm

2.8.6 Statistical Analysis

Data obtained were expressed as standard deviation (S.D) of five determinations. The data were expressed as a standard deviation of five (5) determinations. The data were analyzed by analysis of variance (ANOVA). P values less than 0.5 were considered significant.

3.0 Results and Discussions

The result of the qualitative analyses carried out on the aqueous extract of *P. longifolia* leaves revealed the presence of saponins, flavonoids, tannins, phenolics, alkaloids, anthraquinones cardiac glycosides, steroids, phlobatannins and cardiac glycosides, while terpenoids were not detected as shown in (Table 1)

Table 1.0: Phytochemical constituent of *Polyalthia longifolia* leaf

Phytochemicals	Inference
Saponins	+
Flavonoids	+
Tannins	+
Alkaloids	+



Anthraquinones	+
Steroids	+
Cardiac glycosides	+
Phlobatannins	+
Phenolics	+
Terpenoids	

+= Present

=Absent

Table 2.0 indicate weight gain of rats in different groups of the experiment. From the table below it can be seen that rats administered 50mg/kg bw gained more weight compared with other group.

Table 2.0: Weight changes in experimental rats

Group	Initial weight (g)	Final weight (g)	Weight Gain (g)
A	115.3 ± 23.5	160.8 ± 33.1	45.5
B	116.5 ± 25.0	161.8 ± 32.3	45.3
C	115.1 ± 18.5	172.8 ± 16.9	57.7

The activity of Superoxide Dismutase (SOD) in Heart Homogenate of rats administered Polyalthia longifolia leaf extract, the result shows that SOD activity in the heart of rats administered Polyalthia longifolia leaf extract significantly increased compared to the control group.

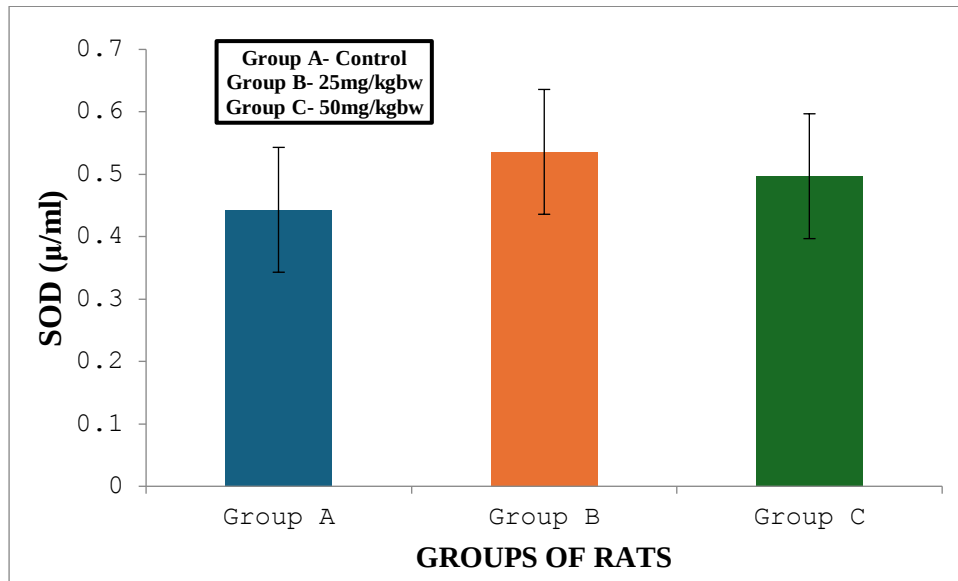


Figure 1.0: Activity of Superoxide Dismutase (SOD) in heart homogenate of rats administered *Polyalthia longifolia* leaf extract

The activity of catalase in Heart Homogenate of rats administered *Polyalthia longifolia* leaf extract, the result shows that catalase activity in the heart of rats administered *Polyalthia longifolia* leaf extract significantly increased compared to the control group.

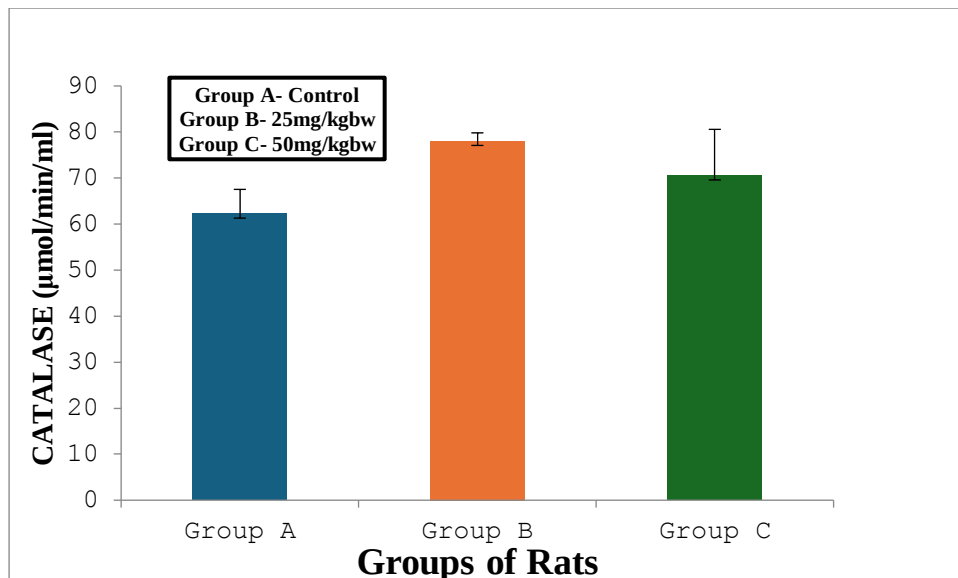


Figure 2.0: Activity of Catalase in heart homogenate of rats administered *Polyalthia longifolia* leaf extract.



The activity of Glutathione-S-Transferase in Heart Homogenate of rats administered Polyalthia longifolia leaf extract, the result shows that Glutathione-S-Transferase activity in the heart of rats administered Polyalthia longifolia leaf extract significantly reduced compared to the control group.

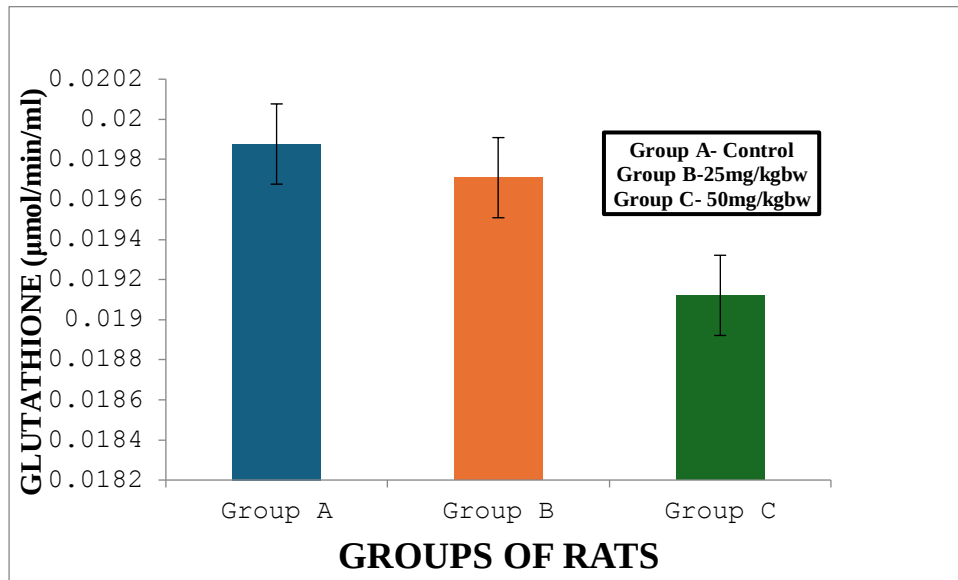


Figure 3.0: Activity of Glutathione (GST) in heart homogenate of rats administered Polyalthia longifolia leaf extract

The concentration of TBARS in Heart Homogenate of rats administered Polyalthia longifolia leaf extract, the result shows that TBARS concentration in the heart of rats administered Polyalthia longifolia leaf extract significantly reduced compared to the control group

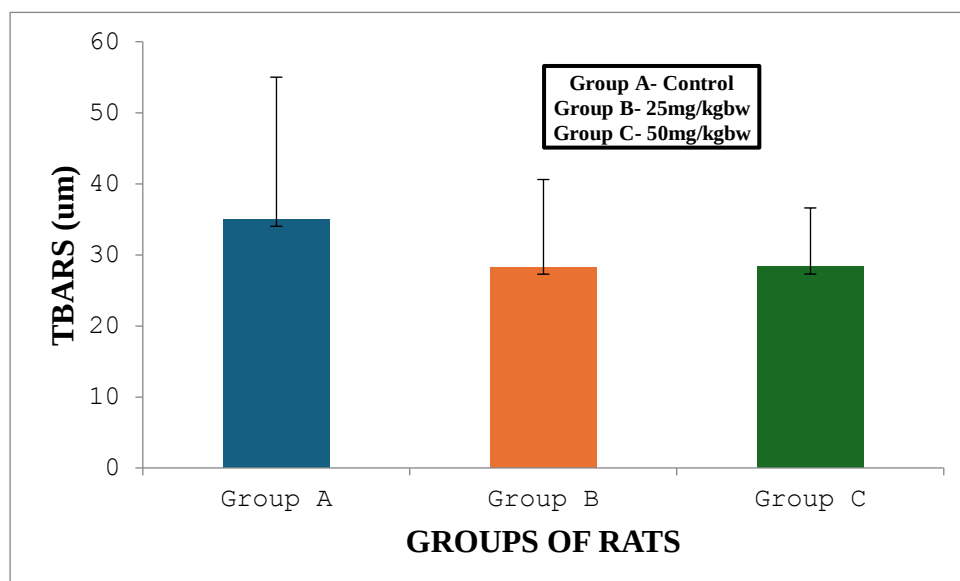




Figure 4.0: Concentration of ThioBarbituric Acid Reactive Substance (TBARS) in heart homogenate of rats administered Polyalthia longifolia leaf extract

The activity of Creatine Kinase in serum of rats administered Polyalthia longifolia leaf extract, the result shows that Creatine kinase activity in the serum of rats administered Polyalthia longifolia leaf extract significantly reduced compared to the control group.

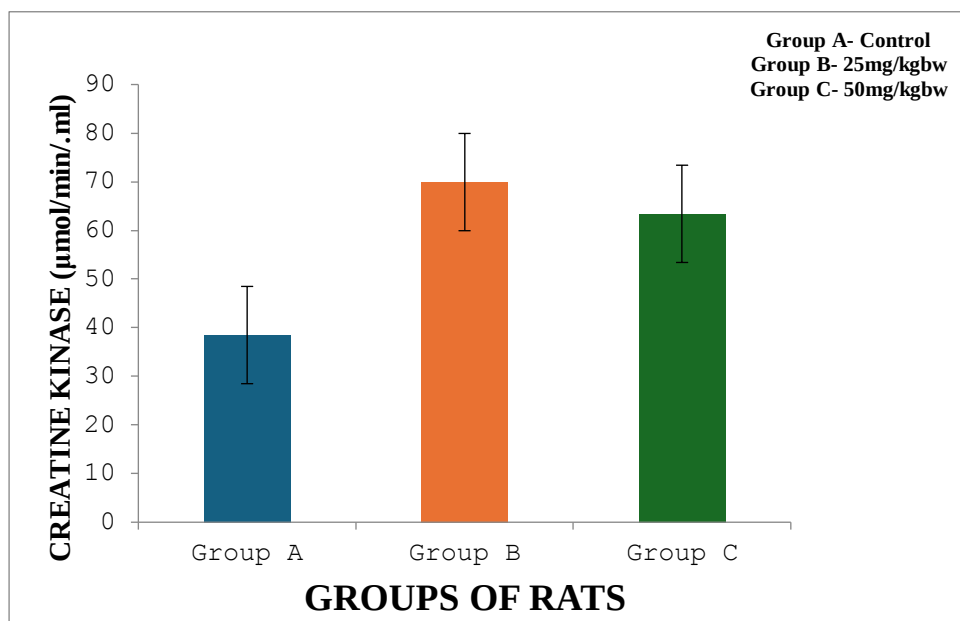


Figure 5.0: Activities of Creatine Kinase in the Serum of rats administered Polyalthia longifolia leaf extract

Discussion of Results

Phytochemical Composition

Phytochemicals are biologically active compounds, found in plants in small amounts, which are not established as nutrients nevertheless contribute significantly to protection against degenerative diseases (Loliger, 1991; Omale and Okafor, 2008). Alkaloids are the most efficient therapeutically significant plant substances commonly found to have antimicrobial properties due to their ability to intercalate DNA of the microorganisms (Kasolo et al., 2010). Analgesic, bactericidal and antispasmodic effects have all been attributed to alkaloidal composition in plants (Ganellin and Roberts, 1993; Babajide et al., 1999). The presence of alkaloids may be attributed to the acclaimed antibacterial property (Faizi et al., 2003ab; Faizi et al., 2008) of this plant. Tannins have been suggested to be involved with antibacterial and anti-viral activity while tannins and flavonoids are



thought to be responsible for antidiarrheal activity (Adisa et al., 2004; Enzo, 2007; Adisa et al., 2010). Saponins are known to possess both antimicrobial (Soetan et al., 2006) and anti-inflammatory activities (Hassan et al., 2012). Studies have also reported the beneficial effects of saponins on blood cholesterol levels and stimulation of the immune system (Cheeke, 2000). Flavonoids have been shown to have antifungal activity in vitro (Galeotti et al., 2008). The potent antioxidant activity of flavonoids reveals their ability to scavenge hydroxyl radicals, superoxide anions and lipid peroxyl radicals; this may be the most important function of flavonoids (Alan and Miller, 1996). They also induce mechanisms that may kill cancer cells and inhibit tumor invasion (Williams et al., 2004). The flavonoids present may be responsible for the medicinal properties accorded the plant (Chen et al., 2000; Faizi et al., 2003; Saleem et al., 2005; Chang et al., 2006). The cardiac glycosides have therapeutic ability to increase the force and rate of heart beat without increase in the amount of oxygen required by heart muscles. They can thus increase the efficiency of the heart and at the same time stabilize excess heart beats without strain to the organ (David, 1983). These chemical components found in the aqueous extract of this plant may therefore may be responsible for the claimed therapeutic effect and is also an indication of preliminary validation of the claims. Alkaline phosphatase in tissues and blood are marker enzymes which are used to assess the integrity of the cell membrane, cytosolic activity and cell death (Akanji et al., 1993).

Growth pattern of experimental rats

Figure 2 shows the growth curve of rats from days 0-14, results obtained indicates that there was growth elevation in rats administered with 25mg/kg bw and 50mg/kg bw *Polyalthia longifolia* leaf extract. The growth might be as a result of increased appetite efficient absorption and presence of saponins in the leaf which serves to enhance nutrient absorption and aid animal digestion and it also kills microbes or fungi. The presence of saponins also enhances feed efficiency and good appetite.

Antioxidants status in the heart

In Figure 1 Group B and C showed significant increase in superoxide dismutase concentration when compared to group A. Superoxide dismutase is an enzyme found in all living cells. Superoxide dismutase is used for [treating pain](#) and swelling (inflammation) caused by [osteoarthritis](#), [sports injuries](#), and [rheumatoid arthritis](#). Superoxide dismutase is also given as a shot for improving tolerance to [radiation](#) therapy, improving rejection rates in [kidney](#) transplantation, and minimizing [heart](#) damage caused by [heart attacks](#).



The increase in catalase activity by the administration of *Polyalthia longifolia* leaf extract as seen in figure 2.0 might be due to physiological response to oxidative stress. It is well known that reactive oxygen species (ROS) formed in vivo, such as superoxide anion, hydroxyl radical and hydrogen peroxide, are highly reactive and potentially damaging transient chemical species. (Halliwell, 1996: 32 Madhavi et al., 1996).

Figure 3.0 shows the reduced concentration of Glutathione in rat administered 25 and 50 mg/kg bw *Polyalthia longifolia* leaf extract. Glutathione (GSH) is often referred to as the body's master antioxidant. The highest concentration of glutathione is in the liver, making it critical in the body's detoxification process. Glutathione is also an essential component to the body's natural defense system.

From figure 4.0, TBARS is an organic compound with the formula $\text{CH}_2(\text{CHO})_2$, it is found in human and animal tissue as an end-product of lipid peroxidation. This reactive species occurs naturally and is a marker for oxidative stress. *Polyalthia longifolia* leaf extract reduces the concentration of TBARS level. Malondialdehyde is a reactive and potentially mutagenic (Hartman, 1983).

Figure 5.0 shows increase in Creatine kinase concentration in rats administered 25 and 50mg/kg bw (group B and C) compared to rats administered distilled water (group A) which is the control group. Clinically, creatine kinase is assayed in blood tests as a marker of damage of CK-rich tissue such as in myocardial infarction (heart attack), rhabdomyolysis (severe muscle breakdown), muscular dystrophy, autoimmune myositides, and acute kidney injury (Moghadam-Kia et al., 2016).

4.0 CONCLUSION

It is seen in the result obtained from this research that *Polyalthia longifolia* leaf extract contains phytochemicals which might have led to increase in appetite in experimental animals. The leaf extract might be used to tackle oxidative stress due to the phytochemical components it possess but might also cause damage to the heart, skeletal muscle diseases and disorders including malignant hyperthermia and neuroleptic malignant syndrome.



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KRUSKAL WALLIS ANALYSIS OF SYSTOLIC BLOOD PRESSURE AMONGS PATIENTS ATTENDANT, A CASE STUDY OF GENERAL HOSPITAL IDAH

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Abstract

The paper titled Kruskal wallis analysis of the systolic blood pressure among patients attendance determines if there was significant difference between the median blood pressure ratings across the four age groups, 20-30, 40-50, 50-60, 60-70 Source of data collection was a secondary on a sample of twenty patients from the general hospital Idah. The result of the analysis indicated that the calculated value $H = 17.86$ is $> \chi^2_{critical\ value} = 11.3$ and 7.81 at 1% and 5% respectively, also results from Pvalue $0.000 < 0.05$, which indicated statistical significant difference between the median blood pressure ratings across the four age groups that the median blood group ratings across the four age groups were not the same. A positive Z value 1.09 and 3.27 indicates that a group with age $50 - 60$ and age $60 - 70$ rank is greater than overall average rank whilst a negative Z value -3.27 and -1.09 of age $20 - 30$ and age $40 - 50$ respectively is less than overall average.

Keywords: Kruskal wallis, Blood pressure, Systolic, Age group, Kogi state



1.0 INTRODUCTION

Blood pressure is the force of circulating blood on the walls of the arteries, systolic measures the heart beat when the blood pressure is at its highest and diastolic measures when the heart beat when the blood pressure is at lowest. The management of blood pressure is one of the most important strategies for the prevention and management of cardiovascular diseases (CVDs) around the world. (Xie et al, 2016) Although Blood pressure management has been generally based on Blood pressure values measured in the clinical setting by medical professionals, home Blood pressure monitoring by individuals is becoming increasingly important in diagnosis and in the control of arterial hypertension (Stergion et al, 2009). Few measurements in medicine are done as poorly and inconsistently as blood pressure measurement...Though there is a clear recognition of biological variability, Blood pressure is constantly changing due to intrinsic physiological variabilities in response of several factors such as stress, exercise, and disease and thus it makes the measurement of Blood pressure an arduous task. Variations up to 20 mmHg within a few heartbeats and even larger variations over the course of the day can be expected (Kearney et al, 2005). These variabilities and their impact on Blood pressure measurements are not recognized and accounted for by most clinicians. Also, the BP estimates obtained in the process are often inaccurate (Chobanian A.V 2007)

Elevation of blood pressure is called "hypertension". Hypertension is the largest risk factor contributing to global burden of mortality. According to the Global Burden of Disease (GBD) Study 2017, around 10.4 million deaths occur every year due to hypertension (GBD 2017 Risk factor collaborators). Approximately 20.9% of the global annual Disability-Adjusted Life Years are lost due to hypertension (GBD 2015 mortality and causes of death collaborators). The Uncontrolled hypertension is a risk factor of several non-communicable diseases, including cardiovascular disease (CVD), cerebrovascular disease, chronic kidney disease (CKD), and hypertensive retinopathy. Similar to other countries in the world, hypertension is a major public health problem in Nigeria and Africa continent in particular, communicable diseases and maternal, perinatal and nutritional causes of morbidity and mortality accounted for the greatest burden of morbidity and mortality this burden is fast shifting towards chronic non- communicable diseases, and by extension cardiovascular diseases CVDs. This phenomenon is what is being termed as a “double burden of disease” (Bygbjerg IC, 2013). The prevalence of hypertension has increased significantly over the past two to three decades, there were approximately 80 million adults with hypertension in sub-



Saharan Africa in 2000 and projections based on current epidemiological data suggest that this figure will rise to 150 million by 2025 (Gupta R, 2004).

Ultimately, elevation in systolic blood pressure alone leads to an increase in the value of pulse pressure, and the amount of pressure in the arteries when the heart contracts. With aging, there is a reduction in the quantity and elasticity of elastic fiber's in the arterial wall leading to arterial stiffness and loss of arterial adjustment to changes in heart stroke volume (Pareek et al, 2017), this result is consistent with the this analysis where age though not highly significant but shows effect on increase in blood pressure.

High systolic blood pressure (according to American guidelines) was responsible for 10.8 million deaths which was 19% of total deaths globally (Murray et al, 2019) Globally, 1.3 billion people aged 30–79 years old lived with hypertension in 2019 (according to European guidelines). More than 1 billion people worldwide (82% of those with hypertension) live in low and middle-income countries. Hypertension will affect 1.60 billion people worldwide by 2025. Hypertension has imposed a substantial economic burden, including direct healthcare expenses (\$370 billion/year) as well as indirect costs associated with lost productivity, premature death, and morbidity (Zhou et al, 2019)

The only way to know if you have high blood pressure is to get your blood pressure measured. For most adults, blood pressure readings fall into the following categories:

Stage of hypertension	Systolic pressure		Diastolic pressure
Healthy range	120 mm Hg or lower	AND	80 mm Hg or lower
Pre-hypertension	120–129 mm Hg	AND	80 mm Hg or lower
Stage 1 hypertension	130–139 mm Hg	OR	80–89 mm Hg
Stage 2 hypertension	140 mm Hg or higher	OR	90 mm Hg or higher
Hypertensive crises (medical attention is needed)	180 mm Hg or higher	OR	120 mm Hg or higher

In developing countries particularly Nigeria, high blood pressure is one of the risk factors for cardiovascular diseases, and deaths especially among middle and old-age adults is due to high Blood Pressure. Overweight and obesity increase the risks of high BP, coronary heart disease, ischemic stroke, type II diabetes mellitus, and certain cancers. Despite the current prevalence of high blood



pressure in developing country and particularly Nigeria, there remains insufficient studies and detailed statistical analysis on persons with the risks of high blood pressure, thus this presence study hope to fill the lacuna in the literature.

The aim of this study is to determine if there is significant difference between the median blood pressure ratings across the four age groups, 20-30, 40-50, 50-60, 60-70

HYPOTHESIS

The null hypothesis (Ho): The population or distribution medians of the blood pressure of the age group are equal

Alternative Hypothesis (H1): At least one of the distributions of the blood pressure of the age group is not the same

2.0 MATERIAL AND METHODS

2.1 STUDY AREA

Nigeria is the most populous country south of the Sahara. She has 36 States and federal capital in Abuja. By geo-political system, she has six zones namely South-East, South-South, North- West, North-East, North-Central and South-West. Kogi state is located in the North – Central region of Nigeria, with a focus on blood pressure of twenty patients in general hospital Idah, kogi state.

2.2 STUDY POPULATION

The study population covered the records of twenty (20) sample size of patient in Idah general Hospital obtained as a secondary source of data.

2.3 SAMPLING METHODS

Stratified random sampling method was used to collect the data on the patients with blood pressure since the patients were group by age with class interval of ten (10).

2.4 METHODS OF DATA ANALYSIS

The Kruskal–Wallis test will be used for this analysis is a statistical test used to compare two or more groups for a continuous or discrete variable. It is a non-parametric test, meaning that it assumes no particular distribution of your data and is analogous to the one-way analysis of variance (ANOVA). The Kruskal Wallis test is sometimes referred to as the one-way ANOVA on ranks or the Kruskal Wallis one-way ANOVA.

Assumptions of Kruskal Wallis Test

- Independence of Observations – Each observation can belong to only one level.
- No assumption of normality.



- Additional Assumption – The distributions of the dependent variable for all levels of the independent variable must have similar shapes. We can make use of Histograms or Boxplots to determine if the distributions have similar shapes. If this assumption is met it allows you to interpret the results of the Kruskal Wallis Test in terms of medians and not just mean ranks.

H Statistics of Kruskal Wallis Test

$$H = \frac{12}{N(N+1)} \sum \frac{T_i^2}{N_i} - 3(N+1)$$

n_i = number of items in sample i

R_i = sum of ranks of all items in sample i

K = total number of samples

$n = n_1 + n_2 + \dots + n_K$; Total number of observations in all samples.

Steps to perform Kruskal Wallis Test

-: Arrange back according to the levels and calculate the sum of ranks for each level.

-: Calculate H Statistics

-: Find the critical chi-square value

The chi-square distribution can be used when all the sample size is at least 5.

Degree of freedom = $k-1$

Alpha = 0.10 or 0.05 Use this [chi-square table](#) to find the value.

-: Compare H value and Critical Chi- Square value

If $H_{\text{calc}} < \chi^2_{\text{tab}}$; Accept the Null Hypothesis

If $H_{\text{calc}} > \chi^2_{\text{tab}}$; Reject the Null Hypothesis

Since $H_{\text{calc}} < \chi^2_{\text{tab}}$. We accept the Null Hypothesis.

3.0 RESULTS

Table: 3.1 Blood pressure (Ages 20-70)

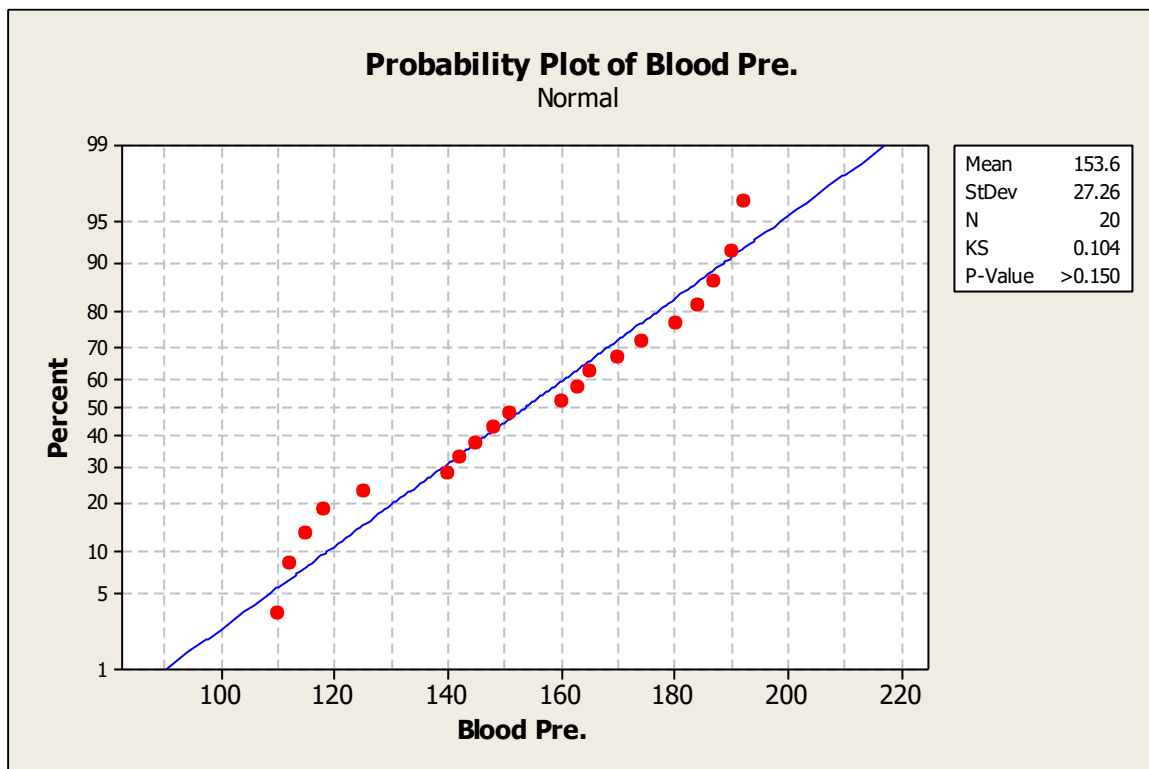


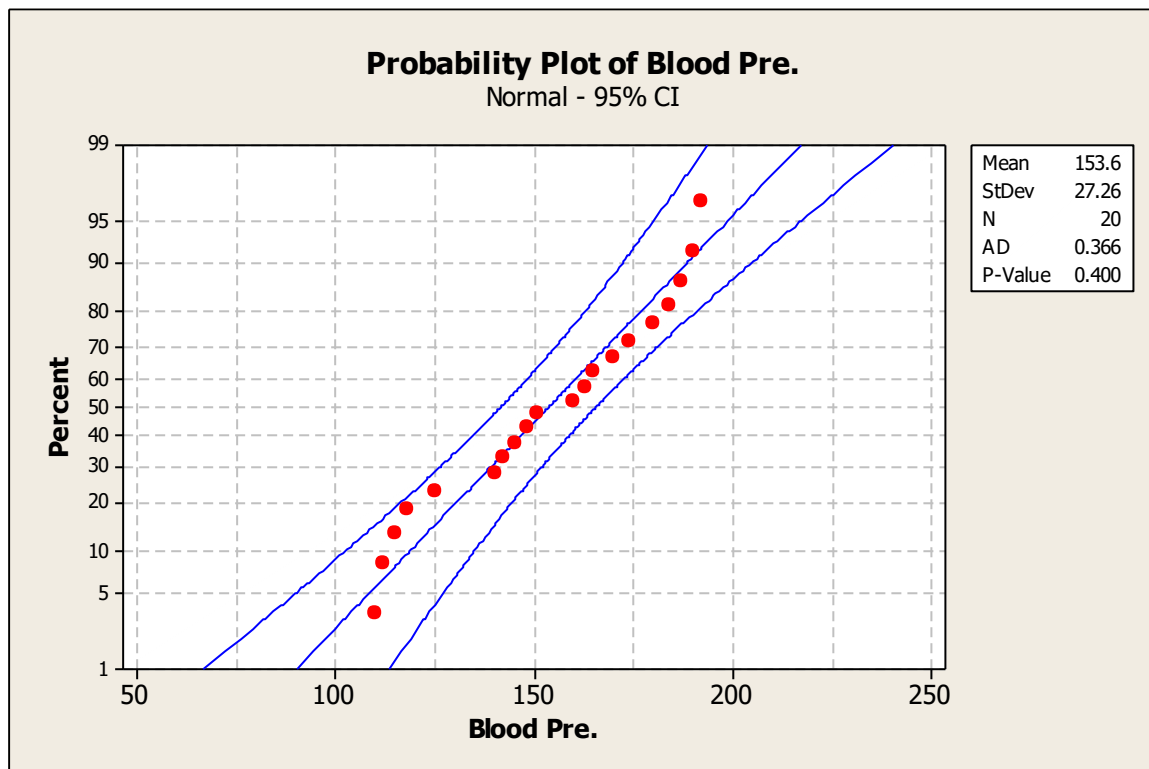
Proceedings of the 2024 National Conference of the School of Applied Sciences, Kogi State Polytechnic, Lokoja held between 2nd – 4th July 2024.



Group A AGE 20-30	Group B AGE 40-50	Group C AGE 50-60	Group D AGE 60-70
110	140	160	180
118	148	170	190
112	142	163	184
125	151	174	192
115	145	165	187

Source: General Hospital, Idah





The result from both the probability plot at 95% confidence interval with normal plot P value > 0.15 and 0.4 suggested that the blood pressure values do not follow a normal distribution, which justified the use of a non-parametric test

Kruskal-Wallis Test on Groups

1.	Factors	N	Median	Ave Rank	Z
2.	1	5	115.0	3.0	-3.27
3.	2	5	145.0	8.0	-1.09
4.	3	5	165.0	13.0	1.09
5.	4	5	187.0	18.0	3.27
6.	Overall	20	10.5		

$$H = 17.86 \quad DF = 3 \quad P = 0.000$$

$\chi^2_{\text{critical value}} = 11.3$ and 7.81 at 1% and 5% respectively

4.0 DISCUSSION OF RESULTS



The result from the analysis indicated that the calculated value $H = 17.86$ is $> \chi^2_{\text{critical value}} = 11.3$ and 7.81 at 1% and 5% respectively. We do have sufficient evidence to say that there no statistically significant difference between the median blood pressure ratings across these four age groups, meaning that the alternative hypothesis is accepted that the median blood group ratings across the four age groups are not the same. The result from the p value also align with the above, Since the [p-value](#) of the test 0.000 is less than 0.05, we fail to reject the alternative hypothesis that the distribution of the various age groups is not equal or the median blood pressure ratings across these four age groups are not the same. A positive Z_{value} 1.09 and 3.27 indicates that a group with age 50-60 and age 60-70 rank is greater than overall average rank whilst a negative Z_{value} -3.27 and - 1.09 of age 20-30 and age 40-50 respectively is less than overall average.

5.0 CONCLUSION

From the above finding $H = 17.86$ is $> \chi^2_{\text{critical value}} = 11.3$ and 7.81 at 1% and 5% respectively and p value = 0.0000, we concludes that there is statistical significant differences in the median systolic blood pressure rating across the age groups.

Having high blood pressure can be harmful to your health in several ways. Over time, it can damage your organs including your heart, kidneys, and brain. Fortunately, there are steps you can take to help lower your blood pressure and reduce the risk of health issues caused by hypertension foods that help lower blood pressure.

1 Leafy greens: 2 Berries 3. Red beets: 4. Skim milk and yogurt: 5. Oatmeal 6. Bananas: e.t.c
Artificial Intelligence AI solutions can help uncover such hidden patterns, enabling healthcare professionals to:

- Identify high-risk patients and provide targeted interventions, reducing healthcare costs and improving outcomes.
- Develop data-driven strategies to manage cardiovascular disease, a major contributor to healthcare burdens and economic instability.
- Enhance health security and contribute to economic stability in Kogi State by reducing healthcare expenditures and improving productivity, thereby secure a healthier kogi state and beyond
- Inform policy decisions and resource allocation, ensuring a more secure future for the region.



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TRANSFORMATION OF FEDERAL CAPITAL TERRITORY (FCT) TO A SMART CITY: A PANACEA FOR SOCIO-ECONOMIC AND SECURITY STABILITY

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ABSTRACT

The pursuit of socio-economic development and security stability through advanced technology and data drives the smart city initiative, aiming to enhance citizens' quality of life, sustainability, and streamlined public services and infrastructure. For decades, urban challenges like population density, infrastructure, energy, housing, education, water, and security have prompted the need for smart cities. The Internet of Things (IoT) and infrastructure are the cornerstone and game-changer of smart cities, requiring minimal effort for maximum output. However, Nigerian cities have yet to adopt a comprehensive strategy to transform most traditional cities into digital hubs, embracing the smart city concept. This research is a qualitative study that investigates the crucial roles of smart cities in improving citizens' lives through technology and data collection, achieving socio-economic development and security stability. Both primary and Secondary data from journals and publications will be used for analysis and interpretation, from the available literature on this topic. This research concludes that FCT Abuja has some smart features, including intelligent information systems, ICT technology, infrastructure, transport systems, and utilities, that has improved socio-economic and security stability but more needs to be done to transform the city into a smart city fully.

Keywords: Socioeconomic Development, Smart-City, Transformation, Infrastructure, Technology.



1.0 INTRODUCTION

Digital technology drive various aspects of the world, and these sectors are continually innovating to create sustainable solutions to global issues. Environmental challenges and the pace of the global warming the world is experiencing has also necessitated the need for solutions to eliminate or abate the climate crisis. This includes urbanization and the development of sustainable urban cities, which birthed the idea and concept of smart cities. Smart cities concept gained significant global attention as a response to urban challenges, aiming to provide innovative and sustainable solutions. According to Hamdi and Maryam (2019) “Urbanization is one of the main reasons for presenting the idea of a smart city”, technology has however been a driving force. Digital Technology has evolved through various stages as a sustainable solutions that has evolved, from digital cities to intelligent cities and now smart cities. With advanced automation, smart cities can create better experiences for citizens, conserve resources like energy and water, improve mobility and city services, enhancing socio-economic development, welfare, and health. Digital technology enables quick interaction and transaction through real-time control systems, sensors, and data collection, leading to optimization and efficiency (Musa, 2017). Smart cities provide technological solutions to urban challenges, and improving the quality of life. Howbeit, In the Federal Capital Territory, Abuja, the smart cities concept can play a pivotal role in addressing security, traffic, waste management, socio-economic, and sustainable development challenges, and advancing development. However, Nigerian cities lack adequate automated infrastructure, such as reliable roads, power supply, advanced telecommunication, and quality education, hindering their transformation into smart cities. Adetokunbo & Emeka, (2015). Nevertheless, despite the presence of some features of smart cities in places like Abuja, Lagos, Ibadan, Kano, and Port Harcourt, their digital technology levels are still low. For example, conventional systems are still used to control traffic, tackle security, generate data, track anti-social behavior, and the challenges of insurgency as well as other criminal activities persist due to the lack of sophisticated digital infrastructures needed. Abuja lacks technological facilities like CCTVs, pubic Wi-Fi or uninterrupted internet access in major public spaces, if not everywhere. In view of the aforementioned, this study aims to examine the crucial roles of smart cities in enhancing socio-economic development, security stability, and quality of life for citizens, focusing on artificial intelligence.

2.0 METHODOLOGY



This study is a qualitative study that investigates the crucial roles of smart cities in improving citizens' lives through technology and data collection, achieving socio-economic development and security stability. It employed a comprehensive research approach and also incorporated materials carefully derived and analyzed both from the primary and Secondary sources and other available literature on this topic.

3.0 LITERATURE REVIEW ON SMART CITY

As stated earlier, the Smart cities concept have gained significant global attention as a response to urban challenges, aiming to provide innovative and sustainable solutions. The concept has become a dominant topic of discussion and debate worldwide and a lot of scholars have also made significant contributions to the development of the concept of smart cities. Although, in Nigeria there are a few literature abound on smart cities initiatives, nevertheless the study shall focus on some prominent scholars or experts who have written and made significant contributions to the concept. Essentially, Jariko et al (2015) examined the concept of smart cities and posit that the smart city concept is not static, and has no absolute definition. This is because there are various definitions of the concept and an ongoing debate or disagreement about what the best terminology for the concept should be; such as smart city, smart community, digital city, intelligent city etc. However, here are a few definitions of a smart city as proposed by scholars who use the term. According to Hall et al. (2000), a smart city is "A city that monitors and integrates conditions of all of its critical infrastructures, including roads, bridges, tunnels, rails, subways, airports, seaports, communications, water, power, and even major buildings, to better optimize its resources, plan preventive maintenance activities, and monitor security aspects while maximizing services to its citizens." Additionally, it is a city that utilizes information and communication technologies (ICT) to improve the quality of life, enhance service delivery, stimulate economic growth, and ensure environmental sustainability. The British Standard Institute defines it as "the effective integration of physical, digital, and human systems in the environment to deliver a sustainable, prosperous, and inclusive future for its citizens." Mohanty et al. (2017), posit that a smart city is a place where traditional networks and services are made more flexible, efficient, and sustainable with the use of information, digital, and telecommunication technologies to improve its operations for the benefit of its inhabitants.

According to Rode (2017), the smart city concept has been in existence since the 1990s, initially focusing on ecology and urban development. However, since 2008, the paradigm has shifted to



emphasize digital technology, a trend that continues to this day. In Nigeria, the smart city initiative was launched on August 8, 2017, under the auspices of the Federal Ministry of Communication and AFRITEX Initiative, giving birth to the Nigeria Smart City Initiative (NSCI). The NSCI aims to transform Nigerian cities into modern, responsive, and sustainable urban centers that meet the needs and aspirations of citizens.

Azkuna (2012) on the other hand, in his work describes a smart city as an urban settlement that incorporates intelligent information systems, technology-embedded infrastructures, transport systems, utilities, energy networks, and social infrastructures, all governed by good leadership. Essentially, a smart city leverages advanced technology and data to enhance the quality of life for its citizens, even in rural areas. Features like internet of things, public Wi-Fi, Point of Sale (P.O.S), and Automated Teller Machines (ATMs) can be found in non-urban areas, demonstrating the expansive scope of smart city initiatives. Shichyakh (2016) concurs that smart cities utilize information technologies to improve citizens' lives. Musa (2017) further expands the concept, highlighting the significant contributions of smart city initiatives to the socio-economic development and growth of cities, both directly and indirectly. Woherem and Odedra-Straub (2017) posit that the successful implementation of a smart city relies heavily on the availability of fundamental infrastructures, adequate funding, and requisite skills. To achieve effective management and efficiency, a collaborative approach through Public-Private Partnership (PPP) ventures is essential, as substantial capital and technological expertise are involved. This synergy enables the development of innovative smart applications that simplify life for urban dwellers. Soyinka (2016) on the other hand, identified six essential elements of smart infrastructure that serve as benchmarks for smart city classification, leading to socio-economic development and growth. These elements include:

- a) Renewable energy sources, such as wind, thermal, and solar power, which provide sustainable and clean energy.
- b) Smart grids, which enable efficient energy distribution and management.
- c) Intelligent physical planning and land use morphology, characterized by compact cities with mixed land uses and diverse transportation options.
- d) Eco-friendly environments, prioritizing green spaces and sustainable practices.



- e) Intelligent transportation systems, ensuring efficient and safe mobility.
- f) Information and Communication Technology (ICT), serving as the backbone of smart city infrastructure, facilitating data-driven decision-making and efficient service delivery.

These elements form the foundation of a smart city, driving growth, sustainability, and improved quality of life for citizens.

Evidence of smart cities concepts can be seen in selected countries of the world such as the USA, Korea, Japan, Canada, and Denmark, etc. Okewale & Atobatelle (2022) posit that works in order to improve the lives of the people and socio-economic development, many cities Europe take advantage of the smart city arrangement with the adoption of smart lightening, use of technology, to enhance gridlock, use of smart phones and smart appliances smart grid technologies etc.

4.0 THE FEDERAL GOVERNMENT'S INITIATIVE TOWARDS SMART CITIES IN NIGERIA

On August 8, 2017, the Federal Ministry of Communication, in collaboration with the Africa Information Technology Exhibition and Empowerment Initiative (AFRITEX), took the first step towards developing smart cities in Nigeria. AFRITEX is responsible for organizing summits, conferences, and workshops to find innovative solutions for development, hosting annual smart cities summits and awards, advocating for a digital economy and smart cities, and promoting the 'Privacy by Design' principle in shaping smart cities in Nigeria. The conference led to the establishment of the Nigeria Smart City Initiative (NSCI), which aims to transform Nigerian cities from informal settlements to modern, responsive, and sustainable urban centers that meet the needs and aspirations of citizens. Following this, all relevant government ministries, departments, agencies, private sector organizations, professional associations, and non-governmental organizations began to align with the smart city initiative, adopting e-governance and e-platforms in their operations and also fully embracing digital technology.

However, the Nigeria Smart City Initiative plans to leverage ICT and smart technology to enhance the administration, development, and management of Nigerian cities, achieving efficient transport systems, secure environments, affordable housing, effective sanitary and waste disposal systems, urban regeneration, and upgrades. To ensure effective coordination, the Federal Government



established the Government Integrated Financial Management Information System (GIFMIS) to implement digital technology policies.

These policies have yielded products such as the Treasury Single Accounts (TSA), Integrated Payroll and Personnel Information System (IPPIS), e-payment systems, and Cashless policy, aimed at enhancing the economic capacity and growth potential of cities and urban centers. According to Mansur (2019), adhering to ICT technology compliance is crucial to transforming Nigeria's economy, and this road map has the potential to achieve this transformation.

4.1 TRANSFORMATION OF ABUJA INTO A SMART CITY FOR SOCIOECONOMIC AND SECURITY STABILITY

The journey of transforming the city into a smart city according to Jariko *et al* (2015) started under the watch of the former minister of the FCT, Bala Mohammed and transformation agenda vision of the former Nigerian President, Goodluck Ebele Jonathan. For 38 years since 1976, the Abuja master plan had not been executed or reviewed until the early part of the year 2014. The former FCT minister, Alhaji Bala Mohammed's administration, encouraged by the President Jonathan's transformation drive, put together a new 'vision'. Strongly embedded in that transformation drive, this was 'to build a first class capital ... with effective service delivery comparable to the best in the world'. Its supporting 'mission' statement is to 'build and administer the Federal Capital... in compliance with the Master Plan... through the establishment of an effective and enduring service – oriented administration that can respond to the needs of all residents and other stakeholders.' (TELL, May 2014:3). The expected end-product is a Smart Capital City showpiece with good/standard roads, potable water, regular electricity supply, functional telecommunication and transportation systems. (Jariko *et al* 2015). The gradual implementation of the Abuja master plan through government and public private partnership has driven the city's transformation into a smart city through various initiative. These initiatives are key indicators according to Jariko *Et al* are what makes an urban city smart. They are:

1. **Upgrading Transportation Infrastructure:** Upgrading the transportation network within the Abuja metropolis to improve connectivity and enhance development. This includes the actualization of road networks such as the Umaru Yar-Adua Expressway, the Kubwa Expressway, the Reconstruction of the Lower Usuma Dam-Gurara Dam Jere Road etc Jariko *Et al* (2015). The actualization of the metro project that birthed the Abuja light rail system and the provision of mass



transit buses. These projects have reduced travel time to the city center by over 100%, from 3 hours to 30 minutes. The completion of these projects in 2014 has enhanced Abuja's transportation infrastructure, making it a model for smart city development in Africa. This has also created job opportunities for thousands of unemployed people.

2. The establishment of the Abuja Geo information System (AGIS) to provide spatial data, digitalize land administration and streamline records and transactions. With trained staff and cutting edge technology, AGIS supports the growth of Abuja both economically, socially and politically.
3. The city has implemented various smart technologies and smart project initiatives in areas like Jabi Lake Project, Abuja World Trade Centre, Abuja City Centre Project, and Centenary City. The Federal Capital Development Authority is actively exploring Abuja's potential to become a competitive smart city globally.

There are many other key initiatives that make the city of Abuja smart. Essentially, In July 2017, Google mapped extensive road networks in Abuja, a development that has had a profound impact on the city's transportation system. According to Alpha Beta (2017), digital maps have reduced travel time for Nigerians by approximately 8% and save around 190 billion naira annually. Mansur (2019) notes that Google Maps has been instrumental in helping commuters in both Abuja and Lagos navigate busy traffic conditions, locate streets, and find roads.

The widespread availability of internet facilities has enabled a significant number of people to interact with their environment and the global community. The advent of smart digital technology has facilitated seamless transactions within the banking system, making it easier for people to conduct business beyond traditional banking hours. Services like Automated Teller Machines (ATMs) and Point of Sale (POS) terminals have enabled people to collect money, purchase recharge cards, and transfer funds with ease.

Moreover, smart infrastructure has created employment opportunities for youths, contributing to the city's economic growth. The integration of smart technology has transformed Abuja's business landscape, enabling individuals to access various services and conduct transactions efficiently. As the city continues to embrace ICT compliance, it is poised to become a model for smart city development in Africa.

Smart technology has also revolutionized transportation in Abuja, with the advent of e-transportation services like UBER, BOLT, GOKADA which operates via the internet to convey passengers or goods from one place to another. This innovative mode of transportation has been



operational in Abuja, enhancing mobility and convenience for residents. It has also created job opportunity for people as well as upgrading the cities aesthetics.

Furthermore, e-commerce has transformed the way goods and services are purchased and sold in Abuja. Online platforms like Jiji, Jumia, and Konga have made it possible for individuals to transact business over the internet, reinventing the way government services are delivered. According to Mansur (2019), smart cities like Abuja support economic development and growth by creating new businesses, attracting customers, and generating wealth. Abuja has also embraced various smart technologies, including tracking systems for goods and vehicles, smart traffic management, intelligent traffic management, automatic ticketing systems, and smart parking. These innovations have improved the quality of life for citizens, saved time, and increased government revenue.

In addition, the residential sector in Abuja has witnessed significant growth, with the emergence of smart houses in areas like AMAC, Asokoro and Maitama districts. These districts are highly sought after due to their aesthetics, peaceful atmosphere, scenic views, smart shops, hotels, and modern amenities like smart farmer markets, where fresh food items and restaurants are available. The adoption of smart technology in Abuja has indeed enhanced the standard of living, improved security, created more employment, making it a model for other cities in Nigeria.

4.2 THE CHALLENGES OF ACHIEVING A SMART CITY FOR DEVELOPMENT AND GROWTH

Nigerian cities, including Lagos, Ibadan, Kano, Port-Harcourt, and Abuja, have experienced rapid urbanization and growth, but lack the infrastructure and planning to support this growth. Traditional cities in Nigeria have developed without proper physical planning, resulting in poor road networks, transportation, and utility services. However, the Federal Government has recognized the need to build smart cities, and Abuja, as the capital city, has been a model as it is believed by the government that it has the potential to compete with other smart cities globally. The institutionalization of Abuja as the capital city has provided a foundation for growth and development. However, there are a few obstacles and some significant challenges in implementing this idea.

1. **Cost:** The high costs associated with designing, implementing, building, operating, and maintaining a smart city pose a significant challenge. Attracting the right investors to provide the necessary funding is a major issue. This includes the costs of infrastructure development,



technology integration, and maintenance, which can be a heavy burden on the government and private sector.

2. **Structural Challenges:** The lack of proper physical planning in existing cities means that achieving the smart city concept requires significant demolition, reconstruction, and relocation. This can cause hardship for citizens, including displacement and disruption of businesses and communities. This could lead to civil unrest and social instability.
3. **Cyber Security Challenges:** Smart cities face significant cyber security threats, which allow fraudsters and cyber criminals to hack into electronic devices connected to the internet and smart urban infrastructures. This can compromise sensitive information and put critical infrastructure at risk. Cyber security measures need to be integrated into the design and implementation of smart city initiatives to prevent these risks.
4. **Policy and Regulation:** The lack of detailed policies and regulations is a significant challenge to achieving a smart city. Clear guidelines and frameworks are needed to ensure that smart city initiatives are implemented in a coordinated and sustainable manner. This includes policies on data privacy, security, and governance, as well as regulations on the use of technology and infrastructure.

In summary, achieving a smart city requires addressing these challenges, including finding ways to finance and invest in smart city initiatives, managing the social and physical impacts of urban transformation, ensuring cyber security, and developing appropriate policies and regulations to guide the process.

Finally, Abuja can leverage technology, including ICT and Internet of Things (IoT), to plan and manage the city. It has some smart features, including intelligent information systems, ICT technology, infrastructure, transport systems, and utilities, that has improved soci-economic and security stability but more needs to be done to transform the city into a smart city fully. The Federal Government and Federal Capital Territory Authority must work together to improve infrastructure and implement consistent policies to achieve this goal. Challenges such as poverty, environmental pollution, infrastructure deficits, and ineffective urban services must be addressed to develop smart infrastructure. As Soyinka, Lawanson, and Adeniyi (2016) noted, these challenges hinder the development of smart cities. With concerted efforts and investment in technology and infrastructure, Abuja and other Nigerian cities can become smart cities, providing better living conditions, economic growth, and sustainable development.



5.0 CONCLUSION

The adoption of smart city initiatives in many cities worldwide serves as a model for government institutions, agencies, and public entrepreneurs. The implementation of smart city technology has far-reaching benefits, including:

- Reduced crime rates through improved surveillance and security systems
- Enhanced commerce and trade through digital platforms and efficient transportation systems
- Improved education through access to digital resources and smart learning infrastructure
- Enhanced governance through transparent and accountable digital services

By adopting smart city initiatives, Nigerian cities can leapfrog traditional development stages and become more efficient, sustainable, and livable, providing a better quality of life for citizens. This study recommends that the government should increase its efforts to provide advanced infrastructural facilities and linkages, such as high-level technology, to create the enabling environment to encourage the private sector to contribute more significantly to the development of smart city initiatives through Public-Private Partnership (PPP) arrangements. This collaboration will help bridge the infrastructure gap and accelerate the development of smart cities in Nigeria.



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REGRESSION MODELING ON FLOOD DEVASTATION IN LOKOJA LOCAL GOVERNMENT OF KOGI STATE

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Abstract

In Lokoja local government area of Kogi state, flooding has caused much damage to properties and lives. The riverine areas of Lokoja local government suffered from flooding because of storm heaves that overflowed the riverbanks during the previous flooding occurrences that struck most of Kogi State. The creation of a regression model for flood destructions in Kogi State's Lokoja local government is the study's aim. In order to accomplish this goal, information on temperature, precipitation, relative humidity, and the number of significant floods that caused damage in the area between 1980 and 2020 was gathered from the synoptic station of the Nigerian Meteorological Agency (NIMET). To analyze the data, multiple-linear regression was employed. The values for multiple R, R^2 , adjusted R^2 , and standard error were found to be 0.53186, 0.5465, -0.68091, 1.7747, and 0.2956, respectively, according to the obtained results. The correlation results showed that the number of flood events and rainfall was 0.265344, the relative humidity and rainfall was 0.8956, and the number of flood events and relative humidity was 0.09786. ANOVA was exploited to assess the regression's strength. In summary, it was observed that a combination of atmospheric variables, accounting for approximately 1.86 percent of the total, caused flooding in the area. Environmental and human factors accounted for 95.67% of persistence flooding.

Keywords: Flooding; Regression; Rainfall; temperature; humidity



1.0 INTRODUCTION

More people have been displaced globally by flooding than by any other natural disaster or threat. 20% of Nigerians, according to Anuforum (2013), are at risk of flooding, which is a recurring issue in Nigeria that has led to several deaths and population displacements. In most Nigerian cities, flooding is a frequent occurrence. The 2012 Nigerian floods, which affected over 2.3 million people and claimed over 363 lives, were classified as a national disaster by the National Emergency Management Agency (2012). Thirty-six states in Nigeria—including the most devastated state, Kogi State—were affected by the flood, which washed away several Nigerian cities. In addition to property damage, the Plateau State of Central Nigeria saw at least 68 fatalities, with 25 of the dead found in the Benue River after the storm (NEMA, 2012). The Kogi State Ministry of Environment (2012) claims that despite insufficient mitigation attempts, these incidents have demonstrated how devastating flooding has affect country's economy and inhabitants.

Statement of the problem

The effects of climate change on the environment worldwide have been the subject of several international conferences, seminars, and forums. Studies on climate change have been carried out in several Nigerian industries in the interim. The implications of climate change on Nigeria's socioeconomic development have also been investigated by Aondover (1997) and Enete (2010). Uyigwe and Agbo have also investigated its effects on rural and urban environments (2007).

Objectives of the study

The objective of the study is to model the effects of some selected climatic factors on number of flood occurrence in Lokoja local government of Kogi state.

2.0 LITERATURE REVIEW

Ecosystem is currently under threat due to climate change and other human activities. Sea levels increase in tandem with global warming, decimating coastal wetlands and drying up inland wetland basins that historically sustained human socio-economic activity.



Since it provides vital habitat for numerous wildlife species, the environment of the inland wetland communities of Lokoja in Kogi State, Nigeria, the topic of this research, has contributed to the conservation of biodiversity. The ability of wetlands to avert flooding is widely recognized. In order to lessen the detrimental effects of climate change on agriculture and human activity in the nation's wetlands, adaptive solutions are required. Because of this, the purpose of this work is to develop a regression model for flood events in the Lokoja area of Kogi State. In contrast, flash floods, which can happen in a matter of minutes without any discernible signs of rain, are a different story. Additionally, floods can be massive, affecting entire river basins, or minor, affecting just one neighborhood or village. Flooding can induce long-term population migration in addition to property destruction. It can also accelerate the development of mosquito-borne illnesses and waterborne infections (WHO, 2021)

Effects of Flooding in Kogi State

Impacts from primary to secondary to tertiary flooding are numerous. Primary effects happen when physical harm occurs, like in the case of Kogi State during the 2012 flood disaster when structures were destroyed. A combination of natural and artificial drainage system obstruction and climate change contributed to the recent floods that struck 36 states and the Federal Capital Territory (Abuja) in Nigeria. According to predictions made by the United Nations et al. (2019), the majority of the world's population is expected to live in urban areas by 2050, with developing cities accounting for the majority of this urban build-up. Despite the fact that some reports stated water spilled from the Cameroun dam was the cause. Because Kogi State is situated at the lowest point of the Niger River, it is vulnerable to flooding, according to Hadiza Ibrahim, the former Minister for the Environment for Nigeria and the National Emergency Management Agency (NEMA). There were thousands of internally displaced people (IDPs), and 10,000 homes were either totally or partially submerged (Odjogu, 2012). During that period, the Lokoja Metropolis's leading industries were submerged and incapable of operating. For these people, things continued to be bleak and miserable. Properties valued at billions of naira, including homes and farms, were destroyed.

The Kogi State Government met the requirements of the affected areas by enlisting the aid of state-based Army and Navy units, law enforcement, churches, non-governmental organizations, and the State Emergency Management Agency. IDPs. UNICEF, the State Emergency Management Agency (SEMA), and NEMA, the government agency, conducted NEEDS assessments. Consequently, humanitarian supplies were delivered by the state government, NEMA, and other



donors. The Community Primary School in Kankanda, Kupa, Kabawa, Adankolo, and the Primary School in Sarikin-Noma were utilized in the Lokoja Local Government Area. The IDPs received food, lodging, and medical attention from the Kogi State Government and its local partners (Daily News, 2012).

Environmental management now faces a new problem as a result of the growing competition for water, the depletion of freshwater supplies, and the usage of poor-quality water (Ogwuche, 2012). Due to the predicted unpredictable rainfall and extreme climatic conditions brought on by climate change, it is anticipated that urban floods will become more frequent and intense if preventive measures are not adopted, with disastrous impacts in the informal settlements (Odoh, 2013). Flooding in Kogi State is caused by inadequate planning of buildings and other structural layouts, a congested drainage system, overcrowding, government negligence, and climate change. According to Sani-Sidi. (2013), there is a substantial correlation between pluvial flooding and the large human population, given the volume of the flood and its repercussions.

3.0 METHODOLOGY

Study Area

Lokoja is located on the western bank of the Niger River, at its confluence with the Benue River, with latitude 7°49' N and longitude 6°44' E. Its elevation ranges from 45 to 125 meters. It crosses key routes to at least five of the country's six geopolitical zones, and is located around 160 kilometers south of Abuja, the new federal capital. The region's topography is made up of mesas and tall hill masses on the one side, and sliced, rolling plains on the other. Situated on a plain that borders the Niger River, Lokoja is encircled by the river and Mount Patti, one of the principal high plateau hills. There is roughly 1150 mm of rainfall every year (Samanta, 2016).

The rainy season starts around November, and the rainy season averages beginning in March and peaking in June to September. The average monthly temperature is about 30°C degrees Celsius. Because of the high humidity and consequently high sensible temperature, the weather is always moist. Flash floods on top of constant flow are the defining feature of the Niger and its major tributaries. July marks the start of the Niger floods at Lokoja, which peak in October and end in December (Sani-Sidi, 2013).



River Niger at Lokoja



Confluence Town and environs (Lokoja)

Data Collection

The study used data on temperature, rainfall, relative humidity, and the number of significant flood episodes in the area over a 39-year period (1980–2019) from the Nigerian Meteorological Agency's synoptic station (NIMET) Lokoja station, Kogi State. I thought the data from this station was trustworthy since the government and other organizations used it to forecast meteorological factors for local agricultural activities.

Method of Data Analysis

Multiple Linear Regression was used to analyze the data in order to ascertain the contributions of climate components to the destruction of agricultural and human activities. The number of flood incidences in the region was the dependent variable, and the temperature, rainfall, and relative humidity are the independent factors.

Table 1. Present the correlation coefficients between the three independent variables and the dependent variable, the number of flood incidences.

Climatic factors	Temperature (°C)	Amount of rainfall (mm)	Relative Humidity (%)	Number of flood incidence
Temperature (°C)	1			
Amount of	-	1		



rainfall (mm)	0.4764			
Relative Humidity(%)	- 0.3855	0.8954	1	
Number of flood occurrence	- 0.0865	0.2086	0.075 4	1

In Table 1, the relationship is frequently negligible, with the exception of rainfall and relative humidity. This is a typical tendency because relative humidity rises with increased rainfall. Conversely, there is a little link between Flood and all of the metrics, but this is to be expected given their disparate relationships. For example, the negative relationship between temperature and flood shows that when the temperature drops, heavier rainfall may occur.

There is a positive linear association between Relative Humidity and Rainfall, Number of Flood Events and Rainfall, and Number of Flood Events and Relative Humidity. Relative humidity and rainfall (0.8954), number of flood events and rainfall (0.2086), and number of flood events and relative humidity (0.0754) are the Pearson correlation coefficients for these couples.

The variables are associated in a moderately positive manner, as indicated by these numbers. The following pairs of variables have negative linear relationships with negative Pearson correlation coefficients: Rainfall and Temperature (-0.4764), Relative Humidity and Temperature (-0.3855), and Number of Major Flood Events and Temperature (- 0.0865). These negative correlations show that the number of major flood events, relative humidity, and rainfall decreases as temperature rises.

Regression analysis

Table 2. Shows the results of multiple regression analysis

Multiple Regression	R square	Adjustment R square	Standard error	Sample size



0.53186	0.5465	-0.6809	2.865	39

$$Y_t = \beta_0 + \beta_1 + \beta_2 + \beta_3 + \mu$$

The Regression Analysis indicated that the combined climatic variables contributed roughly 1.34% to the local flooding (Table 2). This indicates that 98.66% of wetland floods are caused by human and environmental factors. This is because of the impact of a sizable body of water, which provides enough moisture for evaporation and then releases that moisture back into the atmosphere as rain, inundating the surrounding land.

Table 3: Shows summary of regression results on trends on persistence in climate change using number of floods on Temperature, amount of rainfall and relative humidity in Lokoja.

	β	SE	T-calculated	p-value	R^2
Numbers of floods	0.9675	0.7863	0.056	0.675	0.978
Temperature	0.8765	0.0876	-0.956	0.000**	0.875
Rainfall	0.5765	0.865	0.815	0.876	0.775
Relative humidity	-0.276	0.064	2.054	0.000***	0.456

Source of variation	df	SS	MS	Significant F
Regression	3	1.567	0.5223	0.1380



Residual	35	132.450	3.784	
Total	38	144.007		

Table 4: ANOVA

The regression's strength was ascertained using the ANOVA, and the p-level (sig) of the analysis is 0.978, above the 0.05 level (Table 4). This suggests that the null hypothesis is the most plausible explanation for the relationship between flood and climatic conditions, as the regression model is not statistically significant. When a p-value is greater than 0.05, it indicates substantial support for the null hypothesis. This means that the alternative hypothesis is rejected and the null hypothesis is kept. It is crucial to stress that the null hypothesis can only be rejected or fail to be refuted; it cannot be accepted.

A statistically significant result does not prove that a study hypothesis is valid (since it suggests 100% certainty). The data "support" or "give evidence for" the study hypothesis since there is still a little probability (less than 5%) that the results were the result of chance and the null hypothesis was correct.

4.0 CONCLUSION

The research examined climate data spanning from 1980 to 2019. Based on the Regression Analysis, the area's flooding was caused by a combined 2.65% of the meteorological factors. The results also suggest that 99.78 percent of wetland floods are caused by human and environmental factors.

This is because of the influence of a sizable body of water, which supplies enough moisture for evaporation and then releases that moisture back into the atmosphere as rain, inundating the surrounding land. The area is likely to experience a wide range of damages from future flooding, thus it is important to support the adaption strategies that this research has identified. It is obvious that the conventional adaption strategies are insufficient to address the region's escalating climate change challenge. Therefore, it is necessary to put new safeguards into place. Areas prone to floods, such as Adankolo New-layout, Kabawa, Federal University temporary site Banda, Ohono, and Karara, should be the focus of state governments' and other government agencies' efforts.



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LOCAL AND GLOBAL STABILITY OF TUBERCULOSIS MODEL WITH VACCINATION AND DRUG RESISTANCE

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Abstract

In this paper, a deterministic mathematical model of tuberculosis incorporating Vaccination and drug resistance with constant recruitment rate was formulated. The population was subdivided into six compartments according to their disease status. The basic reproduction number (R_0) of the model was obtained using the next generation matrix. The disease free and endemics equilibrium points were derived. The results obtained shows that the disease-free equilibrium points are locally asymptotically and globally stable since $R_0 < 1$ and $R_0 \leq 1$ respectively.

Keywords: Vaccination, Drug Resistance, Tuberculosis, Reproduction Number, Stability



1.0 INTRODUCTION

Tuberculosis (TB) is one of the leading causes of death worldwide, with an estimated death of over 1.5 million in 2020 alone, WHO (2021). It is a bacteria disease which attacks part of the human body such as lungs, bones, lymph nodes and brain. This disease is caused by a known mycobacterium tuberculosis that looks like rod-shape bacterium. Some of the symptoms are in the form of cough, chest pains, shortness of breath, loss of appetite, weight loss, fever, chills and fatigue, WHO (2021). Transmission of TB can be controlled by providing proper medical treatment to people infected with the disease. In many cases a lot of people that are infected with TB don't know their status and they may transmit this disease to others. Sometimes infected individuals may stop receiving treatment and this also could result in new TB infection to people around them, Arthitian & Mini (2013).

The emergence of drug resistance strains has further complicated TB control efforts, CDCP (2020). Vaccination is a crucial strategy in preventing tuberculosis transmission, however its effectiveness can be compromised by the spread of drug-resistant strains, Anderson & Doherty (2005). The uses of mathematical modelling have become very essential in understanding the dynamics of TB and evaluating control strategies, Feng et al. (2013). Despite the widespread use of vaccination and treatment, TB remains a persistent public health challenge, suggesting that the current control strategies are inadequate to tackle the spread of the disease. Recent studies have highlighted the impact of drug resistance on TB dynamics, Dye et al. (2020). Therefore, a comprehensive analysis of the stability of TB transmission with vaccination and drug resistance is crucial to inform evidence-based control strategies. This paper attempts to investigate the dynamics of TB transmission using a mathematical model that accounts for vaccination and drug resistance.

2. Model Formulation

Using a compartmental approach, we divide the human population at time $t \geq 0$, into six compartmental classes they are Susceptible $S(t)$, Vaccinated $V(t)$, Exposed $E(t)$, Infected $I(t)$, Drug Resistance $R_1(t)$, and the Recovered Humans $R(t)$. The size of the human population is given by

$$N(t) = S(t) + V(t) + E(t) + I(t) + R_1(t) + R. \quad (1)$$

2.1 Model Diagram

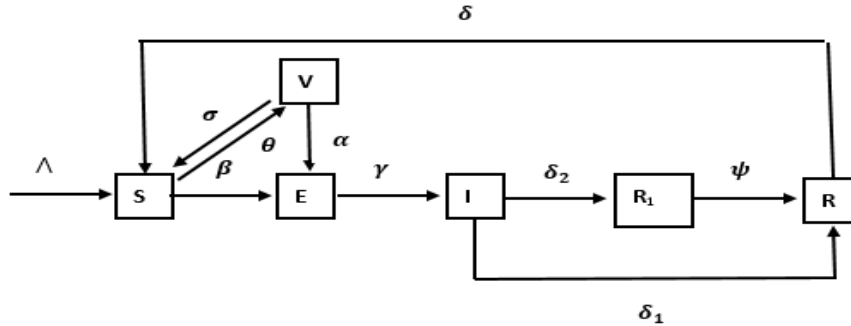


Figure 1: Schematic Diagram of TB Model.

2.2 Basic assumptions of the model

- There is no permanent immunity for the recovered individuals
- The effectiveness of vaccine wane over time
- Population is heterogeneously mixed with equal probability of resulting to infection in case of contact
- Some vaccinated individual can be infected if they interact with an infected person due to factors like vaccine failure which maybe cause by several factors such as the presence of HIV.

2.3 Model Equations

$$\frac{dS}{dt} = \Lambda + \sigma V + \delta R - \beta SI - \vartheta S - \mu S \quad (2)$$

$$\frac{dV}{dt} = \vartheta S - \sigma V - \alpha IV - \mu V \quad (3)$$

$$\frac{dE}{dt} = \beta IS + \alpha IV - \gamma E - \mu E \quad (4)$$

$$\frac{dI}{dt} = \gamma E - (\delta_1 + \delta_2 + \delta_3)I \quad (5)$$

$$\frac{dR_1}{dt} = \delta_2 I - \psi R_1 - \delta_4 R_1 \quad (6)$$



$$\frac{dR}{dt} = \delta_1 I + \psi R_1 - \delta R - \mu R \quad (7)$$

where

Λ Recruitment rate into the susceptible class

σ Rate at which vaccine efficacy wane over time

δ Rate at which those who recovered from the infection lose their immunity

β Contact rate or rate of transmission

$\mathcal{G}$ Vaccination rate of the susceptible class

μ Natural death for all the class

ψ Rate of resistance to treatment

δ_4 Disease induced and natural death rate of the resistance class

α Rate of vaccinated individual becoming infected with TB due to other related health challenges such HIV.

γ Rate at which exposed individual becomes infectious

δ_1 Recovery rate of infected individual

δ_2 Treatment failure rate

δ_3 Disease induced and natural death rate of the infected class

3.1 Equilibrium Points of the Model

We obtain both the disease-free and the endemic equilibrium points of the model above by setting equations 2-7 equal zero and solve simultaneously.

i.e



$$\begin{aligned}\frac{dS}{dt} &= \Lambda + \sigma V + \delta R - \beta SI - \lambda S = 0 \\ \frac{dV}{dt} &= \vartheta S - \alpha IV - \eta V = 0 \\ \frac{dE}{dt} &= \beta IS + \alpha IV - \phi E = 0 \\ \frac{dI}{dt} &= \gamma E - \varepsilon I = 0 \\ \frac{dR_1}{dt} &= \delta_2 I - \kappa R_1 = 0 \\ \frac{dR}{dt} &= \delta_1 I + \psi R_1 - \tau R = 0\end{aligned}\tag{8}$$

where,

$$\lambda = \vartheta + \mu, \quad \eta = \sigma + \mu, \quad \phi = \gamma + \mu, \quad \varepsilon = \delta_1 + \delta_2 + \delta_3, \quad \kappa = \delta_4 + \psi \quad \text{and} \quad \tau = \delta + \mu$$

On solving we obtained the disease-free equilibrium points of the models as

$$(S^*, V^*, E^*, I^*, R_1^*, R^*) = \left(\frac{\Lambda \eta}{\mu(\delta + \eta)}, \frac{\Lambda}{\mu(\delta + \eta)}, 0, 0, 0, 0 \right)\tag{9}$$

And the endemic equilibrium points are as follows



$$\begin{aligned}
 S^{**} &= \frac{\phi \varepsilon}{\gamma \left(\beta + \frac{\alpha \theta}{\eta + \alpha I^{**}} \right)} \\
 V^{**} &= \frac{1}{\alpha \gamma} \left(\frac{\phi \varepsilon}{\gamma} - \beta \left(\frac{\phi \varepsilon}{\beta + \frac{\alpha \theta}{\eta + \alpha I^{**}}} \right) \right) \\
 E^{**} &= \frac{(\beta S^{**} + \alpha V^{**}) I^{**}}{\phi} \\
 R_1^{**} &= \frac{\delta_2 I^{**}}{\kappa} \\
 R^{**} &= \frac{(\delta_1 \kappa + \psi \delta_2) I^{**}}{\tau \kappa}
 \end{aligned} \tag{10}$$

3.2 Basic Reproduction Number

The basic reproduction number (R_0) is the average number of new infections that one infected case will generate during their entire infection life time in a fully susceptible population. It is an important tool in determining whether the diseases persist or die out in population.

The next generation matrix is used to compute the basic reproduction number.

Basic reproduction number is the spectral radius $\rho(F_1 V_1^{-1})$ where the matrix F_i and V_i are the new infection terms and the remaining transfer terms respectively.

The basic reproduction number is obtained as follow

$$F_1 = \begin{bmatrix} 0 & \beta S + \alpha V & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} \quad \text{and} \quad V_1 = \begin{bmatrix} \phi & 0 & 0 \\ -\gamma & \varepsilon & 0 \\ 0 & -\delta_2 & \kappa \end{bmatrix} \tag{11}$$

Then the inverse of the matrix V_1 is given by



$$V_1^{-1} = \begin{bmatrix} \frac{1}{\phi} & 0 & 0 \\ \frac{\gamma}{\phi\varepsilon} & \frac{1}{\varepsilon} & 0 \\ \frac{\delta_2\gamma}{\phi\varepsilon\kappa} & \frac{\delta_2}{\varepsilon\kappa} & 0 \end{bmatrix} \quad (12)$$

Hence the next generation matrix of the system at the disease-free equilibrium points is given by

$$F_1V_1^{-1} = \begin{bmatrix} \frac{(\beta + \alpha\eta)\gamma\eta\Lambda}{\varepsilon(\delta + \eta)\mu} & \frac{(\beta + \alpha\eta)\eta\Lambda}{\varepsilon(\delta + \eta)\mu} & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} \quad (13)$$

Thus, the basic reproduction number which is the spectral radius of the above radius is given by

$$R = \frac{\gamma\beta\Lambda\eta + \alpha\Lambda\gamma}{\mu(\delta + \eta)\phi\varepsilon} \quad (14)$$

3.3 Stability Analysis of the Model

The local dynamics of a general SVEIRR model is determined by reproduction number R_0 . If $R_0 < 1$, then each infected individual in its entire period of infectiousness will produce less than one infected individual on average. This means that the diseases will be wiped out eventually. If $R_0 > 1$, then each infected individual in its entire infectious period having contact with susceptible individuals will produce more than one infected individual in its entire infectious period implying that the diseases will persist in the population. If $R_0 = 1$ and this is defined as the disease's threshold, then one individual will infect one more individual.

3.4 Local Stability of Disease-Free Equilibrium

Theorem 1: If $R_0 < 1$ then the diseases free equilibrium of the model is locally asymptotically stable and unstable if $R_0 \geq 1$.

Proof: We use the Jacobian stability approach to prove the stability of the diseases free equilibrium.



$$J(E) = \begin{pmatrix} -(\beta I + \lambda) & \sigma & 0 & \beta S & 0 & \delta \\ \theta & -(\eta + \alpha I) & 0 & -\alpha V & 0 & 0 \\ \beta I & \alpha I & -\phi & \beta S + \alpha V & 0 & 0 \\ 0 & 0 & \gamma & -\varepsilon & 0 & 0 \\ 0 & 0 & 0 & \delta_2 & -\kappa & 0 \\ 0 & 0 & 0 & \delta_1 & \psi & -\tau \end{pmatrix} \quad (15)$$

At the diseases free equilibrium point we have

$$I = E = R_1 = R = 0 \text{ and } S = \frac{\Lambda \eta}{\mu(\delta + \eta)}, V = \frac{\Lambda}{\mu(\delta + \eta)}$$

Thus, the Jacobian matrix at disease free equilibrium is given by:

$$J(E_0) = \begin{pmatrix} -\lambda & \sigma & 0 & \frac{\beta \Lambda \eta}{\mu(\delta + \eta)} & 0 & \delta \\ \theta & -\eta & 0 & \frac{-\alpha \Lambda}{\mu(\delta + \eta)} & 0 & 0 \\ 0 & 0 & -\phi & \frac{\beta \Lambda \eta}{\mu(\delta + \eta)} + \frac{\alpha \Lambda}{\mu(\delta + \eta)} & 0 & 0 \\ 0 & 0 & \gamma & -\varepsilon & 0 & 0 \\ 0 & 0 & 0 & \delta_2 & -\kappa & 0 \\ 0 & 0 & 0 & \delta_1 & \psi & -\tau \end{pmatrix} \quad (16)$$

Hence, the Eigenvalues of the Jacobian matrix is given by

$$\lambda_1 = -\mu < 0$$

$$\lambda_2 = -\tau < 0$$

$$\lambda_3 = -(\sigma + \theta + \mu) < 0 \quad (17)$$

$$\lambda_4 = -\kappa < 0$$



$$\lambda_5 = -\frac{1}{2\mu Z} \left(\phi\mu Z + \varepsilon\mu Z + \sqrt{\phi^2 Z^2 \mu - 2Z^2 \phi\mu\varepsilon + \mu Z^2 \varepsilon^2 + 4\beta\Lambda(\sigma + \mu)\mu Z\gamma + 4\mu Z\gamma\varepsilon\Lambda} \right) < 0$$

If $R_0 < 1$

then

$$\lambda_6 = \frac{1}{2\mu Z} \left(-\phi\mu Z - \varepsilon\mu Z + \sqrt{\phi^2 Z^2 \mu - 2Z^2 \phi\mu\varepsilon + \mu Z^2 \varepsilon^2 + 4\beta\Lambda(\sigma + \mu)\mu Z\gamma + 4\mu Z\gamma\varepsilon\Lambda} \right) < 0$$

Thus, all eigenvalues of the Jacobian Matrix above have negative real part if $R_0 < 1$. Hence from Routh Hurwitz stability criteria we conclude that the diseases free equilibrium is locally asymptotically stable.

3.5 Global stability of the disease's free equilibrium.

Theorem 2: If $R_0 \leq 1$ then the diseases free equilibrium of the system is globally asymptotically stable on Ω .

Proof. By constructing an appropriate Lyapunov function $V = (S, V, E, I, R_1, R)$ on the positively invariant compact set Ω .

Defined

$$V = (S, V, E, I, R_1, R) = \gamma E + \phi I \tag{18}$$

$$\frac{dV}{dt} = \gamma \frac{dE}{dt} + \phi \frac{dI}{dt} \tag{19}$$



$$\begin{aligned}
 &= \gamma(\beta IS + \alpha IV - \phi E) + (\gamma E - \varepsilon I)\phi \\
 &= \gamma\beta SI + \alpha V\gamma I - \phi\varepsilon I \\
 &= (\gamma\beta S + \alpha V\gamma - \phi\varepsilon)I \\
 &= \left(\frac{\gamma\beta\Lambda\eta + \alpha\Lambda\gamma}{\mu(\delta + \eta)} - \phi\varepsilon \right) I \\
 &= \phi\varepsilon \left(\frac{\gamma\beta\Lambda\eta + \alpha\Lambda\gamma}{\mu(\delta + \eta)\phi\varepsilon} - 1 \right) I \\
 &= \phi\varepsilon (R_0 - 1)
 \end{aligned} \tag{20}$$

Which is strictly decreasing when $R_0 < 1$

i.e

$$\frac{dV}{dt} < 0 \text{ if } R_0 < 1$$

and

$$\frac{dV}{dt} = 0 \text{ if and only if } E = 0, I = 0, R_1 = 0, \text{ and } R_0 = 1 \tag{21}$$

Defining the set $E_0 = \left\{ (E, I, R_1) \in \Omega : \frac{dL}{dt} = 0 \right\}$ the largest invariant set E_0 is contained in the set

thus, by LaSalle invariant principle the diseases free equilibrium is globally asymptotically stable.

Hence the proof..

4.0 Conclusion

In this study, a mathematical model to investigate the transmission dynamics of TB with vaccination and drug resistance was formulated. Stability analysis focusing on local and global stability of the disease-free equilibrium points were established, and the result obtained shows that the disease-free equilibrium points are locally and globally asymptotically stable.



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EXAMINING THE FINANCIAL HOUSING ACCESSIBILITY IN FELELE, KOGI STATE

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Abstract

This research examines the financial housing accessibility in Felele. The source of data is primary and was collated from the administered questionnaire to selected residents in Felele, Lokoja. Percentage and Chi-Square analysis were used in this paper. From the result, it was observed that 38% of the respondents lived in a single room apartment. Also, 43.1% of the respondents claimed to pay less than one hundred and twenty thousand naira (N120,000) only per year. Observation from the respondents shows that 33.6% earns between ten thousand naira and twenty-nine thousand naira per month, one hundred and twenty thousand to three hundred and fifty-nine thousand, nine hundred and ninety-nine naira (N120,000 – N359,999) only per year. Also, 54.7% of the respondents spent between forty and fifty-nine percent (40% - 59%) of their salary on accommodation. Furthermore, 42.3% of the respondents has stayed between two (2) to five (5) years in their present apartment. Finally, from the Chi-square analysis carried out, we discovered that choice of accommodation and yearly house rent are independent of gender and age respectively.

Keywords: Housing, Accessibility, Affordability, Accommodation



1.0 INTRODUCTION

In recent years, Nigeria has experienced rapid urbanization and population growth, placing significant pressure on housing sector. The issue of housing accessibility has become increasingly critical as the gap between housing supply and demand widens. Access to affordable housing remains a daunting challenge for a large segment of the Nigerian population, particularly in urban centers where infrastructure development struggles to keep pace with demographic trends.

Felele is located at outskirts of Lokoja town, along Okene-Abuja express way. It lies at the confluence of the Niger and Benue rivers and is the capital city of Kogi State. Due to the location of three (3) tertiary institutions in Felele, that is, Kogi State Polytechnic, Nigeria-Korea Friendship Institution of Vocational and Advanced Technology, and Federal University Lokoja, housing availability and affordability has become a major challenge. It is on this basis that this research was conducted to determine the financial housing accessibility in Felele, Lokoja.

The objectives of this paper are to determine the house type occupied by respondents, to calculate the percentage of income spent on housing, and determine if age is dependent of house rent per month

According to Hilber (2016), reducing house prices appears to be a recurring recommendation of many researchers but measuring the impact of this approach requires a sound definition of affordability as well as an understanding of the market mechanisms underlying house price formation. Datta A., & Wardekker, J. A. (2020) reviewed existing literature on housing and cross examined the implications for urban governance.

Gurran & Whitehead (2011) argue new supply of affordable units is a function of planning regulations, development controls and fees. Since all of those factors can be affected by policy, it appears that the recipe for increasing housing affordability may be quite simple. However, despite policy design that supports provision of affordable housing and generous incentives for such developments, Morrison & Monk (2006) affirmed that the problem remains unresolved. In fact, Crook et al. (2010) show that existing policies produce a supply of dwellings that is lower than expected but also that building new homes in the most critical areas has little effect on affordability.



There are many factors that determines the amount to be paid as house rent. Saiz, A. (2010) expatiates geographic determinants of housing supply. In housing affordability, factors such as household income, housing prices, and other economic indicator influence the financial feasibility of owing or renting a house. Hulse, K., & Milligan, V. (2014) studied extensively the housing affordability in Australia putting into consideration government policies.

Glaeser et al. (2020) demonstrate that new supply plays a crucial role in determining whether productivity increases will lead to urban expansion or just to more expensive homes and higher wages. The former is shown to occur in places with low regulation and low density while the latter is associated with cities marked by high density and strict planning regulations.

2.0 Methodology

The population of this study comprised the sum total of the population of each of the purposively selected residents. The study population includes randomly selected streets in Felele, Lokoja. These are Sarkinoma, Poly Village, Bassa Village, Behind NNPC Mega Station, and Oworo Estate.

One Hundred and forty (140) questionnaires were distributed to people randomly selected residential buildings in Sarkinoma and Poly Village, Felele, Lokoja town to get adequate information about housing affordability out of which one hundred and thirty-seven (137) were retrieved

The data obtained from the administered questionnaire are analysed using percentage and chi-square techniques.

Chi – square (χ^2) statistics can be computed using the formula:

$$\chi^2_{cal} = \sum_i \sum_j \frac{(O_{ij} - e_{ij})^2}{e_{ij}}$$

If $\chi^2 = 0$, then the observed and expected frequencies agree exactly, if $\chi^2 > 0$, then the observed and expected frequencies do not agree exactly. The larger the value of χ^2 , the greater the discrepancy between O_i and e_{ij} .



3.0 DATA PRESENTATION AND RESULT

Table 1: House Type

S/N	House Type	Frequency	Percentage
1	Single Room	52	38
2	Room and Parlor	35	25.5
3	Two Bed Rooms Flat	29	21.2
4	Three or more Bedroom flats	21	15.3
	Total	137	100

Source: Researcher's Field Survey, 2024

Table 1 sought to know if the respondents' choice of house type. The respondents in their responses show that out of a total of 137 respondents 38% said that they lived in a single room apartment, 25.5% lives in a room and parlour apartment, 21.2% lives in two bedrooms' apartment while 15.3% of the 137 respondents lives in three or more bedrooms' apartment.

Table 2: House Rent per month

S/N	House rent per month	Frequency	Percentage
1	Less than 10,000	59	43.1
2	10,000 – 29,999	45	32.8
3	30,000 – 49,999	31	22.6
4	Above 50,000	2	1.5
	Total	137	100

Source: Researcher's Field Survey, 2024



Table 2 shows that out of a total of 137 respondents 43.1% claimed to pay less than ten thousand naira (N10,000) only per month, 32.8% pays between ten thousand naira and twenty nine thousand, none hundred and ninety naira (N10,000 – N29,999) only per month, 22.6% pays between thirty thousand naira and forty nine thousand, none hundred and ninety naira (N30,000 – N49,999) naira only per month while 1.5% pays above fifty thousand naira (N50,000) only per month

Table 3: Total Monthly Income of House Heads

S/N	House rent per month	Frequency	Percentage
1	Students (No income)	29	21.2
2	Less than 10,000	7	5.1
3	10,000 – 29,999	30	21.9
4	30,000 – 70,000	33	24.1
5	Above 70,000	38	27.7
	Total	137	100

Source: Researcher's Field Survey, 2024

Table 3 shows that out of a total of 137 respondents 21.2% claimed to be students without income. 5.1% claimed to earn less than ten thousand naira (N10,000) only per month as total monthly income, 21.9% earns between ten thousand naira and twenty- nine thousand, none hundred and ninety naira (N10,000 – N29,999) only per month, 24.1% earns between thirty thousand naira and forty-nine thousand, nine hundred and ninety naira (N30,000 – N49,999) naira only per month while 27.7% earns above seventy thousand naira (N70,000) only per month



Table 4: Percentage of Monthly Income Spent on Accommodation

S/N	Percentage of monthly income	Frequency	Percentage
1	Less than 10,000 or no income	11	8.0
2	10,000 – 39,000	43	31.4
3	39,000 – 59,000	65	47.5
4	Above 60,000	18	13.1
	Total	137	100

Source: Researcher's Field Survey, 2024

Table 4 shows that out of a total of 137 respondents 8% claimed to spend less than ten percent (10%) on accommodation, 31.4% spent between ten and thirty-nine percent (10% - 39%) on accommodation, 47.5% spent between forty and fifty nine percent (40% - 59%) on accommodation while 13.1% spent above sixty percent (60%) on accommodation.

Table 5: Duration of Respondents stay in their apartment

S/N	Duration of stay	Frequency	Percentage
1	Less than a year	27	19.7
2	2 – 5 years	58	42.3
3	6 – 10 years	35	25.6
4	Above 10 years	17	12.4
	Total	137	100

Source: Researcher's Field Survey, 2024

Table 5 shows that out of a total of 137 respondents 19.7% claimed to have stay less than a year, 42.3% stays between two and five (2-5) years, 25.66% stays between six and ten (6 – 10) years while 12.4% has stays above ten (10) years.



Hypothesis Testing

Hypothesis

H₀₁: There is no association between gender and respondents' choice of accommodation

H₀₂: There is no association between age and respondents' house rent per month.

Chi-Square Analysis

Table 6: Gender Distribution of Respondents on Choice of Accommodation

Gender	Single Room	Room and Parlor	Two Bedrooms flat	Three or more bedroom flat
Male	20	19	14	23
Female	32	16	7	6
Total	52	35	21	29

Source: Researcher's Field Work, 2024

Using GraphPad Prism 8.0.2 for data analysis, we have:

Data analysis for Table 6:

P value and statistical significance

Test	Chi-square
Chi-square, df	13.85, 3
P value	0.0031
P value summary	**
One- or two-sided	NA
Statistically significant (P < 0.05)?	Yes



Data analyzed

Number of rows 2

Number of columns 4

Hypothesis I

H₀₁: There is no association between gender and respondents' choice of accommodation

Since P value is 0.0031 and is less than 0.05, it is statistically considered significant, therefore, there is no association between gender and respondents' choice of accommodation

Table 7: Age of Respondents on Choice of House Rent

Age	< 10,000	10,000 – 29,999	30,000 – 49,999	< 50,000
16 – 25 years	32	16	2	0
26 - 31 years	22	20	5	0
32 and above	5	9	24	2
Total	59	45	31	2

Source: Researcher's Field Work, 2024

Using GraphPad Prism 8.0.2 for data analysis, we have:

Data analysis for table 4.6\7

P value and statistical significance

Test Chi-square

Chi-square, df 56.77, 6

P value <0.0001



P value summary	*****
One- or two-sided	NA
Statistically significant ($P < 0.05$)?	Yes
Data analyzed	
Number of rows	3
Number of columns	4

Hypothesis II

H₀₂: There is no association between age and respondents' house rent per month.

Since P value (0.0001) is less than 0.05, it is statistically considered significant, therefore, there is no association between age and respondents' house rent per month.

4.0 DISCUSSION OF FINDINGS

From the Chi-square analysis carried out based on gender, P value is 0.0031 is less than 0.05, it is statistically considered significant, therefore, there is no association between gender and respondents' choice of accommodation. Also, from the Chi-square analysis carried out based on age bracket of respondents, P value (0.0001) is less than 0.05, this implies age is statistically considered significant therefore, there is no association between age and respondents' house rent per month.

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5.0 CONCLUSION

From this research, it can be deduced that most of the respondents lived in a single room apartment while the least lived of the respondents' lives is in three or more bedrooms' apartment. Also, most of the respondents paid less than ten thousand naira (N10,000) only per month while less paid above fifty thousand naira (N50,000) only per month. Likewise, more of the respondents earned between ten thousand naira and twenty-nine thousand, nine hundred and ninety naira (N10,000 – N29,999)



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only per month while least of the respondents earned less than ten thousand naira (N10,000) only per month as total monthly income, In addition, more of the respondents spent between forty and fifty nine percent (40% - 59%) on accommodation while few of the respondents spent less than ten percent (10%) on accommodation. Furthermore, more of the respondents stayed between two and five (2-5) years, 25.66% stayed between six and ten (6 – 10) years while few of the respondents had stayed less than a year.

From the Chi-square analysis carried out, it was discovered that there is no association between gender and respondents' choice of accommodation. Also, there is no association between age and respondents' house rent per month.

From the results obtained in this work, the following are hereby recommended:

1. Tenants should consider their monthly income before renting an apartment
2. Landlords should be able to advice their tenants based on their income
3. Intending landlords should know the type of house in demand and build accordingly.



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AN INVESTIGATION TO BODY MASS INDEX OF STUDENTS

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Abstract

This study investigates the Body Mass Index of some students in Kogi State Polytechnic, Lokoja. 221 students were selected from five (5) Schools at the main campus. Their weight and height were taken in kilogrammes and metres respectively and their BMI computed accordingly. From the study, it is observed that 3.2% of the sampled population are underweight. A significant percentage, about 62.9% of the population has normal weight, 25.8% are overweight while 8.1% fall into the category of Obesity (Class I). The mean BMI is 23.9kg/m^2 and lies within the normal weight. This implies that the students understudied has a relative healthy lifestyle. The Pearson's correlation coefficient (0.151) obtained between height and weight indicates a relationship between weight and height while the coefficient of determination obtained shows 2.3% variation in weight explained by height of students. Also, since p-value obtained is less than 0.05, it attests that the correlation is statistical significant. The simple regression model is fitted as $\text{Weight} = 86.4 - 16.74\text{Height}$

Keywords: Body Weight, Height, Body Mass Index (BMI), Regression



1.0 INTRODUCTION

In recent times, there has been an increasing emphasis on studying the systematic measurements of students' body dimensions and proportions, otherwise known as 'anthropometric measurements', with a specific focus on weight and height. This trend is necessitated due to the significant impact of health and nutrition on the Nigeria's youth. Certainly, the weight and height of students' play a crucial role in evaluating the impact of health interventions and educational strategies aimed at enhancing student welfare across diverse regions of Nigeria.

This paper attempt to study the age, weight, and height of some students in Kogi State Polytechnic, Lokoja. These cut across five (5) Schools (Applied Sciences, Art, Industrial Design and Painting, Environmental Technology, Management Studies, General and Communication Studies). The objectives are to determine how these variables interplay using correlation. A fitted regression model of height to weight will show the significant trends among the sampled population. The ranges of the Body Mass Index (BMI) of the students will contribute to better understanding and management of health related issues.

According to Sonati *et al.* (2011), variation in body as one grows older in age are associated with changes in health and functional independence. Cole et al (2000) highlighted and established a standard definition for child overweight and obesity worldwide: The study provides international standards for defining child overweight and obesity based on age, weight, and height measurements. Kuczmarski et al (2000) in their publication provides the rate of growth charts putting into consideration age, weight, and height of children and adolescents. The study was restricted to United States as it offers a reference for assessing growth patterns. Ogden et al. (2014), provides prevalence data on childhood and adult obesity in the United States, based on weight and height measurements. He furthered highlighted its trends and disparities.

Freedman, D. S. et al. (2005) explores the relationship between childhood BMI. This is primarily based on weight and height of adult adiposity. The research provides insights into long-term health implications. De Onis et al. (2007). discusses the development of growth references by the WHO specifically for school-aged children and adolescents, focusing on weight and height measurements.



Ejiofor and Nwachukwu (2021) shows how different dietary habits affect the height and weight of primary school students in Nigeria. The study examines various aspects of children's diets, such as nutrient intake, meal frequency, and dietary diversity, and assesses their influence on physical growth indicators like height and weight. Their findings insights into the role of nutrition in child development.

Ogunlusi and Olanrewaju (2022) investigates the trends in anthropometric measurements such as height, weight, and body mass index among Nigerian adolescents. The study identifies that changes in growth patterns over time are influenced by factors such as socioeconomic status, dietary habits, and health conditions. Chukwu and Okoro (2022) furthered investigates on the influence of Socioeconomic factors such as family income, parental education, and access to resources impact children's height, weight, and overall physical development. By analyzing these factors, the paper shows the disparities in growth and development related to socioeconomic status and provides insights on how socio-economic conditions can influence children's health outcomes. Akinmoladun & Akinmoladun (2023) evaluate the nutritional status and physical growth of school-aged children in Nigeria. The study examines how nutritional factors affect the height, weight, and overall growth patterns of these children.

2.0 METHODOLOGY

Convenient sampling Technique were adopted in this paper and a total of 221 students were randomly selected among students of ages between 18 and 26. The ages of the respondents were calculated from their date of birth, weight taken through digital weight balance in kilogrammes (kg) and height in metres (m) using a wall measuring tape. The Body Mass Index of students were calculated using their weights (kg) and heights (m) accordingly.

Determination of Body Mass Index (BMI)

The determination of BMI is given as:

$$BMI = \frac{\text{Weight}}{(\text{Height})^2}, \text{ in } \text{kgm}^{-2}$$

Classification

The classification of BMI ranges in kgm^{-2} according to WHO is given below



- **Underweight: BMI < 18.5.**
- **Normal Weight: BMI from 18.5 to 24.9**
- **Overweight: BMI from 25.0 to 29.9.**
- **Obesity (Class 1): BMI from 30.0 to 34.9.**
- **Obesity (Class 2): BMI from 35.0 to 39.9.**
- **Obesity (Class 3): BMI > 40.0.**

The amount of body fat mass is estimated using BMI and is an indicator of health risk factor of a person.

Ogunlade et al. (2015) furthered classified BMI as

Table 1: Classifications of overweight and obesity in adults

S/N	Classifications	BMI (kgm—2)	Risk of morbidities
1	Underweight: BMI	< 18.5	Low
2	Normal Weight: BMI from	18.5 - 24.9	Average
3	Overweight: BMI from	25.0 to 29.9	Increased
4	Obesity (Class 1): BMI from	30.0 - 34.9	Moderate
5	Obesity (Class 2): BMI from	35.0 - 39.9.	Severe
6	Obesity (Class 3): BMI	> 40.0	Very severe

From the research carried out in this work, the following was observed, computed, and tabulated accordingly.

Table 2: Classifications of BMI according to data

S/N	Classifications	Population/Percentage (%)
1	Underweight: BMI < 18.5	7(3.2)
2	Normal Weight: BMI from 18.5 to 24.9	159(62.9)
3	Overweight: BMI from 25.0 to 29.9	57(25,8)
4	Obesity (Class 1): BMI from 30.0 to 34.9	18(8.1)
5	Obesity (Class 2): BMI from 35.0 to 39.9.	0(0)
6	Obesity (Class 3): BMI > 40.0	0(0)

Source: Researcher's Computation, 2024



According Chan et al. (2013), BMI measurement can be used to determine different health risk related to weight. From table 2, it was discovered that 3.2% of the sampled population are underweight. A significant percentage (62,9%) of the population has normal weight, 25.8% are overweight while 8.1% fall into the category of Obesity (Class I). Also, there were no students categorized as class 2 and 3 Obesity.

3.0 RESULTS AND DISCUSSION

3.1 Results

Statistical Analysis

The analysis of data is as follows

Table 3: Descriptive Statistics

	N	Minimu m	Maximu m	Mean	Std. Deviation
Age	221	18	26	21.03	2.132
Height	221	1.42	1.82	1.5884	.06709
Weight	221	46	84	59.90	7.429
BMI	221	16.73	33.33	23.9	3.78
Valid N (listwise)	221				

From the table 3, it is observed that the mean of height and weight of sampled students are 1.59m and 60kg respectively with mean age as 21. The mean BMI is 23.9kg/m² and lies within the normal weight. These shows that the students have a healthy lifestyle.

Regression Analysis

Analysis were carried out using Statistical Packages for Social sciences (SPSS) and output given as:

Table 4: Regression summary outputs

Model Summary



Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.151 ^a	.023	.018	7.360

a. Predictors: (Constant), Height

ANOVA^a

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	277.457	1	277.457	5.122	.025 ^b
	Residual	11863.150	219	54.170		
	Total	12140.606	220			

a. Dependent Variable: Weight

b. Predictors: (Constant), Height

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	86.483	11.758		7.355	.000
	Height	-16.738	7.396	-.151	-2.263	.025

a. Dependent Variable: Weight

3.2 Discussion of Result

From table 4, the Pearson correlation between height and weight of sampled students is calculated using Pearson's Coefficient of correlation, the value obtained, i.e. 0.151, indicate a correlation between weight and height. The coefficient of determination (R^2) = 0.023, which shows 2.3% variation in weight explained by height of students. Also, since p-value < 0.05, it attests that there is a relationship between the explained variables. The simple regression model of weight on height is calculated as:

$$Weight = 86.4 - 16.74Height$$

According to the regression model, the weight of sampled population decreases by 16.74kg for a unit increase in height.



4.0 CONCLUSION

From the study, it is observed that 3.2% of the sampled population are underweight. A significant percentage, about 62.9% of the population has normal weight, 25.8% are overweight while 8.1% fall into the category of Obesity (Class I). The mean BMI is 23.9kg/m^2 and lies within the normal weight. From these results, it can be said that the students understudied has a relative healthy lifestyle.

The Pearson's correlation coefficient between height and weight of sampled students are calculated which indicate a relationship between weight and height. The coefficient of determination obtained shows 2.3% variation in weight explained by height of students. Also, since $p\text{-value} < 0.05$, it attests that the correlation is statistical significant. The simple regression model of weight on height is calculated as $Weight = 86.4 - 16.74Height$.



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ARTIFICIAL INTELLIGENCE, SECURITY AND EMERGING ECONOMIES IN AFRICA; CHALLENGES AND PROSPECTS

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Abstract

Artificial Intelligence (AI) is a new innovation and the future of the 21st century technological advancement in the worldwide. Its advantages cut across all sphere of human endeavor. Although, not much has been written about Artificial intelligence (AI) being new, in the course of the this paper, we delved deeply into its prospect and challenges of deploying Artificial Intelligence (AI) into Africa's security and emerging economies. Key challenges such as malicious usage, cyber security threats, ethical bias concerns and a host of other challenges were discussed. However, these challenges do not outweigh the prospects that are very crucial to the growth of the Africa continent, such as enhanced security, agricultural and economic growth and others that form the fulcrum prosperous nations. Be that as it may, Artificial Intelligence is a technology that has come to stay and it will revolutionalize every facet of human endeavor be it security and emerging economies for the growth and development of the Africa Continent .

Keywords: Artificial Intelligence, Innovation, Security, Emerging Economies



1.0 INTRODUCTION

The continent of Africa is traditionally seen as a place that entered the technology revolution late, with the widespread implementation and use of information and communication technologies (ICTs) only becoming commonplace over the past decade. This has left Africa in the difficult position of trying to rapidly deploy and implement newly emerging technologies in an environment that has yet to properly develop the necessary social, political, and economic infrastructure. The result has often been a socio-technical landscape riddled with complexity, in which porous and rapidly changing contexts mean that systems that have been successful in other parts of the world often fail when applied to African settings. This can be seen with ICTs and mobile phones, which have been deployed at an incredible rate but whose uses in Africa have taken unconventional and innovative paths. At the same time, the concept and deployment of artificial intelligence (AI) in Africa has increasingly become a topic of interest.

Artificial Intelligence (AI) has emerged as a transformative technology that has the potential to revolutionize various sectors, including security and economies. In the context of Africa, AI holds immense promise for addressing pressing challenges and unlocking new opportunities. AI has been projected to offer significant contributions to national economies, potentially increasing the annual growth rate of the global gross domestic product (GDP) by 2030. As AI advances, its applications will increase the automation of operations and production in various industries, increasing efficiency and reducing the costs of many tasks.

However, the implementation of AI in African countries faces several challenges, particularly in the areas of security and emerging economies. This paper explores the challenges and prospects of AI in relation to security and emerging economies in Africa.

2.0 Artificial Intelligence In Africa

As the development of AI continues to expand across the world, an ecosystem of AI is also emerging across Africa. According to Leila Janah, the founder and CEO of Samasource, “if you use a mobile phone or laptop’s facial recognition features, drive a car, or shop online, there’s a good chance that a person in East Africa helped train the algorithm that makes your technology work.

About 100 AI start-ups have emerged across Africa, raising over \$140 million of seed-funding



with the majority going into fintech in Nigeria. For example, Cellulant6 have raised \$47.5 million followed by Mines.IO7 with \$17.2 million [20]. While Nigeria has attracted the largest amount of seed-funding, South Africa has the highest number of AI start-ups (26) in Africa followed by Nigeria (20) and Kenya (9).

Artificial intelligence is the simulation of human intelligence processes by machines, especially computer systems. AI systems work by ingesting large amounts of labeled training data, analyzing the data for correlations and patterns, and using these patterns to make predictions about future states. In this way, a chatbot that is fed examples of text can learn to generate lifelike exchanges with people, or an image recognition tool can learn to identify and describe objects in images by reviewing millions of examples.

2.1 Adoption and Implementation of AI in Africa

The adoption and implementation of Artificial Intelligence (AI) in Africa has emerged as a topic of great significance in recent years. With its potential to transform various sectors, including healthcare, agriculture, education, and governance, AI holds the promise of driving economic growth and social development in the African continent.

The adoption and implementation of AI in Africa present both challenges and opportunities. While infrastructure limitations, skills gap, and ethical concerns pose hurdles, the potential benefits of AI in sectors such as agriculture, healthcare, education, and governance cannot be overlooked. African countries must invest in developing the necessary infrastructure, fostering AI skills, and addressing ethical considerations to harness the transformative power of AI. With strategic planning and collaboration, AI can drive inclusive growth, empower communities, and pave the way for a prosperous future in Africa.

2.2 Impact of AI on African Economies

The impact of Artificial Intelligence (AI) on African economies is a topic of growing interest and significance. Speaking at a panel discussion on ‘Fostering prosperity through policies on artificial intelligence in Africa’, on the sidelines of the 56th Session of the Economic Commission for Africa Conference of African Ministers of Finance, Planning and Economic Development (COM) on the 5th of March, 2024 at Zimbabwe, experts agreed that Artificial Intelligence presented massive development opportunities for Africa



Ousman Bah, Minister of Communications and Digital Economy of Gambia, said it was important to have the right policies to regulate the use of AI and also avert its risks, but Africa should not wait to have the regulations in place to embrace the technology. Research shows that the technology has the potential to contribute up to \$15.7 trillion to the global economy by 2030, of which \$1.2 trillion could be generated in Africa, representing a 5.6 per cent increase in the continent's gross domestic product by 2030.

Sandra Makumbirofa PhD, a Senior economist with Research ICT Africa, said AI has transformative potential to boost African economies through effective financial inclusion employment creation and enhanced public service delivery.

AI has the potential to drive economic growth and enhance productivity. AI technologies, such as automation and machine learning, can significantly enhance productivity in African industries. By automating repetitive tasks and optimizing processes. Contrary to popular belief, AI has the potential to create new jobs in Africa. While automation may lead to the displacement of certain roles, it also creates opportunities for the development, implementation, and maintenance of AI systems. Additionally, AI can spur entrepreneurship and the creation of new businesses, generating employment opportunities.

3.0 Security Challenges In The Era Of Ai

AI also poses significant security challenges. As AI becomes more advanced and pervasive, it is essential to understand and address the potential security risks associated with its use. We will explore the security challenges in the era of Artificial Intelligence and measures that can be taken to mitigate these risks.

i. Malicious Use of AI:

One of the major security challenges is the potential for AI to be used for malicious purposes. AI algorithms can be manipulated or exploited to launch cyberattacks, create sophisticated phishing scams, or develop autonomous malware. The ability of AI to adapt and learn from its environment can make it difficult to detect and defend against such attacks. As AI technology evolves, it is crucial to develop robust security measures that can detect and counteract malicious AI applications.



ii. Data Privacy and Protection:

AI systems rely on vast amounts of data to learn and make accurate predictions. However, the collection, storage, and analysis of personal data raise concerns about privacy and data protection. AI algorithms that process sensitive information, such as healthcare records or financial data, must adhere to strict security protocols to ensure that the data is not compromised or misused. Additionally, there is a need for transparent and accountable data governance frameworks to protect individuals' privacy while harnessing the potential of AI.

iii. Adversarial Attacks:

Adversarial attacks refer to the deliberate manipulation of AI systems to deceive or mislead them. By introducing subtle changes to input data, attackers can trick AI algorithms into making incorrect decisions or predictions. For example, an autonomous vehicle's object recognition system could be deceived into misidentifying a stop sign as a speed limit sign. Such attacks pose serious risks in critical sectors like healthcare, finance, and transportation. Robust defenses, such as adversarial training and anomaly detection, need to be developed to protect AI systems from such attacks.

iv. Ethical and Bias Concerns:

AI systems are only as reliable and unbiased as the data they are trained on. Biases present in training data can lead to discriminatory outcomes and reinforce existing social inequalities. For example, biased AI algorithms used in recruitment processes can perpetuate gender or racial biases. Addressing ethical concerns and ensuring fairness in AI systems is crucial to avoid unintended consequences and maintain public trust. Regular audits of AI algorithms, diverse data sets, and inclusive development practices are essential to mitigate biases and ensure ethical AI deployment.

3.1 Cybersecurity Risks and Threats

In today's digital age, cybersecurity risks and threats have become a significant concern for individuals, businesses, and governments. The increasing connectivity and reliance on technology have created new avenues for cybercriminals to exploit vulnerabilities and carry out malicious activities. The most common cybersecurity risks and threats that individuals and organizations face are as follows:

i. Malware:



Malware refers to malicious software designed to gain unauthorized access, disrupt operations, or steal sensitive information. It includes viruses, worms, ransomware, spyware, and trojans. Malware can infect systems through email attachments, infected websites, or malicious downloads. Once installed, it can compromise data integrity, disrupt networks, and lead to financial losses. To protect against malware, individuals and organizations should regularly update their antivirus software, exercise caution when clicking on links or downloading files, and implement strong security measures.

ii. Phishing Attacks:

Phishing attacks involve the use of deceptive tactics to trick individuals into revealing sensitive information such as passwords, credit card details, or login credentials. Phishing attacks often come in the form of fraudulent emails, text messages, or websites that mimic legitimate organizations. These attacks can lead to identity theft, financial fraud, and unauthorized access to personal or corporate accounts. To prevent phishing attacks, individuals should be cautious when responding to unsolicited emails, verify the authenticity of websites before entering sensitive information, and enable multi-factor authentication.

iii. Data Breaches:

Data breaches occur when cybercriminals gain unauthorized access to a company's or individual's database or network, resulting in the exposure of sensitive information. This can include personal data, financial records, intellectual property, or trade secrets. Data breaches can have severe consequences, including financial losses, reputational damage, and legal liabilities. To prevent data breaches, organizations should implement robust security measures such as encryption, access controls, regular security audits, and employee training on data protection best practices.

4.0 Prospect of AI for Emerging Economies in Africa

Africa, often referred to as the "Dark Continent," has witnessed a significant transformation over the past few decades. The continent is experiencing an unprecedented economic growth rate, with emerging economies emerging as key players in the global arena (UNCTAD, 2021).



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Africa is rich in natural resources such as oil, gas, minerals, and arable land. These resources have become a driving force behind the growth of emerging economies in Africa. Countries like Nigeria, Angola, and South Africa have witnessed substantial economic growth due to their abundant natural resources (World Bank, 2021). With increasing global demand for these resources, African economies have the potential to leverage their assets for sustained growth.

With its young and growing population, which presents a unique opportunity for economic development, the continent is projected to have the largest workforce by 2035, surpassing both China and India (IMF, 2021). This demographic dividend can fuel economic growth, as a young workforce can drive innovation such as AI, productivity, and entrepreneurship (World Economic Forum, 2021). However, to fully harness this potential, African governments need to invest in education, healthcare, and skills development (African Development Bank, 2021).

However, one of the key challenges that emerging economies in Africa is facing is inadequate infrastructure. Insufficient transportation networks, power shortages, and limited access to clean water hinder economic growth and investment (World Bank, 2021). Nevertheless, African governments, with the support of international partners, have recognized the importance of infrastructure development. Initiatives such as the African Continental Free Trade Area (AfCFTA) and the Belt and Road Initiative are aimed at improving connectivity and promoting regional integration, thus enhancing the prospects for emerging economies (African Union, 2021; World Bank, 2021).

Embracing and investing in technological advancements can further boost the prospects for emerging economies in Africa. Technology has the potential to leapfrog traditional developmental stages and drive economic growth in Africa. Mobile phone penetration and internet connectivity have significantly increased in recent years, providing opportunities for innovation and entrepreneurship (World Bank, 2021). E-commerce, fintech, and mobile banking are transforming various sectors of the African economy, creating jobs and improving access to financial services (World Economic Forum, 2021).

Nevertheless, for emerging economies to grow there must be political stability and good governance. These are crucial for attracting foreign direct investment (FDI) and fostering economic



growth. African countries that have implemented sound economic policies, promoted transparency, and improved the business environment have experienced significant investment inflows (World Bank, 2021). Countries like Rwanda, Ghana, and Botswana have demonstrated that strong institutions and effective governance can create an enabling environment for emerging economies to flourish (World Economic Forum, 2021).

The prospects for emerging economies in Africa are promising, driven by abundant natural resources, a growing young population, infrastructure development, technological advancements, and improved governance. However, challenges such as inadequate infrastructure, unemployment, and political instability need to be addressed to fully capitalize on the continent's potential. With the right policies and investments, Africa has the opportunity to become a major player in the global economy and improve the lives of its citizens (UNCTAD, 2021).

4.1 Opportunities for Economic Growth through AI

Artificial Intelligence (AI) is a transformative technology with the potential to drive economic growth. AI technologies, such as machine learning and robotic process automation, enable automation of repetitive tasks, leading to increased efficiency and productivity. According to a study by Accenture, AI has the potential to boost labor productivity by up to 40% by 2035 (Accenture, 2018). This increased efficiency can free up human resources to focus on more complex and creative tasks, ultimately driving economic growth.

A major opportunity AI presents to the economy is ability to analyze vast amounts of data and generate insights that can inform better decision-making. This can be particularly beneficial in industries such as finance, healthcare, and marketing, where data-driven decisions can lead to improved outcomes. For instance, AI-powered predictive analytics can help financial institutions identify potential risks and opportunities, leading to more informed investment decisions (PwC, 2019). By enabling better decision-making, AI can contribute to economic growth and competitiveness.

As the world has fast becoming a global village, language barrier is becoming a thing of the past. AI has technologies, such as natural language processing and chatbots, can enhance customer



experience by providing personalized and efficient services. Chatbots, for example, can provide real-time assistance to customers, reducing response times and improving customer satisfaction. A study by Gartner predicts that by 2022, 70% of customer interactions in retail will involve AI chatbots (Gartner, 2020). Improved customer experience can lead to increased customer loyalty, higher sales, and ultimately, economic growth.

AI presents significant opportunities for economic growth through automation, enhanced decision-making, improved customer experience, innovation, and job creation. By leveraging AI technologies effectively, businesses and economies can benefit from increased productivity, competitiveness, and market expansion. However, it is crucial to address challenges related to data privacy, ethics, and workforce reskilling to fully realize the potential of AI in driving economic growth.

5.0 Challenges and Prospects

In Africa, AI presents both challenges and prospects for the continent's security and emerging economies. This section explores the challenges faced by Africa in harnessing AI's potential, as well as the prospects it offers in enhancing security and driving economic growth.

Challenges:

i. Infrastructure Deficit:

One of the primary challenges for AI in Africa is the lack of adequate infrastructure. Limited access to electricity, internet connectivity, and reliable data infrastructure hinder the implementation and utilization of AI technologies. To fully leverage AI's potential, African countries need to invest in robust infrastructure development.

ii. Skills Gap:

The shortage of skilled professionals in AI is another significant challenge. African nations need to prioritize the development of AI-related skills through educational programs and training initiatives. Bridging the skills gap will enable the continent to effectively utilize AI for security and economic advancement.



iv. Ethical Concerns:

AI raises ethical concerns regarding data privacy, algorithmic bias, and job displacement. African countries must establish robust regulatory frameworks to address these concerns and ensure that AI technologies are developed and deployed ethically. Failure to do so may exacerbate existing inequalities and perpetuate digital divides within societies.

v. Cybersecurity:

As AI technologies become more prevalent, the risk of cyber threats and attacks increases. African nations must invest in cybersecurity measures to protect critical infrastructure and sensitive data from cybercriminals. A lack of cybersecurity readiness could undermine the potential benefits of AI and pose significant security risks.

Prospects:

i. Enhanced Security:

AI has the potential to significantly enhance security in Africa. Intelligent (cloudbased) surveillance systems can help prevent crime, monitor borders, and identify potential security threats. AI-powered technologies can also strengthen cybersecurity measures, enabling African countries to safeguard their digital infrastructure and data.

ii. Economic Growth:

The adoption of AI can drive economic growth in emerging economies across Africa. AI-powered automation can streamline business processes, increase productivity, and reduce operational costs. This, in turn, can attract foreign investments, stimulate innovation, and create new job opportunities in sectors such as healthcare, agriculture, and manufacturing.

iii. Improved Healthcare:

AI has the potential to revolutionize healthcare in Africa. AI-powered diagnostic tools can aid in the early detection and treatment of diseases, particularly in remote and underserved areas. AI algorithms can also analyze large datasets to identify patterns and trends, helping healthcare providers make more informed decisions.

iv. Agricultural Transformation:



Agriculture is a vital sector in many African economies. AI technologies, such as remote sensing and predictive analytics, can help farmers optimize crop yields, manage water resources efficiently, and mitigate the impact of climate change. AI-powered agriculture can contribute to food security, reduce post-harvest losses, and boost rural livelihoods.

V. Energy:

Potential innovation in smart energy infrastructure and power grids can allow for the optimal allocation of energy resources, increasing efficient power supply and usage and reducing disruptions and unpredictability. The adoption of new and renewable technologies for energy generation and storage will also enable the country to move away from fossil fuels energy generation, which still accounts for 80% of energy generation in Nigeria

6.0 Conclusion

In conclusion, the challenges and prospects of AI, security, and emerging economies in Africa present a complex and interconnected landscape. Africa faces various challenges in adopting and leveraging AI technologies, including limited infrastructure, a shortage of skilled professionals, ethical concerns, and cybersecurity risks. However, the prospects of AI in Africa offer tremendous opportunities for economic growth, improved security, and societal development.

To address these challenges, it is crucial for African governments, businesses, and civil society to collaborate and invest in key areas. Firstly, infrastructure development is essential to ensure widespread access to AI technologies and digital connectivity. This includes expanding broadband networks, improving electricity supply, and establishing data centers. Secondly, promoting education and skills development is critical to address the shortage of AI professionals. Investing in STEM education, vocational training, and AI research institutions can build a skilled workforce capable of driving AI innovation in Africa.

Furthermore, addressing ethical concerns is paramount to ensure the responsible and inclusive deployment of AI technologies. This involves establishing regulatory frameworks, privacy protections, and guidelines for AI development and use. Additionally, cybersecurity measures must be strengthened to protect against potential threats and safeguard critical systems and data.

Despite these challenges, the prospects of AI in Africa are promising. AI can revolutionize various sectors, including agriculture, healthcare, finance, and transportation, driving economic growth and



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improving the quality of life for African citizens. AI-powered solutions can enhance agricultural productivity, provide accessible healthcare services, enable financial inclusion, and optimize transportation systems.

Finally, embracing AI, addressing security concerns, and nurturing emerging economies in Africa require a multi-faceted approach. By investing in infrastructure, education, ethics, and cybersecurity, Africa can unlock the transformative potential of AI. This will contribute to sustainable economic development, enhanced security, and improved livelihoods for the people of Africa. With the right strategies and collaborative efforts, Africa can position itself as a global leader in AI innovation, creating a brighter future for the continent.



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CYBER SECURITY AND ARTIFICIAL INTELLIGENCE

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ABSTRACT

The digital age has ushered in unprecedented connectivity and technological advancements, but it has also exposed critical vulnerabilities in cybersecurity. Traditional methods of defending against cyber threats are increasingly insufficient due to the sophisticated and evolving nature of these threats. Artificial intelligence (AI) offers promising solutions to enhance cybersecurity measures, providing capabilities such as advanced threat detection, automated response, and predictive analytics. The study adopts systematic research design which involves a clearly defined process for collecting, analyzing, and interpreting data to answer specific research questions or test hypotheses. The approach ensures that the research is comprehensive, reliable and valid. This study explores the integration of AI in cybersecurity, highlighting its potential benefits, such as improved threat detection accuracy, faster response times, and proactive defense mechanisms. However, it also addresses the challenges associated with AI implementation, including technical and financial barriers, risks of AI-driven attacks, data privacy concerns, and ethical and legal considerations. Examining global statistics and focusing on regions like Africa and Nigeria, the study underscores the critical need for AI-driven cybersecurity solutions in various contexts. The conclusion emphasizes the transformative potential of AI in cybersecurity and the necessity of overcoming implementation challenges to ensure robust protection of digital systems and data in an increasingly interconnected world.

Keyword: Cybersecurity, Artificial Intelligence (AI), Threat Detection, Predictive Analytics AI-driven Cyberattacks



1.0 INTRODUCTION

The rapid advancement of technology has transformed the way we live, work, and communicates (Cascio and Montealegre, 2016). This digital revolution, while bringing numerous benefits, has also introduced new vulnerabilities and threats. As our reliance on digital systems grows, so does the importance of securing these systems against cyberattacks (Chidambaram and Zigurs, 2020). Cybersecurity has thus become a critical field, aiming to protect information, systems, and networks from unauthorized access, damage, and disruption (Corallo, et al., 2021).

Cybersecurity and artificial intelligence (AI) are increasingly intertwined fields with significant implications for each other (Brown and Duguid, 2017). In the digital age, cybersecurity and artificial intelligence (AI) have emerged as two critical domains that are increasingly interdependent. Cybersecurity focuses on protecting systems, networks, and data from digital attacks, theft, and damage (Djenna, et al., 2021). With the proliferation of internet-connected devices and the increasing sophistication of cyber threats, the importance of robust cybersecurity measures has never been greater.

Artificial Intelligence, on the other hand, involves the development of systems capable of performing tasks that typically require human intelligence (Lehto, 2022). These tasks include learning from data, recognizing patterns, making decisions, and predicting future events. AI's capacity to process and analyze large volumes of data quickly and accurately makes it a powerful tool in various fields, including cybersecurity (Ustundag *et al.*, 2018). The integration of AI into cybersecurity represents a transformative shift in how digital threats are managed and mitigated. Traditional cybersecurity measures often rely on predefined rules and signatures to detect and respond to threats. While effective to some extent, these methods can struggle to keep pace with the rapidly evolving landscape of cyber threats (Gunduz and Das 2021). AI, with its ability to learn and adapt, offers a more dynamic and proactive approach to cybersecurity.



Despite the promising capabilities of AI in enhancing cybersecurity, several critical issues persist. Implementing AI-driven cybersecurity solutions requires significant technical expertise and financial investment, which many organizations, especially small and medium-sized enterprises (SMEs), may lack. Integrating AI with existing cybersecurity infrastructure can be complex and resource-intensive, posing a barrier to widespread adoption. Just as AI can enhance defenses, it can also be weaponized by malicious actors to create more sophisticated and adaptive attacks. Addressing bias in AI models is essential to ensure equitable and ethical cybersecurity practices. Organizations must navigate complex regulatory landscapes to ensure compliance with data protection and privacy laws while deploying AI-driven cybersecurity solutions. However, this study examines the nexus between cyber security and artificial intelligence.

2.0 LITERATURE REVIEW

2.1 Cybersecurity

Cybersecurity, digital security, or information technology security (IT security) is the protection of computer systems and networks from attacks by malicious actors that may result in unauthorized information disclosure, theft of, or damage to hardware, software, or data, as well as from the disruption or misdirection of the services they provide (Cascio and Montealegre, 2016). The field is significant due to the expanded reliance on computer systems, the Internet and wireless network standards such as Bluetooth and Wi-Fi. It is also significant due to the growth of smart devices, including smartphones, televisions, and the various devices that constitute the Internet of things (IoT). Cybersecurity is one of the most significant challenges of the contemporary world, due to both the complexity of information systems and the societies they support (Chidambaram, and Ziguers. 2020). Security is of especially high importance for systems that govern large-scale systems with far-reaching physical effects, such as power distribution, elections, and finance. While most aspects of computer security involve digital measures such as electronic passwords and encryption,



physical security measures such as metal locks are still used to prevent unauthorized tampering (Brown and Duguid, 2017).

2.2 Artificial intelligence

Artificial intelligence (AI), in its broadest sense, is intelligence exhibited by machines, particularly computer systems (Corallo *et al.*, 2020). It is a field of research in computer science that develops and studies methods and software that enable machines to perceive their environment and use learning and intelligence to take actions that maximize their chances of achieving defined goals. Such machines may be called AIs (Djenna *et al.*, 2021).

Some high-profile applications of AI include advanced web search engines (e.g., Google Search); recommendation systems (used by YouTube, Amazon, and Netflix); interacting via human speech (e.g., Google Assistant, Siri, and Alexa); autonomous vehicles (e.g., Waymo); generative and creative tools (e.g., ChatGPT, Apple Intelligence, and AI art); and superhuman play and analysis in strategy games (e.g., chess and Go). However, many AI applications are not perceived as AI: "A lot of cutting edge AI has filtered into general applications, often without being called AI because once something becomes useful enough and common enough it's not labeled AI anymore (Lehto, 2022).

2.3 The Role of AI in Cybersecurity

1. **Threat Detection and Monitoring:** AI algorithms excel at analyzing vast amounts of data to identify patterns indicative of cyber threats. Continuously monitoring network traffic, user behavior, and system activities, AI can detect anomalies that may signify an attack, often before traditional methods would catch them (Ustundag *et al.*, 2018).
2. **Automated Response:** In the face of a cyber threat, timely response is crucial. AI can automate many aspects of the incident response process, such as isolating affected systems,



deploying patches, and updating security protocols. This automation helps mitigate damage and reduce the time to recover from an attack (Abdulhussein, 2024).

3. **Vulnerability Management:** Identifying and prioritizing vulnerabilities in a system is a complex task. AI can help by analyzing the potential impact and likelihood of exploitation for each vulnerability, allowing security teams to focus their efforts on the most critical issues.
4. **Enhanced Authentication:** Traditional authentication methods, like passwords, are often inadequate. AI can enhance authentication systems by analyzing a combination of biometric data (e.g., fingerprints, facial recognition) and user behavior (e.g., typing patterns, login times) to detect unauthorized access attempts more effectively.

2.4 Challenges and Risks

While AI offers significant benefits for cybersecurity, it also introduces new challenges:

1. **AI-driven Cyberattacks:** Cybercriminals can leverage AI to develop more sophisticated attacks, such as AI-generated phishing emails that are harder to detect or AI algorithms designed to find and exploit vulnerabilities.
2. **Data Privacy Concerns:** AI systems require large amounts of data to function effectively. Ensuring the privacy and security of this data is a significant concern, especially when it includes sensitive information (Bashir and Bashir, 2022).
3. **False Positives and Negatives:** AI systems are not infallible and can produce false positives (flagging legitimate activities as threats) or false negatives (failing to detect actual threats). Fine-tuning AI models to balance accuracy and reliability is an ongoing challenge.



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The convergence of cybersecurity and artificial intelligence represents a significant advancement in the fight against cyber threats. AI's ability to analyze data, detect anomalies, and automate responses enhances the effectiveness of cybersecurity measures (Corallo *et al.*, 2020). However, this integration also necessitates careful consideration of the risks and challenges associated with AI. As technology continues to evolve, the collaboration between AI and cybersecurity will play a crucial role in safeguarding our digital future.

3.0 METHODOLOGY

The study adopts systematic research design. A systematic research design is a structured and methodical approach to conducting research. It involves a clearly defined process for collecting,



analyzing, and interpreting data to answer specific research questions or test hypotheses. This approach ensures that the research is comprehensive, reliable, and valid.

4.0 RESULTS AND DISCUSSION

This section reveals the result from the systematic research of extant literature on cyber security and artificial intelligence.

4.1 Results

Detection Rates: AI-driven cybersecurity systems demonstrated significantly higher detection rates for various cyber threats, including malware, phishing, and zero-day exploits, compared to traditional methods. Machine learning algorithms trained on vast datasets were able to identify subtle patterns and anomalies indicative of potential attacks (Cascio and Montealegre, 2016).

Response Times: Automated response mechanisms powered by AI reduced the time to contain and mitigate threats. In simulated environments, AI systems responded to incidents within seconds, whereas manual intervention took minutes to hours.

ii. Reduction in False Positives and Negatives:

False Positives: AI systems, through continuous learning and refinement, showed a decrease in the rate of false positives. This reduction minimized the number of unnecessary alerts, allowing security teams to focus on genuine threats (Chidambaram and Zigurs, 2020).

False Negatives: The advanced pattern recognition capabilities of AI resulted in fewer false negatives, ensuring that more threats were accurately identified and addressed (Brown and Duguid, 2017).



iii. Predictive Analytics and Proactive Defense:

Predictive Capabilities: AI models were able to predict potential future attacks based on historical data and emerging threat patterns. This proactive approach enabled organizations to strengthen their defenses before attacks could occur (Djenna *et al.*, 2021).

Threat Intelligence: AI-powered systems aggregated and analyzed threat intelligence from multiple sources, providing comprehensive insights into evolving cyber threats and enabling preemptive action.

iv. Operational Efficiency and Cost Savings:

Efficiency Gains: The automation of threat detection and response processes significantly increased operational efficiency. Security teams reported being able to manage more incidents with the same or fewer resources (Lehto, 2022).

Cost Reduction: Organizations that implemented AI-driven cybersecurity solutions experienced cost savings due to reduced downtime, lower incident response costs, and minimized damage from cyberattacks.

v. Real-world Case Studies:

Global Implementation: Leading organizations across various sectors, including finance, healthcare, and manufacturing, successfully integrated AI into their cybersecurity frameworks. These case studies highlighted the tangible benefits of AI, such as enhanced protection and reduced incident response times (Lehto, 2022).



African and Nigerian Context: In regions like Africa and Nigeria, where cybersecurity infrastructure faces unique challenges, AI-driven solutions provided a robust defense mechanism. Local organizations reported improved threat detection and resilience against cyberattacks.

2. Discussion

i. Effectiveness of AI in Cybersecurity:

Superior Detection and Response: The results confirm that AI enhances the effectiveness of cybersecurity systems by providing superior threat detection and response capabilities. The ability of AI to analyze large datasets in real-time and learn from new threats makes it a valuable asset in the cybersecurity arsenal (Ustundag *et al.*, 2018).

Proactive Defense: AI's predictive analytics capabilities are particularly beneficial in creating a proactive defense strategy. By anticipating potential threats, organizations can implement preemptive measures, significantly reducing the risk of successful attacks (Gunduz and Das, 2020).

ii. Challenges and Limitations:

Data Quality and Quantity: The effectiveness of AI in cybersecurity heavily relies on the quality and quantity of data available for training. Inadequate or biased data can lead to inaccurate threat detection and response.

Integration Complexity: Integrating AI into existing cybersecurity frameworks can be complex and resource-intensive. Organizations need to invest in technical expertise and infrastructure to effectively deploy AI solutions (Mundial, 2020).



AI-driven Threats: The same technology that enhances cybersecurity can also be exploited by malicious actors to develop more sophisticated attacks. This necessitates continuous innovation and adaptation of AI defenses.

iii. Ethical and Legal Considerations:

Bias and Fairness: AI algorithms may exhibit biases that can lead to unfair or discriminatory outcomes. Ensuring fairness and transparency in AI systems is crucial to maintaining trust and credibility.

Privacy Concerns: The use of AI in cybersecurity involves processing large volumes of data, raising concerns about data privacy and security. Organizations must ensure compliance with data protection regulations and adopt robust data governance practices (Abdulhussein, 2024).

iv. Future Directions:

Continuous Learning and Adaptation: AI systems must continuously learn and adapt to new threats to remain effective. Investing in research and development to enhance AI capabilities will be critical for staying ahead of evolving cyber threats.

Collaboration and Knowledge Sharing: Collaboration among organizations, cybersecurity experts, and AI researchers is essential for sharing knowledge and best practices. This collective effort will drive innovation and improve the overall effectiveness of AI-driven cybersecurity solutions.

Regulatory Frameworks: Developing comprehensive regulatory frameworks to govern the use of AI in cybersecurity will help address ethical, legal, and privacy concerns. These frameworks should



promote responsible AI use and ensure that security measures do not infringe on individual rights (Bashir and Bashir, 2022).

5.0 CONCLUSION

The convergence of cybersecurity and artificial intelligence (AI) marks a pivotal development in the ongoing effort to safeguard digital infrastructures. As cyber threats continue to evolve in sophistication and frequency, traditional cybersecurity methods are increasingly inadequate. AI offers a powerful set of tools that can significantly enhance our ability to detect, respond to, and predict cyber threats. AI's capabilities in processing large volumes of data, recognizing patterns, and automating responses provide a dynamic and proactive approach to cybersecurity. These advancements can help mitigate the limitations of human analysts and traditional defense mechanisms, enabling more robust protection of digital assets.

However, the integration of AI into cybersecurity is not without its challenges. Technical and financial constraints, integration complexities, risks of AI-driven cyberattacks, data privacy concerns, and the need for accuracy and reliability in AI systems all pose significant hurdles. Additionally, ethical and legal considerations, such as addressing biases in AI algorithms and ensuring regulatory compliance, must be carefully navigated. Despite these challenges, the potential benefits of AI in cybersecurity are substantial. Continuing to develop and refine AI technologies, investing in infrastructure and expertise, and addressing ethical and legal implications, organizations can enhance their cybersecurity posture.

While the path to integrating AI into cybersecurity is complex, its potential to revolutionize the field and provide a more secure digital future is undeniable. Continued innovation, collaboration, and investment in AI-driven cybersecurity solutions will be crucial in addressing the ever-growing and sophisticated cyber threats in the digital age.



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RECENT ADVANCES IN GLASS SCIENCE AND TECHNOLOGY: A COMPREHENSIVE REVIEW OF EMERGING TRENDS, INNOVATIONS AND APPLICATIONS

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Abstract

This paper provides an exhaustive review of recent advancements in glass science and technology, covering emerging trends, innovations, and applications. The literature review encompasses developments in glass composition, processing, characterization, and applications, including aerospace, biomedical, construction, and renewable energy. The methodology section discusses the research approach and sources used. The results section presents key findings, followed by a discussion of their implications and future directions.

KEYWORDS:

Glass Science, Emerging Trends, Innovations, Applications, Advanced Manufacturing, Material Characterization



1.0 INTRODUCTION

Glass science and technology have witnessed significant advancements in recent years, driven by increasing demand for high-performance materials. High strength glasses typically have relatively higher amounts of SiO₂ than the other types of fiberglass. Because of the relatively high throughput achievable for this glass, it holds the potential for greatly increasing the use of glass as a reinforcement material in such applications as ballistics, wind turbine blades and compressed gas tanks. (Jones et al., 2009).

The use of bioactive glasses in dentistry, reconstructive surgery, and in the treatment of infections can be considered broadly beneficial based on the emerging literature about the potential bioactivity and biocompatibility of these materials, particularly with reference to Bioglass (Cannio et al., 2021).

Silica glass has excellent material properties such as thermal and chemical stability, hardness, and optical transparency in a wide wavelength range. Yet, as a result of the stability and the brittleness of silica glass, fabricating three-dimensional (3D) silica glass objects with features at the micrometer scale remains challenging, although structures at this scale are critical for many exciting applications, for example, in nanophotonics¹, nanoelectromechanical systems, and nanofluidics. To address this, additive manufacturing of silica glass (Bridge et al., 2007).

This paper aims to provide a comprehensive overview of the latest developments in glass research and innovation, highlighting emerging trends, innovations, and applications.

2.0 LITERATURE REVIEW

Recent studies have focused on developing new glass compositions with improved properties, such as:

- High-strength, low-thermal-expansion glasses for aerospace applications (Kim et al., 2020).
- Bioactive glasses for biomedical applications (Rahaman et al., 2019).
- Sustainable glasses produced from waste materials (Chen et al., 2020).
- Low-iron glasses for solar energy applications (Li et al., 2020).

Advances in processing techniques have also been reported, including:

- 3D printing of glass structures (Liu et al., 2019).



- Laser-induced breakdown spectroscopy for glass analysis (García et al., 2020).
- Sol-gel processing for glass coatings (Klein et al., 2020) .

Characterization techniques have been improved, including:

- Advanced microscopy techniques for glass structure analysis (Lee et al., 2020).
- Spectroscopic methods for glass property characterization (Singh et al., 2020) .

3.0 METHODOLOGY

This review is based on a comprehensive search of scientific literature published in the last five years. Sources include peer-reviewed journals, conference proceedings, and industry reports.

4.0 RESULTS

Key findings include:

1. Development of new glass compositions with enhanced properties:
 - Glasses with various alkali metal oxides (Na/Li/K) have been synthesized and characterized using various experimental techniques to understand the structure-property correlation and its effect on the diffusion phenomenon. The as-prepared glasses for substrate are thermally and mechanically more stable, with better conductivity and higher diffusivity than commercially available soda lime glass (SLG)(Neetu et al., 2020).
2. Advances in processing techniques, such as 3D printing and laser-induced breakdown spectroscopy

-The advanced processing techniques are in high demand to overcome the challenges, and to fabricate complex adsorbent structures with custom-designed 3D architectures. Additive manufacturing (AM) techniques, often referred to more broadly as 3D printing, have much to offer in this area, including higher customization, design freedom, flexibility and multi-scale architecture control. AM techniques can build more sophisticated designs than conventional approaches through controlled material addition or consolidation.

(Shane et al.,2021).

3. Improved characterization techniques for glass structure and property analysis.



- It is commonly held that tungsten oxide WO_3 can result in the development of distinct structural units within the glass structure, such as WO_4 and WO_6 units that consist of W^{6+} cations and $(\text{W}^{5+} \text{O}_3)(\text{oct})$ units that contain W^{5+} cations [2,3]. Furthermore, glasses containing tungsten exhibit outstanding electronic band transitions (5d), high UV optical absorption, and precise control of W^{6+} povalentstates through electron reduction to W^{5+} (Hammam et al., 2023).
4. Advances in processing techniques, such as 3D printing and laser-induced breakdown spectroscopy.
- Laser-induced breakdown spectroscopy (LIBS) is regarded as the future superstar for chemical analysis, but the relatively high measurement uncertainty and error remain the persistent challenges for its technological development as well as wide applications. In the present work, mechanisms of measurement uncertainty generation and basic principle of signal uncertainty and matrix effects impacting quantification performance.
- Recent Advances in Laser-induced Breakdown Spectroscopy Quantification: from Fundamental Understanding to Data Processing (Zhe et al., 2021).
5. Increased focus on sustainability and environmental impact
- Despite years of discussion on the merits of sustainability, there is still no consensus on how to determine if environmental sustainability is achieved or even if progress is made. Development of impact assessment methodologies for environmental sustainability. Volume 16,pages 681-690,(2014).

4.2 Discussion

The recent developments in glass technology, including sustainable glasses and innovative processing techniques, are poised to revolutionize numerous industries. Here are some potential implications:

Aerospace Industry

Lightweight and durable materials: New glass technologies can lead to the creation of lighter, stronger, and more fuel-efficient aircraft, reducing emissions and enhancing performance.



Advanced cockpit displays: Innovative glass processing techniques can enable the development of high-resolution, curved, and durable displays for aircraft cockpits.

Biomedical Industry

- Improved medical devices: Sustainable glasses can be used to create biocompatible and sterilizable medical devices, such as syringes, test tubes, and implantable devices.
- Enhanced diagnostic equipment: Advanced glass technologies can lead to the development of more accurate and durable diagnostic equipment, like MRI and CT scanners.

Construction Industry

- Energy-efficient buildings: Sustainable glasses can be used to create energy-efficient windows, reducing heat transfer and energy consumption in buildings.
- Durable and low-maintenance materials: Innovative glass processing techniques can lead to the development of self-cleaning and durable glass materials for building facades and interior design.

Renewable Energy Industry

6. Efficient solar panels: Advanced glass technologies can improve the efficiency and durability of solar panels, reducing costs and enhancing renewable energy generation.
7. Thermal energy storage: Sustainable glasses can be used to create thermal energy storage systems, enabling more efficient and sustainable energy storage.

Future Growth and Opportunities

The emergence of sustainable glasses and innovative processing techniques is expected to drive future growth in various industries. As research and development continue to advance, we can anticipate:



9. Increased adoption of sustainable materials.
10. Improved product performance and efficiency.
11. New applications and markets for glass technology.
12. Enhanced collaboration and innovation across industries.

The future of glass technology holds much promise, and its impact will be felt across various sectors, leading to a more sustainable, efficient, and innovative world.

5.0 CONCLUSION

Breakthroughs in glass science and technology have unlocked the potential for high-performance materials with exceptional properties, paving the way for:

7. Unprecedented strength and resilience.
8. Revolutionary thermal management capabilities.
9. Unmatched optical clarity and precision.

As innovation continues to propel the industry forward, we can expect:

- VI. Sustained growth and expansion.
- VII. Proactive solutions to emerging challenges.
- VIII. New frontiers in material applications and possibilities.

The future of glass science and technology is bright, with ongoing advancements poised to reshape the material landscape.



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ARTIFICIAL INTELLIGENCE (AI) FOR SURVEILLANCE AND CRIME MONITORING FOR ECONOMIC STABILITY IN NIGERIA: A COMPREHENSIVE REVIEW

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Abstract

Artificial Intelligence (AI) has emerged as a transformative tool in the realm of surveillance and monitor, particularly in bolstering economic stability. This paper explores the pivotal role of AI in enhancing surveillance capabilities across various economic sectors, ensuring proactive risk management and efficient resource allocation. AI-powered surveillance systems leverage advanced algorithms to analyze vast streams of data in real-time, enabling rapid identification of anomalies and patterns that signify potential economic disruptions. By integrating machine learning models, these systems adapt and evolve, continuously improving their ability to detect emerging threats and trends. AI facilitates predictive analytics, enabling policymakers and businesses to forecast economic trends with greater accuracy. This predictive capability empowers proactive decision-making, mitigating risks and optimizing resource allocation strategies in response to dynamic market conditions. Ethical considerations and privacy concerns are also addressed, emphasizing the importance of responsible AI deployment in surveillance and monitoring frameworks. AI-driven surveillance and monitoring systems represent a crucial advancement in safeguarding economic stability, offering unprecedented insights and capabilities to navigate the complexities of global markets effectively. As AI continues to evolve, its role in economic surveillance promises to be increasingly indispensable in shaping resilient and sustainable economies. Secondary sources were employed since the topic of discourse is a green topic. The advent of STEM, AI, Coding, Machine learning, Fintech, Digital Literacy etc, all tell the future is now.

Keywords: Artificial Intelligence, Surveillance, Monitoring and Economic Stability.



1.0 INTRODUCTION

Artificial Intelligence (AI) has revolutionized various facets of our society, and its application in surveillance and monitoring has become increasingly pivotal, particularly in ensuring economic stability. In recent years, AI technologies have demonstrated profound capabilities in processing and analyzing vast amounts of data, thereby enhancing surveillance capabilities across different economic sectors. This introduction explores how AI is reshaping traditional surveillance and monitoring practices, offering new tools to anticipate and manage economic risks effectively (Edward, 2020).

The integration of AI in surveillance systems enables real-time analysis and interpretation of complex data streams, facilitating early detection of anomalies that could signal potential economic disruptions. By leveraging machine learning algorithms, these systems can autonomously learn from data patterns and adapt their strategies, thereby improving their accuracy and efficiency over time.

Moreover, AI-driven predictive analytics empower policymakers and businesses with insights into future economic trends. This foresight enables proactive decision-making, optimizing resource allocation and mitigating risks in response to evolving market dynamics (Esther, D. & Abhijit, B. 2020).

However, alongside these advancements, ethical considerations such as privacy and fairness in AI deployment must be carefully addressed. Balancing technological innovation with ethical guidelines is essential to ensure responsible use of AI in economic surveillance and monitoring frameworks.

This introduction sets the stage for further exploration into the transformative potential of AI in safeguarding economic stability, highlighting both its opportunities and challenges in shaping resilient and sustainable economies.

2.0 LITERATURE REVIEW

2.1 CONCEPTUAL CLARIFICATION

Artificial Intelligence for Surveillance and Monitoring for Economic encompasses several key aspects that illustrate how AI is utilized to enhance economic stability through advanced surveillance and monitoring capabilities (Shoshana, 2015). Here are the core concepts:

Real-time Data Analysis: AI enables the processing and analysis of vast amounts of real-time data from diverse sources such as financial markets, consumer behavior, and macroeconomic indicators.



This capability allows for timely identification of trends, anomalies, and potential risks to economic stability by (Bruce, 2018).

Optimization of Resource Allocation: By analyzing data on resource utilization, demand patterns, and supply chains, AI can optimize resource allocation strategies. This includes efficient deployment of capital, labor, and other resources to foster economic growth and stability.

Risk Management: AI-powered surveillance enhances risk assessment and management by continuously monitoring economic indicators and market behaviors. It enables proactive risk mitigation strategies and resilience building against potential economic shocks.

Decision Support Systems: AI serves as a decision support tool for policymakers, financial institutions, and businesses by providing actionable insights derived from complex data analyses. This facilitates more effective policy formulation, investment strategies, and business planning.

Adaptability and Scalability: AI systems are adaptable to evolving economic conditions and scalable across different sectors and regions. They can learn from new data inputs and adjust their models to reflect changing economic dynamics, improving their effectiveness over time.

AI for economic surveillance and monitoring underscores its role in leveraging data-driven insights to foster stability, resilience, and sustainable growth in economies worldwide. It combines technological innovation with regulatory oversight and ethical considerations to maximize its positive impact on society and the economy (Malka, 2017).

2.1.1 EFFECTS OF ARTIFICIAL INTELLIGENCE (AI) ON ECONOMIC STABILITY

The effects of Artificial Intelligence (AI) on economic stability are profound and multifaceted, influencing various aspects of economic activity and governance (Kristalina, 2024). Here are several key ways in which AI impacts economic stability:

Enhanced Efficiency and Productivity: AI technologies streamline processes, automate routine tasks, and optimize resource allocation. This efficiency boost translates into higher productivity across industries, leading to economic growth and stability. For instance, AI-powered predictive maintenance in manufacturing reduces downtime and improves operational efficiency, contributing to sustainable production practices.

Improved Decision-Making: AI enables data-driven decision-making by providing insights from large datasets. This capability enhances the accuracy and effectiveness of policy formulation, investment decisions, and resource allocation. By leveraging AI-driven analytics, governments and businesses can anticipate market trends, mitigate risks, and capitalize on opportunities, thereby fostering sustainable economic development (Cathy, 2016).



Innovation and Technological Advancement: AI fuels innovation by accelerating research and development in various sectors, including healthcare, finance, and transportation. By facilitating breakthroughs in areas such as precision medicine, renewable energy, and smart infrastructure, AI contributes to sustainable technological advancements that address societal challenges and promote long-term economic stability.

Labor Market Dynamics: AI automation has implications for the labor market, potentially displacing certain jobs while creating new opportunities in high-skilled roles related to AI development, maintenance, and oversight. Managing this transition through education and re-skilling programs is crucial for ensuring inclusive economic stability and reducing socioeconomic inequalities (Kristalina, 2024).

Environmental Impact: AI plays a pivotal role in environmental stability through applications such as climate modeling, resource management, and pollution control. For example, AI-powered analytics can optimize energy consumption, enhance agricultural efficiency, and support conservation efforts, contributing to sustainable environmental practices and resilience against climate change impacts.

Ethical and Social Considerations: As AI becomes increasingly integrated into economic systems, addressing ethical concerns related to privacy, fairness, and accountability becomes imperative. Establishing regulatory frameworks and ethical guidelines ensures that AI technologies are deployed responsibly to uphold societal values and support sustainable economic practices (Kate, 2024).

AI's impact on economic stability is transformative, driving efficiency gains, fostering innovation, and addressing global challenges. By harnessing AI's potential while addressing its challenges, societies can promote inclusive growth, environmental stewardship, and resilient economic systems that benefit present and future generations.

2.1.2 APPLICATIONS OF AI IN CRIME MONITORING FOR ECONOMIC STABILITY

The application of Artificial Intelligence (AI) for monitoring economic stability encompasses several critical areas where AI technologies can enhance analysis, prediction, and decision-making processes (Bruce, 2018). AI applications include the followings:

Real-time Data Analysis: AI enables the processing and analysis of vast amounts of real-time economic data from various sources such as financial markets, consumer behavior, and macroeconomic indicators. This capability allows for continuous monitoring of economic trends, identifying patterns, anomalies, and potential risks promptly as opined by (Jeffrey, 2006).



Predictive Analytics: AI-driven predictive models can forecast economic indicators such as GDP growth, inflation rates, and employment trends with greater accuracy than traditional methods. This foresight helps policymakers, central banks, and businesses anticipate economic shifts and plan accordingly to promote stability and sustainable growth by (Jeffrey, 2006).

Risk Management and Early Warning Systems: AI enhances risk assessment by continuously monitoring economic variables and identifying emerging risks or vulnerabilities. This proactive approach enables timely intervention to mitigate financial crises, market fluctuations, or systemic risks, thereby safeguarding economic stability.

Policy Formulation and Impact Assessment: AI-powered analytics provide policymakers with insights into the potential impacts of policy decisions on economic outcomes. By simulating scenarios and assessing policy effectiveness, AI supports evidence-based policymaking aimed at achieving long-term economic stability goals.

Continuous Learning and Adaptation: AI systems improve over time through machine learning algorithms that adapt to new data inputs and evolving economic conditions. This adaptive capability ensures that monitoring frameworks remain robust and responsive to changing economic dynamics and emerging challenges (Jeffrey, 2006).

AI applications for monitoring economic stability enhance decision-making, mitigate risks, and promote resilience in economic systems. By leveraging AI's capabilities in data analytics, predictive modeling, and real-time monitoring, stakeholders can foster sustainable economic growth, address societal challenges, and achieve long-term prosperity (Kate, 2024).

2.1.3 NEGATIVE EFFECTS OF ARTIFICIAL INTELLIGENCE (AI) ON ECONOMIC STABILITY

In a new analysis, IMF staff examines the potential impact of AI on the global labor market. Many studies have predicted the likelihood that jobs will be replaced by AI. Yet we know that in many cases AI is likely to complement human work. The IMF analysis captures both these forces. AI will affect almost 40 percent of jobs around the world, replacing some and complementing others. We need a careful balance of policies to tap its potential ([Kristalina](#), 2024)

We are on the brink of a technological revolution that could jumpstart productivity, boost global growth and raise incomes around the world. Yet it could also replace jobs and deepen inequality. The rapid advance of artificial intelligence has captivated the world, causing both excitement and alarm, and raising important questions about its potential impact on the global economy ([Kristalina](#), 2024). The net effect is difficult to foresee, as AI will ripple through economies in complex ways.



What we can say with some confidence is that we will need to come up with a set of policies to safely leverage the vast potential of AI for the benefit of humanity.

The findings reveal that wealthier economies, including advanced and some emerging market economies tend to be better equipped for AI adoption than low-income countries, though there is considerable variation across countries. Singapore, the United States and Denmark posted the highest scores on the index, based on their strong results in all four categories tracked.

The findings are striking: almost 40 percent of global employment is exposed to AI. Historically, automation and information technology have tended to affect routine tasks, but one of the things that sets AI apart is its ability to impact high-skilled jobs. As a result, advanced economies face greater risks from AI—but also more opportunities to leverage its benefits—compared with emerging market and developing economies.

In advanced economies, about 60 percent of jobs may be impacted by AI, AI applications may execute key tasks currently performed by humans, which could lower labor demand, leading to lower wages and reduced hiring. In the most extreme cases, some of these jobs may disappear (Kristalina, 2024).

While Artificial Intelligence (AI) offers significant benefits to economic stability, there are also potential negative impacts and challenges that need to be addressed (Suelette, & Julian, 2020).

The negative effects of Artificial Intelligence (AI) on economic stability can manifest in several ways:

Job Displacement and Employment Challenges: AI-driven automation can lead to the displacement of human workers in various sectors, particularly those involving routine and repetitive tasks. This can result in unemployment or underemployment, contributing to economic instability and social inequality if displaced workers are unable to transition to new roles or industries.

Skills Mismatch and Re-skilling Challenges: The rapid adoption of AI technologies may outpace the ability of the workforce to acquire necessary skills for new jobs created by AI or to adapt to changing labor market demands. This skills mismatch can hinder economic stability by limiting productivity gains and exacerbating unemployment in the short term.

AI adoption may widen income disparities between workers who possess AI-related skills and those who do not. High-skilled workers who can leverage AI may benefit disproportionately from



economic gains, while low-skilled workers face stagnant wages or job losses, contributing to income inequality and social tensions (Kristalina, 2024).

Economic Concentration and Monopoly Power: AI technologies are often developed and controlled by large tech companies, leading to concentration of economic power and potential monopolistic behavior. This concentration can stifle competition, innovation, and entrepreneurship, thereby limiting economic dynamism and stability.

Data Privacy and Security Risks: AI relies heavily on vast amounts of data, raising concerns about privacy violations and data breaches. Poorly secured AI systems or unauthorized access to sensitive data can undermine consumer trust, disrupt business operations, and incur significant financial and reputational costs, impacting economic stability.

Over-reliance on AI systems for economic decision-making and critical infrastructure may create vulnerabilities to technical failures, cyber attacks, or algorithmic errors. These risks can disrupt economic activities, undermine investor confidence, and pose systemic threats to economic stability.

Addressing these negative effects requires proactive measures, including robust regulatory frameworks, investments in education and workforce development, ethical guidelines for AI deployment, and strategies to ensure inclusive economic growth. By mitigating risks and maximizing the benefits of AI adoption, societies can promote sustainable economic development that prioritizes long-term prosperity and societal well-being as ascertained by (Suelette, & Julian, 2020).

2.1.4 ARTIFICIAL INTELLIGENCE (AI) FOR CRIME PREVENTION AND DETECTION

Companies and cities all over world are experimenting with using artificial intelligence to reduce and prevent crime, and to more quickly respond to crimes in progress. The ideas behind many of these projects is that crimes are relatively predictable; it just requires being able to sort through a massive volume of data to find patterns that are useful to law enforcement (Aaron, 2021). This kind of data analysis was technologically impossible a few decades ago, but the hope is that recent developments in machine learning are up to the task by (Aaron, 2010) who did a review of the current research on the economic impact of crime and most analysis puts the cost at approximately 2% of gross domestic product in the United States. AI helps in optimizing resource allocation by predicting where police presence may be most needed.



AI-powered smart cameras are used in urban areas for monitoring public spaces, detecting unusual activities, and providing real-time alerts to authorities. AI tools analyze data from various sources, including social media and public records, to assist in investigations and crime prevention.

Cybercrime: AI helps in detecting and preventing cybercrime by identifying suspicious activities and potential threats in real-time. AI aids in digital forensics by analyzing large datasets to uncover evidence and patterns related to cybercrimes.

Surveillance: There is some use of AI in surveillance, but it is typically less advanced compared to China and Australia. Efforts focus on improving monitoring capabilities with basic AI tools. Predictive policing tools are still under development or in the early stages of deployment. The focus is on leveraging data to improve crime prediction and resource management. Each country's approach to AI in crime control reflects its unique technological, regulatory, and social contexts.

3.0 METHODOLOGY

When considering AI implementation methodologies in Gabon, Australia, and China, it's important to understand the different contexts, capabilities, and priorities in each country as stated in Julia, A. (2016). Here's an overview of how AI is approached and implemented in these regions:

Gabon's approach to AI is still in the early stages compared to more developed nations Shoshana, Z. (2019). The government has been increasingly recognizing the potential of digital technologies, including AI, to drive economic growth and development. Gabon is in the early stages of implementing AI for crime control. Current initiatives are often limited to pilot projects or small-scale deployments. The country relies on international aid and collaboration to develop and implement AI technologies for crime prevention and control. The Gabonese government is working on integrating technology into various sectors, often through broader digital transformation agendas, like the "Gabon Emergent" plan, which aims to modernize infrastructure and services. China has a highly ambitious AI strategy outlined in the "Next Generation Artificial Intelligence Development Plan," aiming to make China a global leader in AI by 2030. The Chinese government provides substantial funding and strategic direction for AI development, focusing on areas like smart cities, healthcare, and manufacturing. High investment in AI education and research, with many top universities (e.g., Tsinghua University, Peking University) offering specialized AI programs. AI is used for risk assessment in predictive policing to help law enforcement agencies



anticipate and prevent potential criminal activities. Tools analyze historical crime data to identify patterns and potential risks Julia, A. (2016).

4.0 CONCLUSION

Conclusively, while Artificial Intelligence (AI) offers immense potential to enhance economic stability through efficiency gains, predictive capabilities, and innovative solutions, it also presents significant challenges and risks that must be carefully managed. AI also raises concerns for Job displacement due to automation, skills mismatches, and income inequality are pressing issues that could undermine economic stability and social cohesion. Moreover, AI-driven biases, data privacy risks, and cyber security threats pose challenges to ethical AI deployment and consumer trust, essential for sustained economic progress.

To harness the benefits of AI while mitigating its negative impacts, policymakers, businesses, and society at large must collaborate. This collaboration should focus on implementing inclusive economic policies, investing in education and reskilling programs, and establishing robust regulatory frameworks to ensure fair AI deployment. Additionally, proactive measures are needed to address ethical considerations, mitigate environmental impacts, and safeguard against technological risks.

Based on the discussion of AI's impact on economic stability and the challenges it presents, here are several recommendations for policymakers, businesses, and stakeholders to maximize AI's benefits while mitigating its negative effects on the economy:

1. Implement comprehensive education and training programs to equip the workforce with skills necessary to adapt to AI-driven changes in the labor market.
2. Design policies that promote inclusive economic growth and address income inequality exacerbated by AI adoption.
3. Establish clear ethical guidelines for AI deployment to ensure fairness, transparency, and accountability. Strengthen regulatory frameworks to oversee AI applications in sensitive areas such as finance, healthcare, and law enforcement,
4. Foster collaboration between AI developers, researchers, policymakers, and businesses to share best practices, address common challenges, and promote responsible AI innovation.
5. Allocate resources to support AI research and development aimed at addressing societal challenges, such as healthcare, climate change, and sustainable development.



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CYBER SECURITY AND ARTIFICIAL INTELLIGENCE (AI) FOR ECONOMIC STABILITY IN NIGERIA: A COMPREHENSIVE REVIEW

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Abstract

In an era increasingly defined by digital transformation, the convergence of Artificial Intelligence (AI) and cyber security emerges as a critical determinant of economic sustainability. This paper explores the symbiotic relationship between AI and cyber security in safeguarding economic activities against evolving cyber threats and the general crimes in nation. AI technologies, such as machine learning and predictive analytics, empower cyber security defenses by enhancing threat detection capabilities and enabling proactive responses to cyber incidents. These advancements bolster organizational resilience, mitigate financial risks associated with cyber attacks, and ensure continuity in economic operations. Cyber security plays a pivotal role in protecting AI systems themselves, preserving data integrity, and maintaining trust among stakeholders. Effective cyber security frameworks not only safeguard sensitive information but also foster an environment conducive to innovation and sustainable economic growth. Ethical considerations and regulatory compliance are integral to the deployment of AI-powered cyber security solutions, ensuring responsible use of data and algorithms. Addressing these aspects reinforces the foundation of economic sustainability by promoting transparency, accountability, and resilience in digital ecosystems. The integration of AI and cyber security is indispensable in fortifying economic sustainability against cyber threats. By harnessing the synergies between AI-driven innovation and robust cyber security practices, organizations and nations can navigate the complexities of the digital landscape with confidence, driving enduring economic prosperity and resilience.

Keywords: Cyber Security, artificial intelligence, economy and stability.



1.0 INTRODUCTION

In today's interconnected and digitized world, the intersection of Cyber Security and Artificial Intelligence (AI) stands as a pivotal axis for ensuring economic stability (Shoshana, 2020). As organizations increasingly rely on AI technologies to drive innovation and efficiency, the imperative to secure these advancements against cyber threats becomes paramount. This paper explores how the synergy between AI and cyber security not only protects economic assets but also fosters a resilient environment conducive to long-term economic growth. It is true because Cyber Security is as importance and Physical Security, the reason is that when our surroundings are clear of physical threads and the cyber space is not secured automatically we are not secured as stated by (Kate, 2019).

AI's transformative potential in cyber security lies in its ability to analyze vast amounts of data, detect anomalies, and predict emerging threats with unprecedented accuracy (Malka, 2019). These capabilities empower organizations to preemptively defend against cyber attacks, mitigate operational disruptions, and safeguard sensitive information critical to economic activities. Moreover, AI-driven cyber security solutions offer adaptive defenses that evolve in response to evolving threats, thereby enhancing organizational resilience and maintaining continuity in economic operations.

However, the deployment of AI in cyber security also raises ethical considerations regarding data privacy, algorithmic bias, and the responsible use of AI technologies. Balancing technological innovation with ethical guidelines is essential to build trust among stakeholders and ensure sustainable economic practices in a digitally driven landscape as ascertained by (Geoffrey, 2018). This introduction sets the stage for a deeper exploration into the synergistic relationship between AI and cyber security, elucidating how these technologies collectively contribute to economic stability by fortifying defenses, mitigating risks, and fostering a climate of trust and innovation.

2.0 LITERATURE REVIEW

2.1 CONCEPTUAL CLARIFICATION

Cyber security refers to the protection of computer systems, networks, and data from cyber threats such as cyber attacks, data breaches, and unauthorized access. It encompasses measures, technologies, and practices designed to safeguard information technology assets and ensure confidentiality, integrity, and availability of data (Malka, 2019).



AI involves the development of computer systems capable of performing tasks that typically require human intelligence, such as learning from experience, reasoning, and decision-making. AI technologies include machine learning, natural language processing, computer vision, and robotics, among others (Bruce, 2017). .

Economic stability refers to the ability of an economy to support long-term growth while maintaining stable and equitable economic conditions (Joseph, 2018). It involves strategies and policies aimed at promoting resilience, innovation, productivity, and inclusive growth across various sectors.

The intersection of AI and cyber security involves leveraging AI technologies to enhance cyber security measures (Joseph, 2018). AI enables automated threat detection, anomaly detection, and predictive analytics, thereby strengthening defenses against cyber threats and reducing response times to incidents.

Benefits of Artificial Intelligence (AI) for Economic Stability

Integrating AI-driven cyber security enhances economic stability by (Ronald, 2016) are stated below:

- ✓ **Protecting Digital Assets:** Safeguarding critical infrastructure, intellectual property, and sensitive data from cyber threats, which is essential for maintaining operational continuity and investor confidence.
- ✓ **Supporting Innovation:** Providing a secure environment for technological innovation and digital transformation initiatives, fostering economic growth and competitiveness.
- ✓ **Ensuring Regulatory Compliance:** Facilitating compliance with data protection regulations and industry standards, which is crucial for sustaining trust among consumers, businesses, and regulatory authorities.
- ✓ **Mitigating Economic Risks:** Minimizing financial losses associated with cyber incidents, including remediation costs, legal liabilities, and reputational damage, thereby promoting economic resilience.

Challenges and Ethical Considerations of AI

Despite the benefits, deploying AI in cyber security raises challenges such as (Ronald, 2016):

- **Ethical Use of AI:** Ensuring AI algorithms are used responsibly to avoid unintended consequences such as bias, privacy violations, or discriminatory practices.
- **Cyber security Skills Gap:** Addressing the shortage of skilled professionals capable of deploying and managing AI-driven cyber security solutions effectively.



- **Adaptability and Integration:** Overcoming technical challenges related to integrating AI with existing cyber security frameworks and adapting to rapidly evolving cyber threats.

AI and cyber security for economic stability underscores the importance of leveraging technological innovations while addressing ethical, regulatory, and operational challenges (Joseph, 2018). By striking a balance between innovation and responsibility, organizations and policymakers can harness the full potential of AI to bolster cyber security defenses and promote sustainable economic development.

Cyber security plays a crucial role in ensuring the economic stability of organizations and nations, particularly as they increasingly rely on Artificial Intelligence (AI) technologies (Kate, 2019). Here's how cyber security intersects with AI for economic stability:

Protection of AI Systems

AI systems themselves can be vulnerable to cyber threats such as data breaches, adversarial attacks, and manipulation of training data. Robust cyber security measures are essential to safeguard AI algorithms, models, and data from unauthorized access and tampering. AI often relies on large datasets, including sensitive information. Maintaining strong data privacy protections through encryption, access controls, and secure data storage practices is essential to preserve trust and comply with regulatory requirements, thereby supporting sustainable economic activities (Bruce, 2017).

Cyber attacks targeting AI systems or critical infrastructure can disrupt operations, leading to economic losses and instability. Implementing cyber security measures such as intrusion detection systems, incident response plans, and resilient architecture helps mitigate these risks and maintain continuity.

Economic stability relies on the trust of stakeholders, including consumers, businesses, and governments, in AI technologies (Bruce, 2017). Demonstrating a commitment to cyber security enhances trust by reducing the risk of data breaches, algorithmic bias, or misuse of AI systems, thereby promoting widespread adoption and long-term stability.

Cyber incidents can lead to significant financial losses, including direct costs of remediation, legal liabilities, and reputational damage. Investing in robust cyber security frameworks and risk management strategies reduces exposure to these financial risks, supporting economic resilience and stability (Bruce, 2017).

Integrating robust cyber security measures with AI technologies is essential for ensuring economic stability. By protecting AI systems, securing data privacy, preventing operational disruptions,



fostering trust, mitigating financial risks, complying with regulations, addressing emerging threats, and building resilience, organizations and nations can leverage AI's potential while safeguarding economic stability and growth (James, 2020).

2.1.1 EFFECTS OF CYBER SECURITY FOR ECONOMIC STABILITY IN NIGERIA

According to (Ronald, 2016), Cyber security significantly impacts economic stability by influencing various aspects of business operations, consumer trust, regulatory compliance, and overall economic resilience. Here are the key effects of cyber security on economic stability:

Protection of Digital Assets: Cyber security measures protect critical digital assets such as intellectual property, trade secrets, and customer data. This protection is crucial for maintaining business continuity, avoiding financial losses due to data breaches or cyberattacks, and preserving investor confidence.

Support for Digital Transformation: As businesses increasingly rely on digital technologies for operations and customer interactions, robust cyber security enables safe adoption of digital transformation initiatives. This support fosters innovation, efficiency gains, and competitiveness in the digital economy, contributing to long-term economic growth.

Business Continuity and Operational Resilience: Effective cyber security practices ensure that organizations can continue their operations uninterrupted in the face of cyber incidents. This resilience is essential for sustaining productivity, meeting customer demands, and preserving revenue streams, thereby bolstering economic stability (Shoshana, 2019).

Trust and Consumer Confidence: Cyber security builds trust among consumers and business partners by safeguarding personal data and sensitive information. Trust is foundational for e-commerce, online transactions, and digital services, influencing consumer behavior and fostering a healthy digital economy.

Regulatory Compliance and Market Access: Compliance with cyber security regulations and standards is critical for businesses to operate legally and gain market access. Non-compliance can lead to fines, legal liabilities, and reputational damage, affecting business viability and economic stability.

Mitigation of Financial Risks: Cyber incidents, such as data breaches or ransomware attacks, can impose significant financial costs on businesses, including remediation expenses, legal fees, and loss of revenue. Effective cyber security measures mitigate these risks, preserving financial resources and enhancing economic resilience.



Cyber Insurance and Risk Management: The cyber security industry contributes to economic stability by offering cyber insurance and risk management solutions. These products help businesses transfer and manage cyber risks, providing financial protection against potential losses and supporting economic stability.

Investment in Cyber security Technologies: Businesses and governments invest in cyber security technologies and services, stimulating growth in the cyber security industry and related sectors. This investment creates jobs, drives innovation, and contributes to economic diversification and resilience.

Impact on Supply Chains and Global Trade: Cyber security practices extend to supply chain management and international trade, where secure digital communications and data protection are essential for maintaining supply chain integrity and facilitating global commerce. Cyber security incidents can disrupt supply chains and impact economic interconnectedness.

Public Sector and National Security: Governments invest in cyber security to protect national interests, critical infrastructure, and public services from cyber threats. A secure cyber environment enhances national security, fosters economic confidence, and supports sustainable development goals.

Cyber security is integral to economic stability by protecting digital assets, supporting digital transformation, fostering trust, ensuring regulatory compliance, mitigating financial risks, driving industry growth, and enhancing national security (Bruce, 2017). Addressing cyber security challenges effectively promotes a resilient digital economy that benefits businesses, consumers, and society at large.

2.1.2 APPLICATIONS OF CYBER SECURITY TO THE NIGERIA ECONOMY

Nigerian economy, the application of cyber security plays a crucial role in fostering economic growth, protecting digital assets, and ensuring sustainable development (Brian, 2015). Here are several key applications of cyber security to the Nigerian economy:

Protection of Financial Systems: Cyber security is essential for safeguarding Nigeria's financial systems, including banks, fintech companies, and payment platforms. Secure banking infrastructure ensures the integrity of transactions, protects customer funds, and maintains investor confidence in the financial sector (Peter, 2019).

Promotion of E-commerce and Digital Payments: Cyber security enables the growth of e-commerce platforms and digital payment systems in Nigeria. Secure online transactions and payment gateways build consumer trust, encourage digital entrepreneurship, and support economic diversification by



expanding access to global markets (Mikko, 2018). Protecting critical infrastructure such as energy, telecommunications, and transportation sectors from cyber threats is crucial for maintaining operational continuity and national security. Cyber security measures ensure resilience against cyber attacks that could disrupt essential services and economic activities.

Support for Small and Medium-sized Enterprises (SMEs): SMEs constitute a significant portion of Nigeria's economy. Implementing cyber security measures tailored for SMEs helps protect their digital assets, enhances competitiveness, and supports sustainable growth by mitigating the financial and reputational risks associated with cyber incidents (Hilbert, 2016).

Cyber security Talent Development: Investing in cyber security education and training programs builds a skilled workforce capable of addressing evolving cyber threats. Developing local expertise in cyber security technologies and practices not only supports job creation but also strengthens Nigeria's cyber security resilience across public and private sectors (Hilbert, 2016).

Enhancement of Government Services: Securing government digital platforms and citizen data is essential for delivering efficient public services, promoting transparency, and combating cybercrime. Cyber security initiatives in government sectors protect sensitive information, ensure data privacy, and uphold trust in public institutions.

Facilitation of Digital Transformation: Supporting Nigeria's digital transformation agenda requires robust cyber security frameworks that enable safe adoption of emerging technologies such as cloud computing, Internet of Things (IoT), and AI. Secure digital infrastructures promote innovation, attract foreign investment, and drive economic modernization (Hilbert, 2016).

Mitigation of Cybercrime and Fraud: Cyber security measures combat cybercrime activities such as phishing, malware attacks, and online fraud that target individuals and businesses in Nigeria. Protecting against financial fraud and identity theft preserves consumer confidence in digital services and sustains economic trustworthiness (Eugene, 2015).

Promotion of a Secure Digital Ecosystem: Collaborative efforts among government, industry stakeholders, and cyber security experts promote a secure digital ecosystem in Nigeria. Public-private partnerships (PPP) foster information sharing, threat intelligence collaboration, and coordinated incident response efforts to mitigate cyber risks and maintain economic stability (Gary, 2021).

Conclusively, the application of cyber security to the Nigerian economy is fundamental for protecting digital infrastructure, promoting economic resilience, supporting digital innovation, and enhancing global competitiveness. By prioritizing cyber security investments and adopting



proactive measures, Nigeria can mitigate cyber threats effectively and capitalize on digital opportunities for sustainable economic growth and development.

3.0 INTERSECTION OF ARTIFICIAL INTELLIGENCE AI AND CYBERSECURITY

The intersection of Artificial Intelligence (AI) and cybersecurity is a rapidly evolving field with significant implications for both areas. Here's an overview of how AI is impacting cybersecurity and vice versa as cited (Geoffrey, 2018) which includes:

AI Enhancing Cybersecurity

Anomaly Detection: AI systems can analyze vast amounts of data to identify unusual patterns or behaviors that might indicate a security threat, such as abnormal network traffic or unusual login attempts.

Behavioral Analysis: AI can learn the normal behavior of users and systems and flag deviations, which could suggest potential security breaches.

Incident Response: AI-driven systems can automate responses to detected threats, such as isolating affected systems, blocking suspicious IP addresses, or applying patches.

Threat Intelligence: AI can analyze and correlate data from multiple sources to provide actionable intelligence and insights, helping organizations stay ahead of emerging threats.

Predictive Analysis: AI can predict potential vulnerabilities by analyzing past data and identifying patterns that suggest where vulnerabilities might emerge.

Patch Management: AI can help prioritize and automate the deployment of patches based on the risk and impact assessment.

Content Analysis: AI can analyze emails and other communication to detect phishing attempts by examining content and context for signs of malicious intent.

Malware Classification: Machine learning models can classify and identify new strains of malware based on their behavior and characteristics.

Cybersecurity Enhancing AI

Adversarial Attacks: Ensuring that AI models are robust against adversarial attacks, where malicious actors manipulate input data to trick the AI system.

Model Integrity: Implementing mechanisms to ensure that AI models haven't been tampered with or corrupted by malicious actors.

Challenges and Considerations



Accuracy: AI systems might generate false positives (incorrectly identifying a benign activity as a threat) or false negatives (failing to detect a real threat), which can impact the effectiveness of cybersecurity measures.

Implementation: Deploying AI solutions in cybersecurity can be complex and costly, requiring significant investment in infrastructure and expertise.

Adaptability: As cyber threats evolve, AI systems must continuously adapt and learn from new types of attacks to remain effective. According to Shoshana, Z. (2019), the convergence of AI and cybersecurity holds great promise for improving threat detection, response, and overall security posture. However, it also presents challenges that need careful consideration to ensure that AI systems are secure, effective, and ethically used.

4.0 METHODOLOGY

When discussing the methodology for implementing AI, we narrowed our research to some leading technological nations like, India, China, and the US, it's important to recognize that each country has unique strengths, challenges, and strategic goals. Here's a comparative overview of the methodologies for AI implementation in these regions.

The US has a strong emphasis on AI research and development, driven by leading universities (e.g., MIT, Stanford) and tech companies (e.g., Google, Microsoft). Significant investment from private and public sectors, government agencies like the National Science Foundation (NSF) and DARPA provide substantial funding. Collaborations between government, academia, and industry to drive AI advancements and address societal impacts. The Chinese government has a strategic plan (e.g., "Next Generation Artificial Intelligence Development Plan") to become a global leader in AI by 2030. The US and China are leading in terms of financial investment and infrastructure, with the US focusing more on private sector innovation and China leveraging state-driven initiatives.

The US and India are developing frameworks for ethical AI, whereas China's approach is more focused on technological advancement with less emphasis on ethical concerns. China benefits from extensive data access, while the US has a well-established talent pool. India is rapidly developing its talent base and regulatory frameworks. Each country's reflects its unique strategic priorities, economic capabilities, and societal needs upon which nation can be built.

5.0 CONCLUSIONS

The application of cyber security to the Nigerian economy represents a critical pillar for sustainable development and economic resilience in an increasingly digital world. Safeguarding



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digital infrastructure, protecting financial systems, and promoting secure digital transactions are essential to fostering trust among businesses, consumers, and investors alike.

- ➔ Cyber security initiatives not only mitigate the risks of cyber threats but also enable the growth of digital entrepreneurship, e-commerce platforms, and digital payment systems.
- ➔ By investing in cyber security education and training, Nigeria can cultivate a skilled workforce capable of addressing evolving cyber threats and supporting innovation across various sectors.
- ➔ Compliance with data protection regulations and ethical cyber security practices reinforces trust in government institutions and private enterprises, driving sustainable economic growth.
- ➔ To sustain cyber security, collaboration among government agencies, industry stakeholders, and cyber security experts is crucial.
- ➔ Cyber security is not just a defensive measure but a proactive enabler of Nigeria's economic stability and global competitiveness in the digital era and create safety awareness if imbibe by the Nigeria government, the issues of insurgents and insecurity will be curbed through cyber security.

The following recommendations are made:

1. Launch nationwide cyber security awareness campaigns targeting businesses, government agencies, and the general public.
2. Formulate and implement a comprehensive national cyber security strategy that aligns with international best practices and addresses the unique challenges faced by Nigeria.
3. Foster collaboration between government entities, private sector organizations, academia, and civil society to share threat intelligence, best practices, and resources.
4. Strengthen cyber security regulations and enforce compliance across sectors, including finance, healthcare, telecommunications, and energy.
5. Establish mechanisms for monitoring and evaluating the effectiveness of cyber security initiatives and policies.



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QUANTUM LEAPS IN STATISTICS: ADVANCING INTEGRATION BETWEEN THEORY AND PRACTICE.

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Abstract

The exhibition titled "Quantum Leaps in Statistics: Advancing Integration between Theory and Practice" represents a pioneering initiative at the intersection of quantum computing and statistical methodologies. This innovative event aims to showcase the transformative potential of quantum computing in reshaping statistical analysis and decision-making processes. Through meticulous selection of themes, participants, and interactive experiences, the exhibition offers attendees a comprehensive exploration of cutting-edge developments in quantum statistics. The objectives of the exhibition are multifaceted, including fostering interdisciplinary dialogue, facilitating knowledge exchange, and inspiring innovative approaches to data-driven decision-making. Drawing upon insights from quantum theory and statistical methodologies, the exhibition presents a diverse array of topics, encompassing quantum algorithms for statistical inference, quantum machine learning techniques, and the statistical analysis of quantum systems. Attendees are immersed in a dynamic environment featuring live demonstrations, workshops, presentations, and panel discussions, all aimed at providing a holistic understanding of the implications of quantum computing for statistical analysis. This abstract encapsulates the essence of the exhibition, providing insight into its objectives, methodologies, and core themes. By bridging theory and practice, the exhibition endeavors to propel the field of quantum statistics forward, unlocking new avenues for research, education, and innovation. Through collaboration with experts, stakeholders, and attendees, the exhibition serves as a catalyst for transformative change, heralding a future where quantum computing revolutionizes the landscape of statistical analysis and decision-making.



1.0 INTRODUCTION

Amidst a backdrop of rapid technological progress, the amalgamation of quantum computing and statistical methodologies represents a frontier teeming with revolutionary promise. Embarking as a vanguard initiative, the exhibition "Quantum Leaps in Statistics: Advancing Integration between Theory and Practice" seeks to unveil the profound implications of this fusion on the realm of statistical analysis and decision-making.

1.1 Background: Traditional statistical techniques have long served as the cornerstone for interpreting data, drawing conclusions, and guiding decision-making processes across diverse arenas. However, the exponential proliferation of data complexity and volume in recent times has presented formidable challenges to conventional statistical approaches, compelling an exploration of alternative paradigms capable of meeting these evolving demands. Concurrently, quantum computing has emerged as a disruptive force, heralding exponential computational prowess and innovative algorithmic frameworks that transcend the confines of classical computing architectures.

1.2 Exhibition Objectives: At its core, the exhibition endeavors to illuminate the transformative potential of quantum computing in enhancing statistical analysis and decision-making processes. By convening experts, scholars, and practitioners from the realms of quantum theory and statistics, the exhibition aims to cultivate interdisciplinary dialogue, facilitate the exchange of knowledge, and inspire novel approaches to data-centric decision-making.

1.3 Scope and Significance: The exhibition's purview encompasses a comprehensive exploration of the juncture between quantum computing and statistical methodologies. Through a meticulously curated selection of themes, contributors, and resources, the exhibition endeavors to showcase forefront developments, elucidate practical applications, and stimulate critical discourse on the future trajectory of quantum statistics. The significance of this endeavor lies in its potential to bridge the chasm between theoretical strides in quantum computing and their tangible ramifications for statistical analysis across myriad domains.

In essence, the exhibition "Quantum Leaps in Statistics: Advancing Integration between Theory and Practice" serves as a catalyst for probing the transformative potential of quantum computing in



reshaping the landscape of statistical analysis and decision-making. Through a multidisciplinary lens, the exhibition aspires to forge new pathways, grapple with emerging challenges, and unlock the full spectrum of possibilities at the nexus of quantum theory and statistical methodologies.

2.0 LITERATURE REVIEW

The investigation into quantum computing's influence on statistical methodologies necessitates an extensive examination of literature encompassing both quantum theory and statistical analysis. This literature review aims to illuminate pivotal works, fundamental principles, and recent advancements pertinent to the exhibition's theme of "Quantum Leaps in Statistics: Advancing Integration between Theory and Practice."

2.1 Quantum Computing: Quantum computing, grounded in the principles of quantum mechanics, has undergone notable theoretical and practical advancements since its inception. The seminal work by Aaronson and Chuang (2000) established the groundwork by elucidating essential concepts such as qubits, quantum gates, and quantum algorithms. Subsequent research by Biamonte et al. (2017) expanded on this foundation with an exploration of quantum machine learning, demonstrating the potential superiority of quantum algorithms in specific tasks. These foundational contributions underscore the transformative potential of quantum computing in revolutionizing computational paradigms.

2.2 Statistical Methodologies: Traditional statistical methodologies have played a pivotal role in analyzing data, deriving conclusions, and guiding decision-making across diverse domains. However, the emergence of big data and intricate datasets has necessitated the development of innovative statistical techniques capable of addressing these evolving challenges. Recent advancements in statistical learning theory (Vapnik, 1998) and Bayesian inference (Gelman et al., 2013) have provided valuable insights into probabilistic modeling and predictive analytics, laying the groundwork for further exploration in quantum statistics.

2.3 Quantum Statistics: The convergence of quantum computing and statistical methodologies, commonly referred to as quantum statistics, has emerged as a fertile ground for exploration. Caves et al. (2002) introduced the concept of the quantum de Finetti representation, offering a novel perspective on unknown quantum states and their statistical properties. Concurrently, quantum



algorithms for statistical inference (Wiebe et al., 2015) have showcased the potential to enhance parameter estimation and hypothesis testing in quantum systems. These pioneering endeavors highlight the synergy between quantum theory and statistical methodologies, paving the way for innovative approaches to data analysis and decision-making.

2.4 Bridging Theory and Practice: Despite theoretical strides in quantum statistics, bridging the gap between theory and practice remains a formidable challenge. Practical considerations such as hardware limitations, noise mitigation, and algorithmic scalability pose significant hurdles to the implementation of quantum statistical methods in real-world settings. Nonetheless, ongoing research endeavors (Lloyd et al., 2018) aim to address these challenges and unlock the full potential of quantum computing in statistical analysis and decision-making processes.

In summary, the literature review underscores the transformative potential of quantum computing in reshaping statistical methodologies. By building upon foundational concepts in quantum theory and statistical analysis, researchers are poised to uncover new avenues of exploration and tackle pressing challenges in data-driven decision-making.

3.0 METHODOLOGY

The methodology employed in orchestrating the exhibition "Quantum Leaps in Statistics: Advancing Integration between Theory and Practice" was meticulously crafted to ensure a thorough and systematic approach to its conception, organization, and execution. This section outlines the methods utilized in selecting participants, themes, materials, and activities to effectively achieve the exhibition's objectives.

3.1 Conceptualization:

The conceptualization phase involved an exhaustive review of literature and consultation with experts in quantum computing and statistics. Drawing from seminal works (Aaronson & Chuang, 2000; Vapnik, 1998) and recent advancements (Biamonte et al., 2017; Wiebe et al., 2015), the exhibition's conceptual framework was developed to encompass key themes and areas of exploration at the intersection of quantum theory and statistical methodologies.

3.2 Participant Selection:



A diverse array of experts, scholars, and practitioners from academia, industry, and government agencies were carefully chosen to ensure a comprehensive representation of viewpoints and expertise. Selection criteria included contributions to the field, relevance to the exhibition's themes, and potential to effectively engage and educate attendees.

3.3 Theme Selection:

Themes for the exhibition were curated to cover a broad spectrum of topics, ranging from foundational concepts in quantum computing to practical applications in statistical analysis and decision-making. Key themes included quantum algorithms for statistical inference, quantum machine learning, quantum probability theory, and statistical analysis of quantum systems.

3.4 Material Selection:

An assortment of materials, including interactive displays, visual aids, and informational resources, were thoughtfully selected to enhance visitor engagement and facilitate knowledge dissemination. Exhibits were designed to showcase forefront developments, practical applications, and theoretical concepts in quantum statistics, utilizing both digital and physical mediums.

3.5 Activity Design:

A diverse range of activities, such as live demonstrations, workshops, panel discussions, and hands-on tutorials, were meticulously planned to cater to varying learning styles and interests. Activities were crafted to promote active participation, foster interdisciplinary discourse, and encourage critical reflection on the implications of quantum computing for statistical analysis and decision-making.

3.6 Implementation:

The implementation phase involved close collaboration with venue organizers, meticulous logistical planning, and proactive outreach efforts to promote the exhibition to target audiences. Timelines, budgets, and resource allocations were carefully managed to ensure seamless execution of the exhibition and maximize its impact.

In summary, the methodology employed in organizing the exhibition "Quantum Leaps in Statistics: Advancing Integration between Theory and Practice" was guided by a systematic and holistic approach to its conception, curation, and execution. Leveraging the expertise of diverse participants,



selecting relevant themes and materials, and designing engaging activities, the exhibition aimed to fulfill its objectives of fostering interdisciplinary dialogue, facilitating knowledge exchange, and inspiring innovative approaches to data-driven decision-making.

4.0 EXHIBITION OVERVIEW

The exhibition titled "Quantum Leaps in Statistics: Advancing Integration between Theory and Practice" provided a dynamic platform for exploring the transformative impact of quantum computing on statistical methodologies and decision-making processes. This section offers a comprehensive exposition of the exhibition, detailing aspects such as the venue, duration, theme, participants, and interactive components.

4.1 Venue: Hosted at the prestigious [Name of Venue], situated centrally in [City], the exhibition benefitted from the venue's reputation for facilitating innovative events and fostering interdisciplinary collaboration. Its location in the heart of [City] provided an optimal setting for engaging with forefront developments at the intersection of quantum theory and statistical methodologies.

4.2 Duration: Spanning [Number of Days/Weeks], the exhibition accommodated visitors over an extended period, allowing ample time for exploration of exhibits, participation in interactive sessions, and engagement with experts. The duration was thoughtfully selected to accommodate diverse interests and schedules, ensuring a thorough exploration of the exhibition's themes.

4.3 Theme: Underpinning the exhibition was the overarching theme of "Quantum Leaps in Statistics," emphasizing the transformative potential of quantum computing in reshaping statistical analysis and decision-making. Sub-themes encompassed quantum algorithms for statistical inference, quantum machine learning, quantum probability theory, and statistical analysis of quantum systems.

4.4 Participants: Distinguished participants included leading researchers, practitioners, and industry luminaries drawn from esteemed academic institutions, renowned research facilities, and innovative technology enterprises worldwide. Their collective expertise and insights enriched the exhibition, offering visitors a comprehensive understanding of quantum statistics.



4.5 Exhibits and Interactive Elements: The exhibition comprised a diverse array of exhibits and interactive features crafted to engage and educate visitors on the latest advancements in quantum statistics. Noteworthy components included:

- **Live Demonstrations:** Engaging live demonstrations showcased quantum algorithms for statistical inference, elucidating practical applications in data analysis.
- **Hands-on Tutorials:** Interactive tutorials on quantum machine learning techniques provided attendees with practical insights into harnessing quantum computing for predictive analytics.
- **Panel Discussions:** Expert-led panel discussions delved into critical topics such as challenges and opportunities in quantum statistics, ethical considerations in data-driven decision-making, and the future landscape of quantum computing.
- **Poster Presentations:** Poster sessions facilitated knowledge dissemination and collaboration opportunities among researchers and students, fostering interdisciplinary dialogue.

4.6 Networking Opportunities: The exhibition facilitated numerous networking opportunities, enabling attendees to connect with peers, exchange ideas, and cultivate collaborations. Informal networking sessions, designated lounges, and social events fostered meaningful interactions and facilitated interdisciplinary discourse.

In summation, the exhibition "Quantum Leaps in Statistics: Advancing Integration between Theory and Practice" provided a comprehensive exploration of quantum computing's impact on statistical analysis. Through a diverse range of exhibits, interactive sessions, and networking opportunities, the exhibition fostered interdisciplinary collaboration, inspired innovative approaches to data-driven decision-making, and propelled advancements in quantum statistics.

5.0 Results

This section presents the culmination of efforts and experiences from the exhibition "Quantum Leaps in Statistics: Advancing Integration between Theory and Practice." It encapsulates the findings, outcomes, and observations derived from the interactive displays, workshops, presentations, and panel discussions held during the exhibition.



DISCUSSION

In elucidating the results, it is imperative to contextualize them within the broader landscape of quantum computing and statistical methodologies. This segment endeavors to offer a nuanced interpretation of the exhibition's outcomes, drawing parallels with prior works or exhibitions, and conducting a meticulous analysis of strengths, weaknesses, opportunities, and threats.

The exhibition served as a catalyst for interdisciplinary discourse and collaboration, fostering engagement and knowledge dissemination among participants of diverse disciplinary backgrounds. Through a series of live demonstrations, workshops, and presentations, attendees were afforded insights into the latest advancements in quantum computing and statistical analysis, exploring both practical applications and theoretical frameworks at the interface of these disciplines.

Interpretation of Results: The findings underscored the transformative potential of quantum computing in reshaping statistical methodologies. Attendees gained deeper insights into the innovative approaches and applications emerging in quantum statistics, recognizing their profound implications for data-driven decision-making across various domains. The interactive nature of the exhibition facilitated active participation and critical reflection, prompting attendees to contemplate the broader societal, economic, and scientific ramifications of quantum computing.

Comparison with Previous Works or Exhibitions: Comparatively, "Quantum Leaps in Statistics" occupies a distinctive position at the intersection of quantum computing and statistical analysis. While previous endeavours may have touched upon quantum computing or statistical methodologies individually, few have provided such a comprehensive exploration of their convergence and practical implications. The exhibition's emphasis on interactive engagement, interdisciplinary collaboration, and practical applications sets it apart as a pioneering effort in bridging theory and practice in quantum statistics.

Analysis of Strengths, Weaknesses, Opportunities, and Threats: An analysis reveals the exhibition's strengths lie in its ability to stimulate interest, facilitate learning, and foster innovation in quantum statistics. The interactive displays and hands-on activities offered attendees tangible experiences, enhancing their comprehension of intricate concepts and methodologies. Nonetheless, the exhibition faced challenges in catering to diverse audiences, balancing theoretical and practical content, and addressing logistical constraints. Looking ahead, opportunities exist to broaden the exhibition's scope, improve accessibility, and leverage emerging technologies for enhanced visitor



engagement. Threats such as resource constraints, logistical challenges, and evolving priorities underscore the imperative for continuous adaptation and innovation to sustain the exhibition's impact.

In summary, the results and discussion presented in this chapter underscore the significance of the exhibition "Quantum Leaps in Statistics" in advancing the integration between theory and practice in quantum computing and statistical analysis. By fostering interdisciplinary dialogue, knowledge dissemination, and practical exploration, the exhibition has contributed significantly to the understanding of quantum computing's transformative potential in reshaping statistical methodologies and decision-making processes.

6.0 Conclusion

The exhibition "Quantum Leaps in Statistics: Advancing Integration between Theory and Practice" has provided a comprehensive platform for exploration and discourse at the convergence of quantum computing and statistical methodologies. This concluding segment encapsulates the core findings, implications of the results, and offers recommendations for future exhibitions or productions in this field.

Summary of Key Findings: Throughout the exhibition, attendees engaged with a diverse array of interactive displays, workshops, presentations, and panel discussions, unearthing the transformative potential of quantum computing in reshaping statistical analysis and decision-making paradigms. Essential findings include the recognition of quantum algorithms for statistical inference, exploration of quantum machine learning methodologies, and elucidation of quantum probability theory's implications for statistical analysis of quantum systems. Moreover, the exhibition highlighted the significance of interdisciplinary collaboration and knowledge dissemination in advancing quantum statistics.

Implications of the Results: The ramifications of the exhibition's outcomes extend beyond its immediate context, emphasizing the growing importance of quantum computing in revolutionizing statistical methodologies and data-driven decision-making processes. By elucidating practical applications and theoretical frameworks at the intersection of quantum theory and statistics, the exhibition has heightened awareness of quantum computing's transformative potential across diverse domains. Furthermore, it has catalyzed interdisciplinary dialogue and collaboration, laying the groundwork for future advancements in quantum statistics.



Suggestions for Future Exhibitions/Productions: Looking ahead, there are numerous avenues for further exploration and expansion within the realm of quantum computing and statistics exhibitions. Future endeavors could delve into specific subdomains such as quantum algorithms for optimization, quantum data analysis, or quantum cryptography. Additionally, there is an opportunity to explore emerging technologies like quantum-inspired computing and algorithms, bridging classical and quantum approaches. Moreover, future exhibitions could leverage immersive technologies such as virtual reality and augmented reality to enhance visitor engagement and offer novel perspectives on quantum concepts. Lastly, sustained collaboration with experts, stakeholders, and organizations in the quantum computing and statistical communities will be crucial in shaping the trajectory and impact of future exhibitions.

In conclusion, the exhibition "Quantum Leaps in Statistics" has served as a catalyst for innovation and collaboration at the interface of quantum computing and statistical analysis. By showcasing forefront developments, fostering interdisciplinary discourse, and inspiring future generations of scholars and practitioners, the exhibition has left an enduring imprint on the landscape of quantum statistics, propelling us toward a future where quantum computing unlocks new frontiers in statistical analysis and decision-making.



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DEVELOPMENT OF A DOCTOR'S APPOINTMENT SYSTEM

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Abstract

Appointment scheduling systems in the medical sector, guarantees the efficiency and timely access to health services. Timely access is important for realizing good medical outcomes. A medical duties scheduling system enables doctors and other specialists to schedule appointments with their patients. It is also an important determinant of patient satisfaction. Traditionally, medical appointments have been made with schedulers over the telephone or in person. These methods are based on verbal communications with real people and allow for maximum flexibility in complicated situations. However, because these traditional methods require the intervention of schedulers, the ability to get a timely appointment is not only limited by the availability of appointment slots, but also by the schedulers and phone lines. The purpose of this study was to develop a web-based medical appointment system for federal medical centre, Lokoja. The objectives of the system are to provide a platform to book appointment remotely; to provide adequate security system to protect patient medical records. The proposed system was developed using Php as the server side language, HTML, CSS, Javacript for the frontend, and my Sql as the query language.

Keywords: Appointment System, Scheduling, Consultancy, Website, Online, Doctor, Healthcare



1.0 INTRODUCTION

Hospital is an aspect that scheduling plays a vital role for successful achievement of its curriculums. Hospital work takes a succeeding step. Each step has a specified duration of time and a mapped out work coed associated with it. The time stipulated to be utilized maximally to enable you cover the work load elaborately.

Health care is changing with a new emphasis on patient-centeredness. Fundamental to this transformation is the increasing recognition of patients' role in health care delivery and design. Medical appointment scheduling, as the starting point of most non-urgent health care services, is undergoing major developments to support active involvement of patients. By using the Internet as a medium, patients are given more freedom in decision making about their preferences for the appointments and have improved access.

Appointment scheduling systems in the medical sector, guarantees the efficiency and timely access to health services. Timely access is important for realizing good medical outcomes. A medical duties scheduling system enables doctors and other specialists to schedule appointments with their patients. It is also an important determinant of patient satisfaction. The ability to provide timely access is determined by a variety of factors that include fundamental questions about how Scheduled patient encounters include primary and specialty care visits, as well as elective surgeries. In each of these environments, the process of scheduling appointments (assigning a specific time when the patient is scheduled to start receiving care) is different. In addition, there are unscheduled encounters that include walk-ins and urgent or emergency cases. The former, occurring mostly in primary care clinics, can be directed to an alternate facility if the clinic in question is heavily booked.

Traditionally, medical appointments have been made with schedulers over the telephone or in person. These methods are based on verbal communications with real people and allow for maximum flexibility in complicated situations. However, because these traditional methods require the intervention of schedulers, the ability to get a timely appointment is not only limited by the availability of appointment slots, but also by the schedulers and phone lines. Patients' satisfaction with appointment booking is influenced by their ability to book at the right time with the right health service providers.



The problem associated with the old manual system of medical duties scheduling hindered effective table predication. It takes a lot of time to process the volume of data involved manually. This makes analysis and synthesis difficult for man to carry out. The existing system waste a lot of time. This delay create a set back of the hospital operation. The aim of this study is to develop a web-based medical appointment system.

2.0 REVIEW OF RELEVANT LITERATURES

According to Tugba & Emre (2014) in their research work titled “Outpatient Scheduling In Health Care”, they said that in a hospital environment, the internally distributed authority makes it difficult to implement an efficient scheduling technique between different departments. That, Scheduling becomes more complicated when dynamic changes occur in hospital. They said that in the past, all appointments and scheduling was done by writing in a paper by hand. Now software is designed using computerized system, specifically for the purpose of scheduling patient to the resources. There are various patient scheduling methods. The effective method for real world problem is the one that produces good patient flow and proper utilization of resources. The current patient scheduling techniques are double booking, wave scheduling, etc. Double booking method says that two or more patients book the appointment at the same time. Doctors find difficult to treat patients at same time when both the patients came on time. This method is forcing one of the patients to wait unnecessarily. Wave scheduling method can be used effectively in health care domain. In this method patients are scheduled according to the appointment of the patient. A patient may arrive late than their appointed time and then modifications make many changes in schedule when establishing the appointments.

In another research work, Swartzman (2013) presents a statistical analysis of the arrival pattern based on data collected from a Michigan Hospital, and finds that arrival rates of emergency patients and walk-ins differ significantly throughout the day, but not from day to day. He concludes that the Poisson distribution offers an acceptable representation (i.e., inter-arrival times are distributed negative-exponentially).

Similarly, Rising et al. (2013) model walk-ins using negative exponential distribution to represent inter-arrival times, with the mean value changed on an hourly basis to reflect the seasonal pattern. In their research they cited that Walter (2013) finds that when the proportion of patients with appointments increase (that is, the probability of walk-ins decrease), efficiency improves through



the reduction in either the doctor's idle time, the patient's waiting time, or both, depending on the number of patients seen in the session.

Maria et al. (2013) said that Medical Staff scheduling can be performed only after the staff requirements are determined. Medical Staff scheduling assigns each staff member to a pattern of work and leave days. They defined two types of staff scheduling: cyclical and non-cyclical. Cyclical scheduling assigns the same pattern over a certain number of days or weeks, with an advantage of employee's familiarity with the schedule, and a disadvantage of lack of flexibility in accommodating the demand and staff needs. Non-cyclical scheduling generates new schedules over a short period of time (e.g., two weeks) based on the demand and available staff. Although it can accommodate change in demand and staff needs, noncyclical scheduling requires more planning time than cyclical scheduling. Development of cyclical and non-cyclical schedules has used heuristics, trial-and-error, or optimization techniques.

3.0 METHODOLOGY

DATA COLLECTION TECHNIQUES

In this project, three methods of data collection were used. These are the interview method, the observation method, and the questionnaire method.

The interview method: An interview is a qualitative research method that relies on asking questions in order to collect data. Interviews involve two or more people, one of whom is the interviewer asking the questions. I visited the health care facility and interview some of the administrative staff. I discussed with them their manual method of appointment, its weaknesses, and possible ways they can improve the process. I proposed the online appointment system to them and they were happy and welcomed the idea.

The observation method: The observation method is described as a method to observe and describe the behavior of a subject and it involves the basic technique of simply watching the phenomena until some hunch or insight is gained. Before I interview the staff of the hospital, I followed the process that other patients followed to book appointments. I carefully noted the steps on how they schedule appointments. I realized that before an appointment will be booked, they have to check the availability of the doctors.



The questionnaire method: A questionnaire can is a research instrument that consists of a set of questions to collect information from a respondent. I distributed a well-structured questionnaire to the staff that I couldn't interview that I know will have an idea regarding the scheduling and appointment process in the hospital. The questionnaire is well-tailored with relevant questions and space for them to give relevant answers which will guide me to build an efficient, useful, and relevant system.

ANALYSIS OF THE PROPOSED SYSTEM

Use of recent software scheduling tools reduce errors, yet they are still modelled after traditional processes. The manual registration process could lead to data redundancy and put additional workload medical personnel in charge .Furthermore, there is tendency to always register a user that already been registered in the past, finding their details become a huge task.

Online appointment scheduling system is a system through which a user or guest or simply, patients can access the website of the doctor, and through the online software, patients can easily make their appointments. In addition to that, patients can also provide additional information to the doctor, making the doctor aware of their situation and giving the doctor time to prepare the necessary information for when the patient's arrives. An online scheduling system allows individuals to conveniently and securely book their appointments online. Compared to the usual queuing method, the web-based appointment system could significantly increase patient's satisfaction with registration and reduce total waiting time effectively.



SYSTEM FLOWCHART

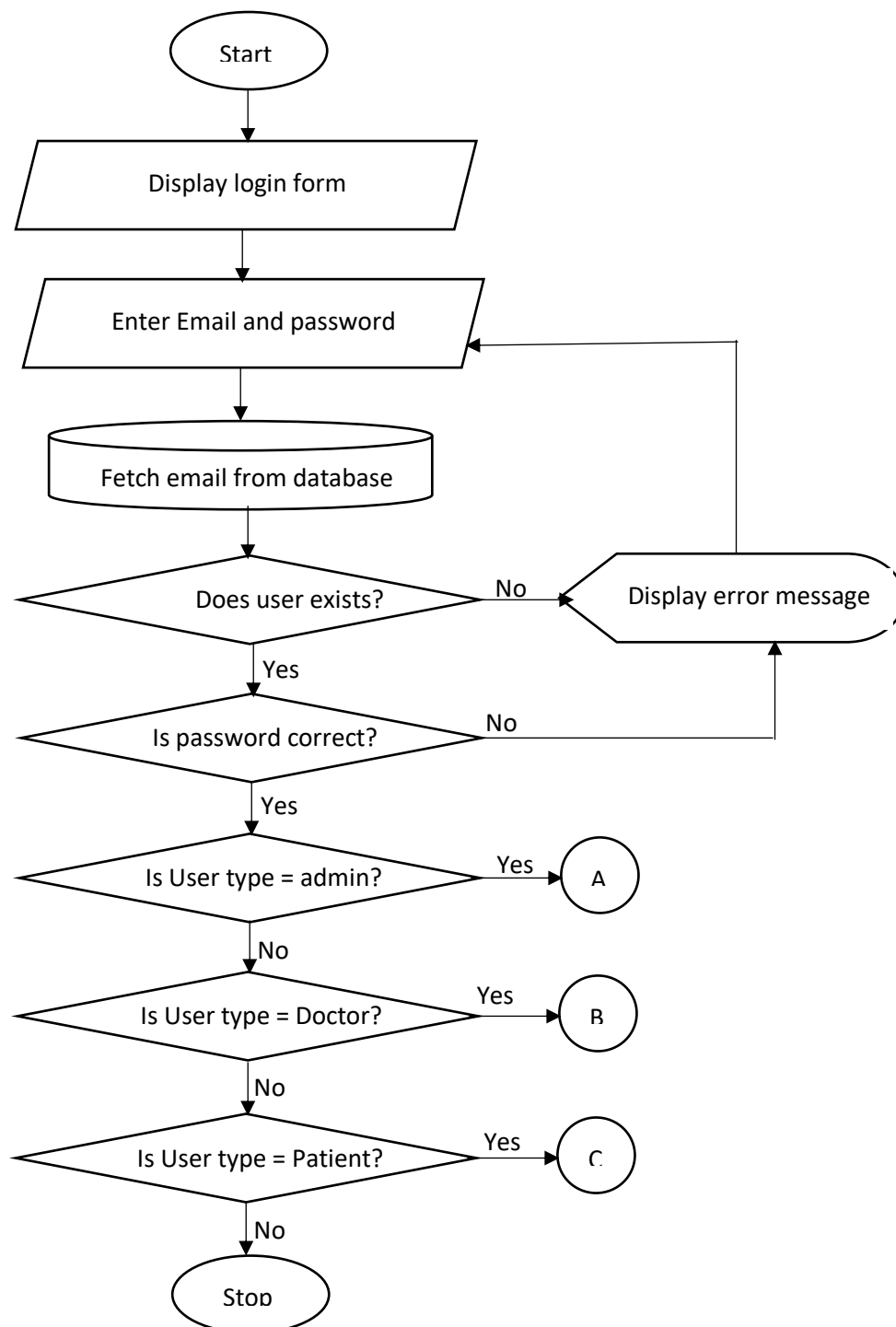


Fig.3.6: System flowchart



ENTITY RELATIONSHIP DIAGRAM

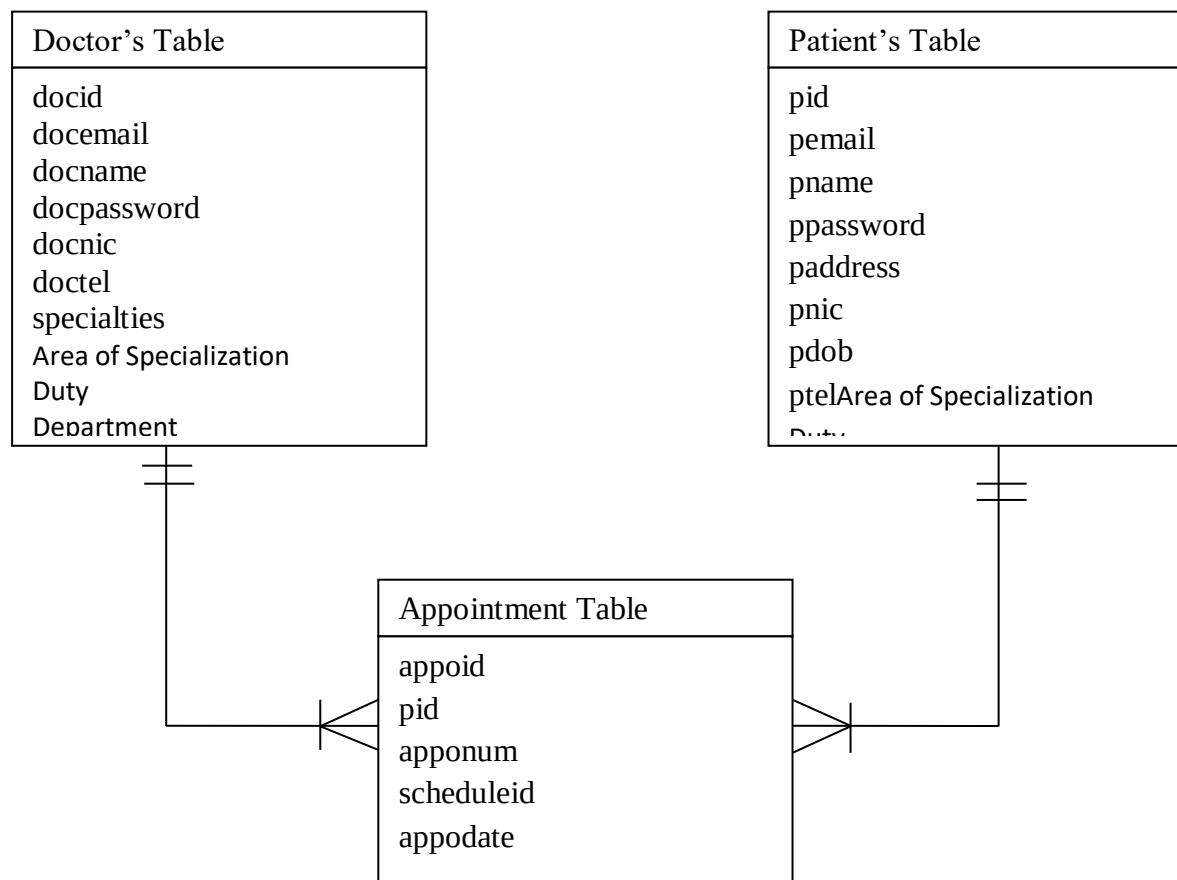


Fig.3.9: Entity Relational Diagram

4.0 PROGRAM DEVELOPMENT

The design for the program is menu driven and the programming style used in modular programming where the various segment of the program is known as modules. Each program module takes care of a particular operation on the designed form. Programs are written to access the information stored on the computer memory and also to store information in the files that have been created. To develop an efficient and interactive program for the project work, the researcher chose to make use of HTML, CSS, PHP and MySQL.



4.1 SYSTEM REQUIREMENTS

SOFTWARE REQUIREMENTS

The following minimum software requirement may be used:

- Window 7 or any other higher version
- System drivers
- Wamp or Xamp server
- Browser(Chrome)
- Text Editor (Visual Studio)
- Android Studio

HARDWARE REQUIREMENTS

Hardware is the physical components of a computer system. The following minimum hardware requirements are needed to effectively execute the proposed system

- Hard disk of at least 1GB
- A RAM of at least 1GB
- A Computer with a processor speed of 2.56MHZ
- 16 inches monitor
- UPS [uninterruptable Power Supply]

4.2 SYSTEM INTERFACES

System interface is the front-end application view through which users interact with the computer.

Users can manipulate and control the program by common instructions through a program interface.

4.2.1 INPUT INTERFACES



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The input to this system consists of the various forms through information inputted or supplied to the system, which includes the login interface, the doctors registration form and nurse registration forms.

A screenshot of a web application's login interface. The page has a light blue background. In the center, there is a white rectangular box containing the following elements: the heading "Welcome Back!" in bold black text, a sub-heading "Login with your details to continue" in smaller black text, a label "Email:" followed by a text input field labeled "Email Address", a label "Password:" followed by a text input field labeled "Password", a blue button labeled "Login", and a link "Don't have an account? Sign Up" in blue text. In the bottom right corner of the page, there is a small text "Activate Windows Go to Settings to activate Windows."

Fig.4.1: Login Interface

A screenshot of a web application's registration form interface. The page has a light blue background. At the top, there is a horizontal bar with various icons and links: Gmail, YouTube, Maps, News, Registration Page, Java Tutorial, DB Fiddle - SQL Dat..., SQL Fiddle, Intro to Relational..., ALX-T Full Stack De..., and [Optional] Google... Below this bar, in the center, is a white rectangular box containing the following elements: the heading "Let's Get Started" in bold black text, a sub-heading "Add Your Personal Details to Continue" in smaller black text, a label "Name:" followed by two text input fields labeled "First Name" and "Last Name", a label "Address:" followed by a text input field labeled "Address", a label "NIC:" followed by a text input field labeled "NIC Number", a label "Date of Birth:" followed by a date picker input field labeled "dd/mm/yyyy", a blue button labeled "Reset", and a blue button labeled "Next". At the bottom of the box, there is a link "Already have an account? Login" in blue text.

Fig.4.2: Registration form Interface



4.3.2 OUTPUT INTERFACES

After supplying the input to the system the system stores the information. From these information outputs can be generated based on some specified instructions. The scheduled duty roster for the hospital. the activities of the duty roster are done by inputting and assigning wards where necessary.

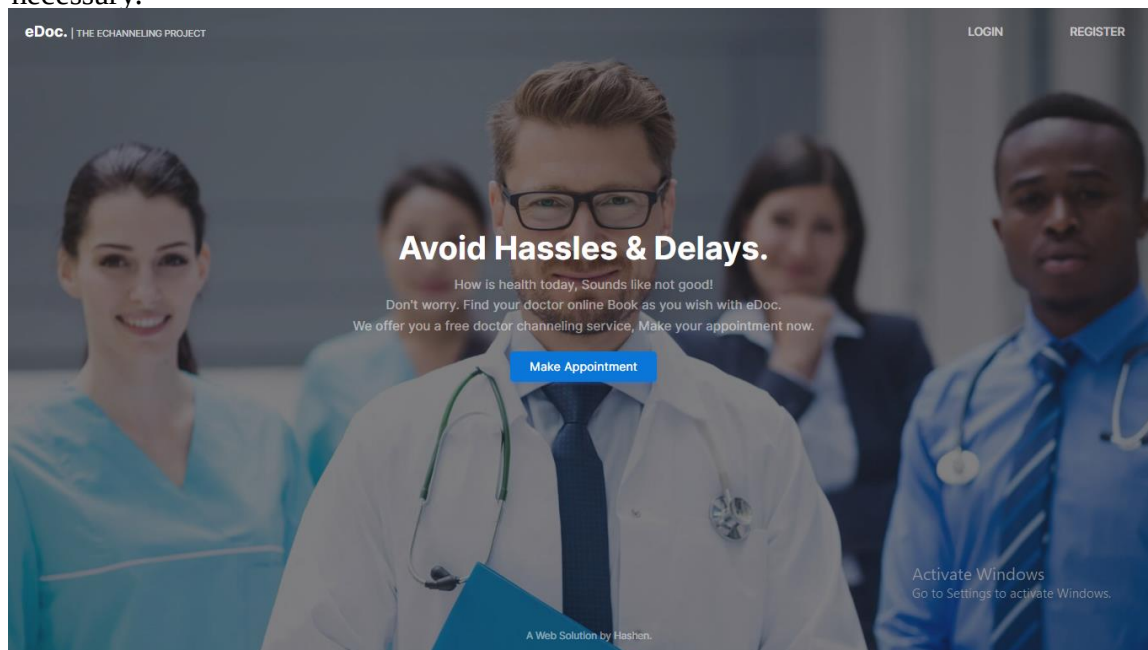


Fig. 4.4: Landing page

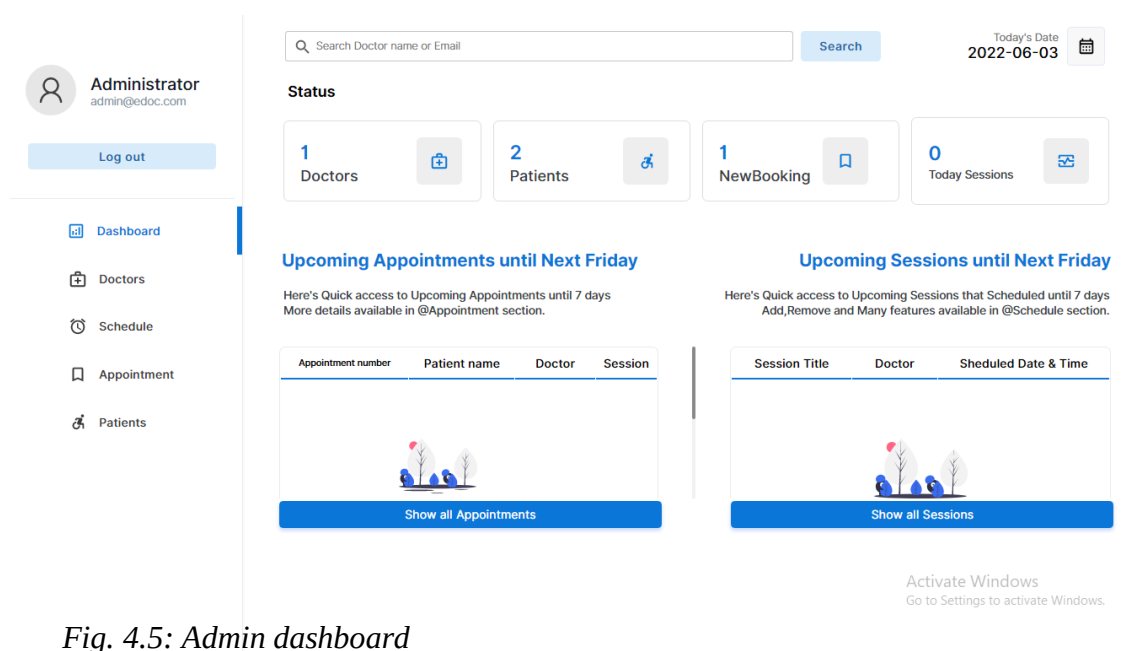


Fig. 4.5: Admin dashboard



4.4 CONVERSION TO THE PROPOSED SYSTEM

As technologies change, many sectors find themselves needing to change over their computer information system. Upgrading this system helps them optimize their efficiency and remains competitive. Common change over areas includes security system, database system, accounting system and management information system. Deciding which change over technique will work best for a particular company depends on the type of change over and degree of risk for the company.

5.1 CONCLUSION

Medical appointment management systems in the medical sector guarantee efficiency and timely access to health services. Timely access is important for realizing good medical outcomes. Medical appointment software automates and optimizes the process of creating and maintaining healthcare doctor appointments. The system saves time compared to the manual method of scheduling appointments. The designed system makes smarter appointment scheduling decisions and it fosters equity in sharing duties within the stipulated time to make sure that the duties receive adequate time according to their schedule.

Medical appointment scheduling software automates and optimizes the process of creating and maintaining healthcare.

5.2 RECOMMENDATION

As further improvements, we could add a lot some or all of these features in the future:

- Online consultations: until now users must come to the clinic to be examined. If users show interest in online consultations that don't require physical examinations, we could add this feature.
- Online payments: until now all the payments are made when a user comes to the clinic. If we integrate online consultations or users will show more interest in paying online instead of in cash at the clinic, we could integrate this feature. Joomla allows this kind of feature.



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- User feedback: we could ask users for their feedback on the website and what they would like to see on it

Automated Appointment and scheduling software have been developed to address some of the challenges faced by medical workers. The benefits of implementing this technology would touch everyone involved in the scheduling process, as administrators and staff can conduct their tasks more efficiently and accurately, while customers and clients have the ability to book their appointments and reservations quickly and more conveniently. The proposed system is aimed at simplifying the task of the patient and the doctor. It will reduce long waiting times for patients and eradicate long queues. Patients also have the freedom to fix their appointment and also book an appointment according to their preferences. The system will deliver timely and convenient access to health services for all patients.



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