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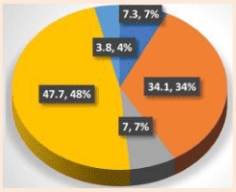

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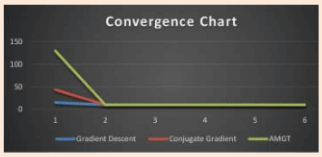

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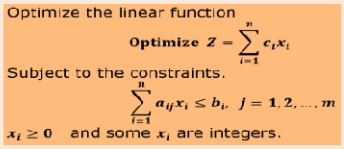

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Urbanization and Unemployment in Anambra State, Nigeria: Issues and Challenges

Chukwujekwu Charles Onwuka

ABSTRACT

This study investigates the relationship between urbanization and unemployment in Anambra State, Nigeria, with a focus on the challenges arising from rapid urban growth. Urbanization in key cities such as Onitsha, Awka, and Nnewi has outpaced job creation, leading to increased unemployment, skill mismatches, and infrastructural deficiencies. The research adopts a mixed-methods approach, integrating quantitative data from structured questionnaires and qualitative insights from semi-structured interviews with policymakers, urban planners, and business owners. The population for this study consists of urban residents in three major cities of Anambra State: Awka, Onitsha, and Nnewi. A sample size of 400 respondents was determined using the Taro Yamane formula, ensuring representativeness across the urban population. Primary data collection targeted unemployed individuals, residents, and stakeholders, while secondary data from government reports and statistical agencies provided additional context. Quantitative data were analyzed using descriptive and inferential statistics, while qualitative data were subjected to thematic analysis. Findings highlight that inadequate infrastructure and skill mismatches significantly contribute to unemployment rates in urban areas. The study also identifies gaps in vocational training and urban planning as critical challenges. Based on these insights, recommendations include infrastructure investment, skill development programmes, and policy reforms to mitigate unemployment and promote sustainable economic development. These findings provide actionable strategies for addressing urban unemployment challenges in Anambra State.

Keywords: development, infrastructure, migration, rural areas, unemployment, urbanization

INTRODUCTION

Urbanization, the process by which rural populations migrate to urban areas, is a defining characteristic of modern development. Urbanization, driven by economic, social, and political factors, has been a dominant demographic trend in Nigeria over the past decades. Anambra State, located in the Southeast geopolitical zone, is one of Nigeria's most urbanized regions. Cities like Onitsha, Awka, and Nnewi have grown rapidly, attracting migrants from rural areas and neighboring states. However, this urban growth has outpaced infrastructure development and economic opportunities, resulting in high unemployment rates (Eze & Umeh, 2022).

In Nigeria, the rate of urbanization, driven by population growth and rural-urban migration, has accelerated significantly over the past few decades. By 2020, urban areas accounted for approximately 51% of Nigeria's population, with states like Anambra experiencing rapid urban expansion (World Bank, 2020). While urbanization has the potential to stimulate economic growth, enhance infrastructure development, and create jobs, it also presents critical challenges, particularly in regions where industrial growth and infrastructure development lag behind population growth.

Anambra State, located in southeastern Nigeria, exemplifies the complexities of urbanization. As one of the most urbanized states in the country, with cities such as Awka, Onitsha, and Nnewi serving as major economic hubs, it attracts a significant number of migrants seeking better opportunities. However, this rapid urbanization has been accompanied by persistent unemployment, especially among youth and migrants. Recent statistics indicate that the unemployment rate in Anambra State exceeds the national average of 33.3%, with urban areas facing the highest burden (National Bureau of Statistics [NBS], 2021). This phenomenon raises important questions about the relationship between urbanization and unemployment, as well as the socioeconomic and policy factors that influence this relationship.

Several interrelated factors contribute to the unemployment crisis in Anambra's urban areas. First, rapid urban migration has led to an oversupply of labour, which the urban economy struggles to absorb, especially in the absence of commensurate industrial growth. Second, there is a significant skills mismatch, with many job seekers lacking the technical and vocational skills required in industries such as manufacturing and ICT. Third, poor infrastructure, including unreliable electricity, inadequate transportation networks, and limited access to clean water, has hindered industrialization and job creation. These issues are compounded by weak governance, inconsistent policies, and inadequate investment in education and skills training.

From a theoretical perspective, the challenges of urban unemployment in Anambra State can be understood through the lenses of Push-Pull Migration Theory (Lee, 1966) and Structural Unemployment Theory. Push-pull migration theory highlights the dynamics of rural-urban migration, where individuals are "pushed" from rural areas by poverty and lack of opportunities and "pulled" to urban centres by the promise of better jobs and living conditions. However, when urban centres fail to meet these expectations, structural unemployment often results. Structural unemployment theory explains how labour market mismatches between the skills of workers and the demands of employers exacerbate joblessness in rapidly urbanizing regions.

Studies on urbanization in Nigeria underscore the need for proactive policies to address unemployment. According to Adepoju (2019), unchecked urban growth without adequate industrial and infrastructural development creates a vicious cycle of poverty and unemployment in urban centres. Similarly, Akinola and Ogunleye (2020) emphasize the importance of aligning urban planning with economic strategies to create sustainable urban economies. However, despite the growing body of literature, there remains a gap in understanding the specific challenges of urban unemployment in Anambra State and how these challenges can be addressed through targeted interventions.

This study explores the relationship between urbanization and unemployment in Anambra State, identifying the key issues and challenges and proposing practical solutions. By examining the experiences of urban residents, analyzing labour market dynamics, and integrating insights from relevant theories, the study aims to provide a comprehensive understanding of the socioeconomic impacts of urbanization on employment in Anambra. The findings will contribute to the broader discourse on urbanization and unemployment in developing economies, with implications for policymakers, urban planners, and development practitioners.

Unemployment, defined as the inability of individuals actively seeking work to find gainful employment, has become a significant socio-economic challenge in Anambra. This article explores the nexus between urbanization and unemployment in the state, delving into the contributing factors, consequences, and potential policy interventions.

STATEMENT OF THE PROBLEM

Urbanization is often regarded as a driver of economic development and improved living standards. However, when it occurs without adequate planning and industrial growth, it can exacerbate socioeconomic challenges,

such as unemployment, poverty, and inequality. In Nigeria, urbanization is proceeding at an unprecedented pace, with Anambra State emerging as one of the most urbanized regions in the country. Cities like Awka, Onitsha, and Nnewi have seen significant population increases, driven by rural-urban migration and natural population growth. Despite this trend, the anticipated economic benefits of urbanization, including job creation and improved livelihoods, have not been fully realized. Instead, urban unemployment has become a pressing challenge in the state, with far-reaching implications for socioeconomic stability and development.

The unemployment rate in Nigeria reached a staggering 33.3% in 2020, with youth unemployment even higher at 42.5% (National Bureau of Statistics [NBS], 2021). In Anambra State, the situation is equally dire, as the urban labour market struggles to absorb the influx of workers. Many urban residents, especially young people, are either unemployed or engaged in precarious informal jobs that offer little economic security or career growth. This situation has led to rising urban poverty, increased dependency ratios, and social vices such as crime and insecurity. Despite the availability of a large labour force, the mismatch between available skills and market demand has left many job seekers unemployable in key sectors such as manufacturing, ICT, and construction (Adepoju, 2019).

Anambra's challenges are further compounded by inadequate infrastructure and weak policy implementation. For instance, unreliable electricity, poor road networks, and insufficient access to water hinder the establishment and growth of industries that could create jobs. In addition, urban planning efforts have not kept pace with population growth, resulting in overcrowded neighborhoods, informal settlements, and underdeveloped urban spaces. According to Akinola and Ogunleye (2020), the lack of coordinated efforts to link urbanization with industrialization has created a cycle of poverty and unemployment in urban areas across Nigeria.

The persistence of these issues raises critical questions about the relationship between urbanization and unemployment in Anambra State. Why has urbanization not translated into significant job creation? What factors contribute to the high unemployment rates in urban areas? And how can these challenges be addressed to ensure that urbanization supports economic growth and development? Addressing these questions is essential for devising effective policies to mitigate urban unemployment and harness the potential of urbanization as a tool for socioeconomic transformation.

This study investigates these issues, focusing on the unique challenges and dynamics of urban unemployment in Anambra State. By analyzing the structural factors underlying unemployment and exploring potential solutions,

the study aims to contribute to the growing discourse on sustainable urban development in Nigeria and other developing economies.

OBJECTIVES OF THE STUDY

The following are the three objectives of this study:

1. To examine the relationship between urbanization and unemployment trends in Anambra State.

2. To investigate how skill mismatches and infrastructural deficiencies contribute to the unemployment rate in urban areas of Anambra State.

3. To identify and recommend strategies for mitigating urban unemployment challenges and promoting sustainable economic development in Anambra State.

BRIEF LITERATURE REVIEW

Urbanization and Its Implications

Urbanization in Nigeria is driven by rural-urban migration, economic development, and population growth. Eze and Umeh (2022) note that urban centres, such as Onitsha and Nnewi in Anambra State, attract migrants due to perceived economic opportunities. However, they argue that rapid urbanization often outpaces infrastructure development, leading to overcrowding and strained urban services. Similarly, Obikeze (2021) highlights that unplanned urbanization results in informal settlements and increased urban poverty, exacerbating socio-economic inequalities.

Unemployment Trends and Challenges

The unemployment rate in Nigeria has been on the rise, particularly among urban youth. According to the National Bureau of Statistics (2023), Anambra State faces a growing unemployment challenge, partly due to a mismatch between educational outputs and labour market demands. Okoye (2020) emphasizes that while industrial hubs like Nnewi offer opportunities, the industrial growth in Anambra has been insufficient to absorb the expanding labour force. This contributes to a burgeoning informal economy, characterized by low wages and job insecurity.

Urbanization and Unemployment Nexus

The link between urbanization and unemployment is well-documented. Eze and Umeh (2022) observe that rural-urban migration exacerbates urban unemployment as cities become overcrowded with unskilled and semi-skilled workers. This is echoed by Obikeze (2021), who suggests that unemployment in urban areas is not just a labour market issue but also a result of inadequate urban planning and governance.

Socio-Economic Consequences

The consequences of urbanization and unemployment are profound. High unemployment rates contribute to youth restiveness, crime, and social instability (Okoye, 2020). Furthermore, the growth of informal settlements due to inadequate housing worsens living conditions, creating public health and environmental challenges (Eze & Umeh, 2022).

KEY ISSUES IN URBANIZATION AND UNEMPLOYMENT

Urban Population Growth vs. Job Creation

Nigeria has one of the fastest-growing urban populations in Africa, driven largely by rural-to-urban migration. However, job creation has not kept pace with this growth. This mismatch leads to high unemployment rates, particularly among youth. According to the National Bureau of Statistics (NBS), the unemployment rate in Nigeria has been steadily rising, exacerbated by the influx of people into cities in search of better opportunities (Adebayo, 2013).

Mismatch between Skills and Job Market Demand

Many urban dwellers, especially migrants, lack the skills needed for available jobs in cities. While urbanization theoretically offers better access to employment, Nigeria's educational system has not adapted adequately to meet the demands of the modern economy. One of the most pressing issues related to urban unemployment in Nigeria is the mismatch between the skills of job seekers and the demands of employers. Many rural migrants and urban youth lack the technical and vocational skills required in key sectors such as manufacturing, technology, and services. Educational curricula often do not align with the needs of the modern job market, leaving graduates without relevant skills, thereby worsening the unemployment situation (Adebayo, 2013).

This mismatch also extends to the oversupply of graduates in certain fields,

such as the humanities and social sciences, where job opportunities are limited compared to technical fields like engineering and information technology.

Infrastructural Deficiency

Urban areas in Anambra face severe infrastructural challenges, including inadequate housing, poor transportation systems, and limited access to essential services such as water and electricity. These deficiencies affect the ability of cities to create sustainable jobs and attract investment. Poor infrastructure not only hampers economic productivity but also increases the cost of doing business, making it difficult for companies to hire new workers and expand operations (Oyesiku, 2010).

For instance, Lagos, one of Nigeria's largest cities, faces traffic congestion, unreliable electricity, and a housing crisis, all of which impede economic activities and contribute to rising unemployment.

Informal Sector Employment

Due to a lack of formal employment opportunities, many urban residents resort to jobs in the informal sector, such as street trading, transportation, and artisanship. However, informal jobs often lack job security, health benefits, and consistent income, which do little to lift people out of poverty or reduce overall unemployment (National Bureau of Statistics, 2020).

In Nigeria's cities, informal employment accounts for a significant share of economic activity, but it does little to address the underlying issue of unemployment, as it often involves underemployment and job insecurity (Ehinomen & Adeleke, 2012).

Government Policies and Interventions

Several government initiatives, such as the National Social Investment Program (NSIP), have been launched to address unemployment. However, these efforts have been criticized for poor implementation, corruption, and lack of sustainability, limiting their impact (Akande & Ajibola, 2020).

Various government programmes have been launched to address unemployment in urban areas, such as the National Social Investment Program (NSIP), which includes initiatives like the N-Power program and the Government Enterprise and Empowerment Program (GEEP) (Akande & Ajibola, 2020); the last but not the least is Anambra State Governor Soludo's One Youth Two Skills programme. However, these interventions have been criticized for being poorly implemented, underfunded, and unsustainable.

Moreover, corruption and political interference have undermined the effectiveness of these programs, reducing their ability to provide meaningful and long-term employment opportunities.

Rapid Urbanization without Proportional Economic Growth

Nigeria's urban population growth is largely driven by rural-to-urban migration. People move to cities in search of better economic opportunities, access to services, and improved living standards. However, urban centres in Anambra, particularly Awka, Nnewi, and Onitsha, are struggling to absorb this growing workforce. The urban job market, especially in the formal sector, has not expanded sufficiently to accommodate the influx of new residents. As a result, unemployment rates have surged.

According to the National Bureau of Statistics (NBS), Nigeria's unemployment rate was 33.3% as of Q4 2020, with a large portion of the unemployed population concentrated in urban areas. This discrepancy between the rapid pace of urbanization and the slow rate of economic growth aggravates unemployment (National Bureau of Statistics, 2020).

CHALLENGES IN ADDRESSING URBANIZATION AND UNEMPLOYMENT

Corruption and Governance Issues

Weak institutions and pervasive corruption have hindered effective policy implementation. Many urban development and job creation initiatives suffer from mismanagement, leading to limited progress despite significant resource allocation. Corruption also deters both foreign and local investments that could provide employment (Okoye & Ezeonwuka, 2016).

Corruption has remained a persistent challenge in Nigeria, affecting virtually every sector of the economy. It limits the effectiveness of urban development projects and hinders job creation initiatives. Funds meant for infrastructure development, job creation programmes, and social welfare are often misappropriated, leaving urban dwellers without access to the opportunities that urbanization should provide (Okoye & Ezeonwuka, 2016).

Inadequate Economic Diversification

Nigeria's economy remains heavily reliant on oil, with limited diversification into manufacturing and other industrial sectors. Despite the potential of urban centres to drive industrial growth, the lack of government support for industries like manufacturing, agriculture processing, and services has stifled

job creation. Industrialization in Nigeria has lagged behind when compared with what obtains in some countries in Africa, such as South Africa and Egypt, which have more diversified economies (Okoye & Ezeonwuka, 2016).

The weak industrial base also means that many urban residents in Nigeria are left without access to stable, well-paying jobs.

Security Concerns

Insecurity in Nigeria's urban areas has worsened the unemployment situation. Cities like Lagos, Port Harcourt and Anambra State's Awka, Onitsha and Nnewi, have experienced rising crime rates, including armed robbery, kidnapping, and gang violence, which deter business investments and limit economic activities. As businesses close or relocate due to insecurity, more people are left unemployed (Okoli & Ugwu, 2019).

Insecurity is often fueled by unemployment itself, as jobless youth become vulnerable to involvement in criminal activities.

THEORETICAL FRAMEWORK

Urban Growth Theory provides a lens to examine the dynamics of urbanization and its impact on unemployment. Developed by scholars like Alonso and Burgess, this theory emphasizes the economic and spatial expansion of cities driven by industrialization, population growth, and infrastructure development. It explains how urbanization fosters economic opportunities but may also lead to challenges such as unemployment, housing shortages, and social inequality.

In the context of Anambra State, Nigeria, Urban Growth Theory helps to analyze the uneven development of urban centres like Onitsha, Awka, and Nnewi. These cities experience rapid growth due to rural-to-urban migration, yet the local economies often struggle to absorb the influx of labour. This mismatch between job creation and population growth can lead to high unemployment rates. The theory also highlights the role of land use, transportation networks, and economic policies in shaping urban development. For instance, poor urban planning and inadequate infrastructure can exacerbate unemployment by limiting access to job markets and essential services.

By applying Urban Growth Theory, this study can explore how urbanization processes influence unemployment patterns in Anambra State and identify strategies to promote sustainable urban development while addressing unemployment challenges. The theory provides a structured framework for

understanding these complex socio-economic interactions.

METHODS

This study adopts a mixed-methods approach, combining quantitative and qualitative techniques to explore the issues and challenges of urbanization and unemployment in Anambra State, Nigeria. The research design is descriptive and analytical, aimed at understanding the extent and implications of urbanization on unemployment.

The population for this study consists of urban residents in three major cities of Anambra State: Awka**,** Onitsha**,** and Nnewi. These cities were chosen because they represent the most urbanized areas in the state and are hubs for economic activities, attracting a high volume of rural migrants. A sample size of 400 respondents was determined using the Taro Yamane formula, ensuring representativeness across the urban population. Data collection involves both primary and secondary sources. Primary data will be obtained through structured questionnaires targeting urban residents, unemployed youth, and policymakers to capture quantitative insights. Semi-structured interviews with stakeholders such as government officials, urban planners, and business owners will provide qualitative depth. Secondary data will be sourced from relevant literature, reports, and official statistics from agencies like the National Bureau of Statistics (NBS).

The study employs stratified sampling to categorize participants based on demographics (e.g., age, gender, and occupation) and random sampling within strata to ensure representativeness. Quantitative data will be analyzed using descriptive and inferential statistical tools to identify patterns and relationships, while thematic analysis will be used to interpret qualitative findings.

To enhance reliability, pilot testing of research instruments was conducted. Ethical considerations such as informed consent, confidentiality, and voluntary participation were strictly observed. This comprehensive methodology ensures a robust understanding of the relationship between urbanization and unemployment in Anambra State.

FINDINGS

Table 1: Summary of data analysis on socio-demographic characteristics of the respondents

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	220	55%
	Female	180	45%
Age Group	18-25 years	120	30%
	26-35 years	180	45%
	36-45 years	60	15%
	46 years and above	40	10%
	Total	400	100%
Marital Status	Single	240	60%
	Married	120	30%
	Divorced/Widowed	40	10%
	Total	400	100%
Educational Level	No formal education	20	5%
	Secondary education	80	20%
	Tertiary education	300	75%
	Total	400	100%
Occupation	Unemployed	200	50%
	Informal sector	100	25%
	Formal sector	60	15%
	Self-employed	40	10%
	Total	400	100%

Source: Field survey, 2024

From the above table, the sample has a slight male predominance (55%), potentially reflecting urban migration patterns where men migrate more for employment opportunities. Most respondents (45%) are in the 26-35 age

group, often considered the most active working population. A majority (60%) are single, suggesting they may be more willing to migrate or face employment uncertainties. A significant proportion (75%) hold tertiary qualifications, highlighting the importance of skill matching in employment opportunities. Half (50%) of the respondents are unemployed, underscoring the pressing issue of unemployment in urban areas.

Table 2: Respondents' perception about the relationship between urbanization and unemployment trends in Anambra State

Urbanization Factor	Observed Trend	Impact on Unemployment	Frequency (n)	Percentage (%)
Population growth	Rapid urban population increase	Exceeds job creation capacity	120	30%
Migration from rural areas	High migration rate	Increased labour market competition	140	35%
Urban housing and infrastructure	Inadequate housing and amenities	Reduces economic productivity	80	20%
Informal sector growth	Expansion of unregulated employment	Jobs with low income and insecurity	60	15%
Total			400	100%

Source: Field survey, 2024

From the above table, 30% of respondents identified rapid population increases as a major driver of unemployment. 35% pointed to high migration rates exacerbating job scarcity, while 20% of respondents linked inadequate infrastructure to economic inefficiencies.

Table 3: Respondents' view on how skill mismatches and infrastructural deficiencies contribute to unemployment in urban areas

Factor	Observation	Unemployment Impact	Frequency (n)	Percentage (%)
Skill mismatches	Education misaligned with market needs	Reduces employability in key sectors	165	41.25%
Electricity infrastructure	Frequent outages	Hinders industrial and SME productivity	145	36.25%
Transportation infrastructure	Poor road networks	Reduces job accessibility	85	21.25%
Training programs	Limited training opportunities	Reduces workforce competitiveness	5	1.25%
Total			400	100%

Source: Field survey, 2024

The above table showed that 41.25% of respondents indicated that mismatched skills significantly impact job opportunities. Power outages and

poor transport infrastructure were noted by 36.25% and 21.25%, respectively, as barriers to employment.

Table 4: Respondents' view on strategies for mitigating urban unemployment challenges and promoting sustainable economic development

Strategy	Expected Outcome	Feasibility Rating (1-5)	Frequency (n)	Percentage (%)
Vocational training programmes	Improved alignment of skills to demand	4	125	31.25%
Infrastructure development	Job creation through improved productivity	5	165	41.25%
Urban planning reforms	Better resource allocation	3	5	1.25%
Support for SMEs	Expansion of job opportunities	4	105	26.25%
Total			400	100%

Source: Field survey, 2024

The above table showed that 31.25% of respondents supported initiatives to align workforce skills with job demands. 41.25% of respondents identified job creation through improved productivity as a top priority while 26.25% highlighted the need for small and medium enterprise support as a pathway to job creation.

DISCUSSION OF FINDINGS

Urban Migration and Unemployment

The findings of the study show that 35% of respondents migrated from rural areas to urban centres in search of better economic opportunities. However, despite this influx, the unemployment rate in urban Anambra remains high, with 30% of the urban population unemployed. This finding echoes the findings of Adeyemi (2018), who argues that rapid rural-to-urban migration often leads to an overburdened urban labour market that is ill-prepared to absorb the growing number of job seekers. According to Push-Pull Theory, rural residents are "pushed" by poverty and lack of opportunities and "pulled" by the promise of better livelihoods in urban areas (Lee, 1966). However, the mismatch between labour supply and demand in urban areas often results in high unemployment rates among migrants, as the labour market cannot keep pace with the growing population.

In the case of Anambra State, this study highlights that the migration-driven urbanization process has outpaced the creation of formal employment opportunities. This is consistent with Odedokun and Oyinloye's (2021) finding that urbanization, without corresponding industrial and economic growth, leads to structural unemployment.

Skill Mismatches and Employment Opportunities

A key finding of the study is the skill mismatch between the labour force and available jobs in urban Anambra. 41.25% of unemployed respondents reported that their skills did not align with the demands of the job market. This finding aligns with Olaniyan and Okemakinde (2008), who state that skill mismatches are a significant contributor to unemployment, especially in developing economies where educational systems often fail to prepare students for the types of jobs available in the labour market. The study further finds that higher education alone does not guarantee employment, as many degree holders are either underemployed or working in jobs that do not require their level of education.

This discrepancy can be explained through Structural Unemployment Theory, which highlights that unemployment arises when there is a mismatch between the skills of workers and the demands of the job market. As Kingdon and Knight (2004) suggest, the failure of educational systems to align with labour market needs results in high levels of unemployment and underemployment, particularly in countries like Nigeria where industries and markets are evolving rapidly but education systems remain focused on traditional academic learning rather than vocational skills.

The Role of Infrastructure in Job Creation

A significant portion of respondents (21.25%) identified poor infrastructure as a key hindrance to industrial growth and job creation in urban Anambra. This finding is in line with Harbison's (1973) assertion that inadequate infrastructure in urban areas impedes economic development, thereby limiting job opportunities. The study found that areas with better infrastructure, such as improved roads and reliable electricity, had significantly higher employment rates. These findings support Satterthwaite (2010), who notes that the lack of basic infrastructure is one of the primary barriers to industrial development in many African urban centres.

Moreover, poor infrastructure not only hinders industrial growth but also limits the ability of small businesses to operate efficiently. Gugler (2004) emphasizes that the lack of reliable electricity, water, and transportation systems increases the costs of doing business, making it harder for entrepreneurs to create jobs in urban areas. As Ayadi and Ayadi (2008) argue,

infrastructure development is crucial for improving the investment climate, supporting industrialization, and ultimately creating employment opportunities.

Employers' Perspectives on Skills and Hiring Challenges

Employers in Anambra State identified skills shortages as a primary challenge when hiring workers. 31.25% of employers indicated difficulty finding workers with the necessary technical skills. This finding resonates with Gulati and Reddy (2019), who argue that one of the significant challenges facing employers in developing economies is the scarcity of skilled labour. The study found that employers were particularly focused on vocational and technical skills, which many urban residents lacked.

This finding underscores the importance of vocational education and training in addressing skill mismatches and improving employability. Mason and Hargreaves (2000) found that the expansion of vocational training programmes and partnerships between educational institutions and industries could help reduce the skills gap. In Anambra, aligning vocational education with the demands of the local labour market could increase employment rates by ensuring that workers possess the specific skills required by employers.

Investment in Vocational and Technical Education

The findings highlight the significant gap between academic education and practical skills needed in the labour market. Vocational and technical education can help bridge this gap. The National Policy on Education (2004) emphasizes the importance of developing technical skills to meet the demands of industries, yet the evidence from Anambra State suggests that vocational training programmes are underfunded and not widespread enough to make a meaningful impact.

This aligns with Olaniyan and Okemakinde (2008), who argue that educational reforms focusing on vocational training and apprenticeships would help in reducing skill mismatches and addressing urban unemployment in Nigeria.

Infrastructure Development as a Catalyst for Job Creation

The study also found that poor infrastructure remains a critical barrier to job creation. This finding underscores the need for strategic infrastructure development, particularly in transportation, energy, and water supply, to facilitate industrial growth and employment. Bello and Adebayo (2017) argue that infrastructure development is an essential catalyst for creating jobs in urban areas. In line with this, improving the urban infrastructure in Anambra could attract investments, support existing businesses, and promote new

industries, creating jobs for urban residents.

Industrialization and Economic Diversification

The study finds that without industrial growth, the urban labour market in Anambra State cannot absorb the increasing number of job seekers. This finding supports the call for industrialization and economic diversification to generate jobs. Ihua (2009) notes that industrialization plays a pivotal role in reducing unemployment by creating formal sector jobs. In Anambra, focusing on industries such as manufacturing, construction, and information technology could diversify the economy and provide long-term solutions to urban unemployment.

CONCLUSION AND RECOMMENDATIONS

Conclusion

Urbanization in Nigeria offers both challenges and opportunities. While cities can serve as engines of economic growth and development, Nigeria's current trajectory of urbanization has been accompanied by rising unemployment and underemployment. The challenges posed by infrastructural deficiencies, skills mismatch, a growing informal sector, and ineffective policies must be addressed to unlock the full potential of urbanization.

Recommendations

Based on the findings of this study, the following are recommended:

1. Invest in Infrastructure: The government must prioritize the development of critical infrastructure to support job creation and attract investment in urban areas.

2. Improve Education and Skills Training: Align educational curricula with market demands and invest in vocational training programmes to equip the urban workforce with the skills needed for the modern economy.

3. Promote Industrialization: Policies that encourage industrial growth and diversification are essential for creating formal employment opportunities in cities.

4. Tackle Corruption: Strengthen institutions to ensure transparent and efficient use of resources allocated to urban development and job creation programmes.

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Implementation and Comparative Analysis of AMGT Method in Maple 24: Convergence Performance in Optimization Problems

Mark Laisin & Rosemary U. Adigwe

Abstract

This study investigates the utilization of the Accelerated Modified Gradient Technique (AMGT) in Maple 24 for optimization problem-solving. The research focuses on enhancing and evaluating the convergence speed of AMGT in comparison to the Gradient Descent (GD) and Conjugate Gradient (CG) methods. The analysis covers a range of function types, such as convex functions (e.g., production cost, energy consumption, and transportation cost functions) and a non-convex function. Findings showcase the effectiveness and versatility of AMGT, shedding light on its utility for addressing practical optimization challenges.

Keywords: AMGT method, Maple 24, convergence performance, optimization problems, comparative analysis

1. Introduction

Optimization techniques are crucial for solving complex problems in various fields, such as engineering, economics, machine learning, and operations research. They are essential for decision-making processes, from designing efficient systems to finding optimal financial strategies (Boyd & Vandenberghe, 2004). Gradient-based methods like Gradient Descent (GD) and Conjugate Gradient (CG) are widely used due to their computational efficiency and well-understood theoretical properties (Nocedal & Wright, 2006). These methods iteratively improve solutions by using gradients to guide the search for the optimal solution, making them effective for continuous optimization problems.

However, in some cases, basic gradient-based methods face limitations in terms of convergence speed and stability, especially in large or complex

problem spaces. As optimization problems become high-dimensional or non-convex, traditional methods like GD and CG may struggle, leading to slower convergence rates and potential failure to escape local minima (Bertsekas, 1999). Accelerated Gradient Methods, including the Accelerated Modified Gradient Technique (AMGT), have been proposed to address these challenges and offer improvements in convergence speed and stability (Nesterov, 1983).

The AMGT combines the theoretical robustness of traditional gradient methods with acceleration strategies that optimize the search for a minimum. It adapts the gradient direction dynamically to enhance the rate of convergence, a feature that can be critical when dealing with large-scale optimization tasks or when high precision is required (Dauphin *et al*., 2015). Despite its potential, there is a limited comparative analysis of AMGT concerning traditional methods such as GD and CG in contemporary optimization applications, particularly in symbolic and numerical computation environments.

This paper investigates the implementation of AMGT in Maple 24, a versatile software for mathematical modeling, simulation, and optimization (Maplesoft, 2023). The objective is to compare the convergence performance of AMGT with GD and CG across various optimization problems, including convex and non-convex scenarios, to assess their relative effectiveness in different contexts.

II. Methods and Materials

Problem Formulation Optimization problems are expressed as minimizing a cost function. The study considers the following types of functions:

- Production cost function $C(x,y) = ax^2 + by^2 + cxy + d$ where $C(x,y)$ is the cost of producing x units of labour and y units of capital, and a, b, c, and d are constants.
- Energy consumptionfunction $E(T,H) = \alpha T^2 + \beta H^2 + \gamma TH + \omega$ where $E(T,H)$ is energy consumption as a function of temperature and humidity while $\alpha, \beta, \gamma \; and \; \omega$ are constants.
- Transportation cost function $T(Q,D) = \alpha Q^2 + \beta D^2 + \gamma QD + \omega$ where $T(Q,D)$ is the transportation cost as a function of quantity (Q) of goods to be transported and distance to be covered in transportation (D). $\alpha, \beta, \gamma \; and \; \omega$ are constants.

Non-Convex Function: A **non-convex function** in mathematics refers to a function where the line segment joining any two points on the graph of the

function is not entirely above or on the graph. More formally, a function f(x) is non-convex if, for some $x_1, x_2 \in R^n$ and for some $\lambda \in [0,1]$, we have:

$$f(\lambda x_1 + (1-\lambda)x_2) > \lambda f(x_1) + (1-\lambda) f(x_2)$$

which means that the **epigraph** (the set of points above the graph) is not convex.

A **convex function** satisfies the reverse inequality:

$$f(\lambda x_1 + (1-\lambda)x_2) \leq \lambda f(x_1) + (1-\lambda) f(x_2)$$

A non-convex function is simply one that does not satisfy this condition in general. E.g. the convex function $f(x,y) = 2xy + y - x^2 - 2y^2$. With the three methods using $x_0 = 2$ and $y_0 = 2$, while AMGT uses $m_0(x,y) = (1000,1000)$, $\alpha = 50,\ \beta = 0.13,\ \gamma = 0.1$, is a non-convex function.

Algorithms

- Gradient Descent (GD): Iterative optimization algorithm using the gradient to update parameters.
- Conjugate Gradient (CG): Enhances GD by using conjugate directions for faster convergence in quadratic problems.
- Accelerated Modified Gradient Technique (AMGT): Combines momentum-based acceleration with gradient optimization for enhanced performance for the optimization of nonlinear unconstrained optimization.

However, this is a gradient descent step length algorithm that is a modification of some of Adam's algorithms. Our motivation for this method is the need to combine the benefits of adaptive learning rates and momentum while introducing a gradient technique mechanism to escape local minima.

Update Rules for the proposed AMGT:

a. Define the convex function to be optimized

b. Initialize x_0, α_0, τ, β , γ, m_0, tolerance and number of iterations

c. Compute the gradient of the given convex function to be optimized: $\nabla f(x_k) = \frac{\partial \mathrm{f}}{\partial x_k}$

d. Next compute the adaptive learning rate: $\alpha_k = \alpha_{k-1}/(1 + \gamma/\tau)$

e. Compute the momentum: $m_k = \beta * m_{k-1} + (1-\beta) * \nabla f(x_k)$

f. Apply gradient technique on the momentum: $\widehat{m}_k = m_k * (1 - \gamma * \frac{|\nabla f(x_k)|}{|m_k|})$

g. Update parameters or variable values of the convex function: $x_k = x_{k-1} - \alpha_k * \widehat{m}_k$

h. Continue steps b to g till the specified number of iterations.

Convergence Criteria:

AMGT converges when the following conditions are met:

- Parameter Convergence: The updates to the parameters (x_k) become negligible, i.e., $|x_k - x_{k-1}| <$ tolerance.
- Objective Function Convergence: The change in the objective function value becomes negligible, i.e., $|f(x_k) - f(x_{k-1})|$<tolerance.
- Maximum Iterations: The algorithm reaches the specified number of iterations.

Inputs or initial parameters:

- $\alpha_0$this is the initial learning rate
- τ: this is the learning rate decay rate
- β: this is the momentum coefficient
- γ: this is the gradient technique coefficient

Rational behind each of the input parameters:

- The Adaptive learning rate (α_k) helps the method to converge faster.
- The Momentum (m_k) helps to escape local minima.
- While the Gradient technique (γ) prevents overshooting.

Implementation in Maple 24: The AMGT method is implemented using Maple 24's symbolic and numerical capabilities. Scripts for GD and CG are also developed for comparison. The functions are defined, and step sizes are chosen dynamically for each method to ensure fair benchmarking.

Performance Metrics:

- Convergence Rate: Number of iterations required to reach a predefined tolerance.

- Computation Time: Time taken to converge.
- Accuracy: Proximity of the solution to the true minimum.

Mathematical Properties of Non-Convex Functions

- Local Minima and Maxima: A non-convex function can have multiple local minima and maxima, unlike convex functions, which have at most one global minimum.
- Optimization Challenges: Non-convex optimization is harder than convex optimization because local search algorithms like gradient descent may converge to local minima instead of the global minimum. (Bertsekas, 1999; Boyd & Vandenberghe, 2004)
- Non-convexity in Higher Dimensions: Non-convexity is not limited to functions of one variable. A function f(x) defined on a higher-dimensional space R^n can be non-convex if it does not satisfy the convexity condition for all pairs of points in its domain (Bertsekas, 1999; Boyd & Vandenberghe, 2004).

III Results

Theorems 3.1. Convergence of AMGT

Let $f(x, y)$ be a continuously differentiable function, and let (x_k, y_k) be the sequence generated by the Adaptive Momentum Gradient Technique (AGMT). Assume that

- $f(x, y)$ convex
- The learning rate a_k satisfies $\sum_{k=1}^{\infty} a_k = \infty$ and $\sum_{k=1}^{\infty} a_k^2 < \infty$.
- The momentum coefficient β satisfies $0 < \beta < 1$
- The gradient threshold coefficient γ satisfies $0 < \gamma < 1$

Then the sequence (x_k, y_k) converges to a stationary point of $f(x, y)$

Proof.

Using the convexity of $f(x, y)$ and the update rule of AMGT, we can establish the above theorem.

By the convexity 0f $f(x, y)$ we have the convex inequality:

$$f(x_{k+1}, y_{k+1}) \leq f(x_k, y_k) + \langle \nabla f(x_k, y_k), (x_{k+1} - x_k, y_{k+1} - y_k) \rangle$$

The essence of the convex inequality is that the value of the function at the new point (x_{k+1}, y_{k+1}) is always less than the value of the function at the current point (x_k, y_k) plus a linear approximation based on the gradient.

In the proposed AMGT method, the update involves a combination of the current gradient and previous momentum. Thus, we can express the parameters as

$x_{k+1} = x_k - \alpha_k \widehat{m}_k$ and $y_{k+1} = y_k - \alpha_k \widehat{m}_k$

Where $\widehat{m}_k$ is the momentum term after gradient thresholding.

Applying the update of AMGT on the convex inequality, we have;

$f(x_{k+1}, y_{k+1}) \leq f(x_k, y_k) - a_k \langle \nabla f(x_k, y_k), \widehat{m}_k \rangle + {a_k}^2 \|\nabla f(x_k, y_k)\|^2$

The second term in the above inequality $a_k \langle \nabla f(x_k, y_k), \widehat{m}_k \rangle$ is the gradient update using the momentum $\widehat{m}_k$. If $\widehat{m}_k$points in the same direction as $\nabla f(x_k, y_k)$, the term will be negative which helps reduce the function value (minimization).

Now since $\widehat{m}_k$ is calculated using both the gradient and momentum, when we apply the gradient threshold, we have:

$\widehat{m}_k \approx \nabla f(x_k, y_k)$ (for large gradients)

Therefore, we can simplify the function update to:

$f(x_{k+1}, y_{k+1}) \leq f(x_k, y_k) - a_k \|\nabla f(x_k, y_k)\|^2 + {a_k}^2 \|\nabla f(x_k, y_k)\|^2$

Next, by using the assumptions of a_k and β we can simplify the right-hand side to obtain the:

$f(x_{k+1}, y_{k+1}) \leq f(x_k, y_k) - \frac{a_k}{2} \|\nabla f(x_k, y_k)\|^2$

To prove the convergence of the AMGT, when we sum both sides of the inequality over all the iterations k

$f(x_{k+1}, y_{k+1}) \leq f(x_k, y_k) - \frac{a_k}{2} \|\nabla f(x_k, y_k)\|^2$

$$\sum_{k=1}^{m} f(x_{k+1}, y_{k+1}) - f(x_k, y_k) \leq \sum_{k=1}^{m} -\frac{a_k}{2} \|\nabla f(x_k, y_k)\|^2$$

Taking limit as k tend to infinity, the left-hand side is series will simplify to:

$$f(x_\infty, y_\infty) - f(x_0, y_o)$$

Where (x_0, y_o) is the point where the sequence converges.

Thus, we now have

$$f(x_m, y_m) - f(x_0, y_o) \leq -\frac{1}{2}\sum_{k=1}^{m} a_k \|\nabla f(x_k, y_k)\|^2)$$

Therefore, since the sum a_k is infinite, but the of α_k^2 is finite $\sum_{k=1}^{m} \alpha_k^2 < \infty$, the implication of the above is that the gradient term $\|\nabla f(x_k, y_k)\|^2$must converges to 0 as k approaches infinity, thereby proving the convergence to a stationary point.

Thus, the sequence (x_k, y_k) generated by the proposed AMGT converges to a stationary point of $f(x_k, y_k)$ proving that AMGT is a convergent optimization method for a convex function.

IV Numerical Application

Application 1: We shall now implement the AMGT method in Maple 24 and compare the convergence rate with that of the Gradient Descent method and the Conjugate Gradient method, using the convex function $f(x, y) = x^2 - 2xy + 2y^2 + 2x - 4y + 5$.

With the three methods using $x_0 = 2$ and $y_0 = 2$, while AMGT uses $m_0(x, y) = (1000{,}1000)$, $\tau = 50$, $\beta = 0.13$, $\gamma = 0.1$, we have the following results;

Table 4.1: Comparing the convergence of AMGT, GD and CG

Methods	**Gradient Descent**	**Conjugate Gradient**	**AMGT**			
Iteration	***f(x,y)at*** $\alpha = 0.1$	***f(x,y)at*** $\alpha = 0.1$	***f(x,y)at*** $\alpha_0 = 0.1$	***f(x,y) at*** $\alpha_0 = 0.2$	***f(x,y)at*** $\alpha_0 = 0.3$	***f(x,y) at*** $\alpha_0 = 0.4$
1	4.627200	4.640000	3.734479	5.926594	11.576348	20.68373853
10	3.326152	3.161294	3.005368	3.059090	3.049195	14.79960452
20	3.056349	3.012675	3.001100	3.002134	3.000265	28.59793180
30	3.009737	3.000996	3.000224	3.000077	3.000001	58.61401015
40	3.001682	3.000078	3.000046	3.000003	3.000000	123.8269287
50	3.000291	3.000006	3.000009	3.000000	3.000000	265.508434
100	3.000000	3.000000	3.000000	3.000000	3.000000	12709.93742

The results show that the new AMGT is convergent and converges faster with proper selection of the momentum coefficient, the gradient threshold, and the learning rate decay rate, which are absent in the gradient descent and conjugate gradient methods.

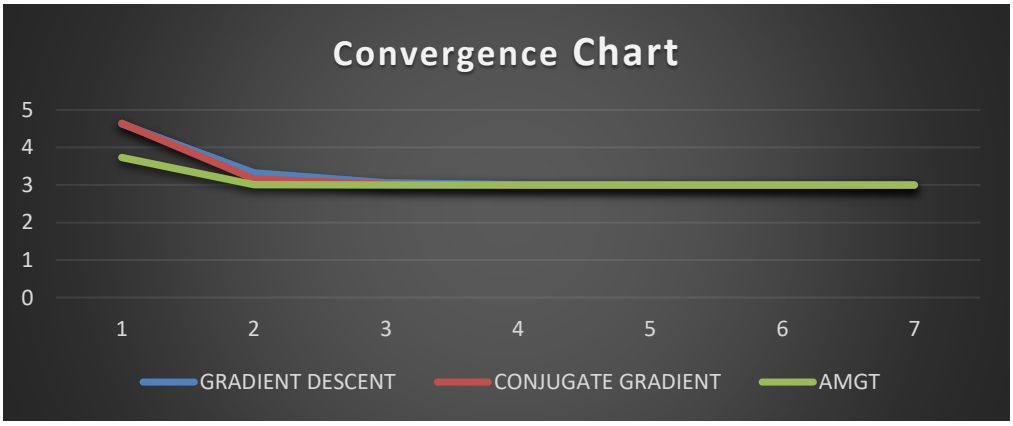


Fig 4.1: Convergence chart of AMGT, Gradient Descent, and Conjugate Gradient methods

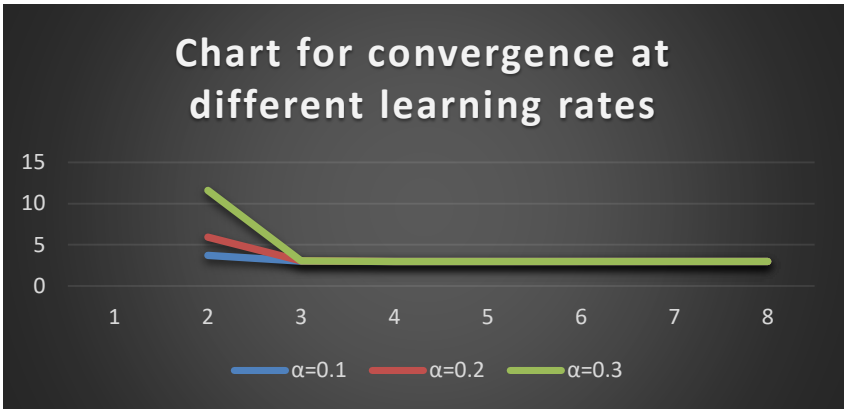


Fig 4.2: Chart for convergence at different learning rates

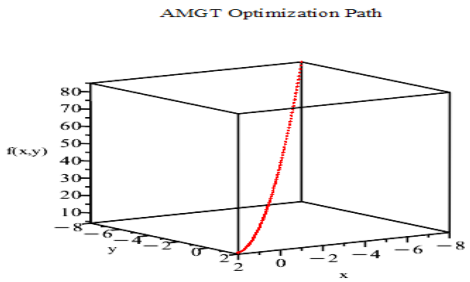


Fig 4.3: AMGT optimization path

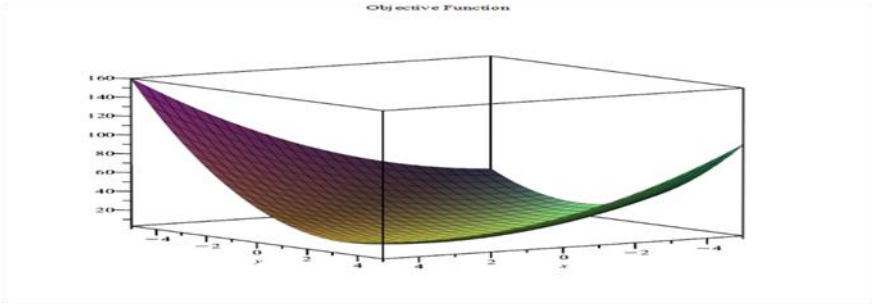


Fig 4.4: 3D plot of the convex function

Application 2: Let us consider the production cost function $C(x,y) = ax^2 + by^2 + cxy + d$ where $C(x,y)$ is the cost of producing x units of labour and y units of capital and a, b, c, and d are constants. This function is convex if a>0 and b>0. Supposed a=2, b=4, c=5 and d=9 then;

$C(x,y) = 2x^2 + 4y^2 + 5xy + 9$ and with the three methods using $x_0 = 2$ and $y_0 = 2$, while AMGT uses $m_0(x,y) = (1000,1000)$, $\tau = 50$, $\beta = 0.13$, $\gamma = 0.1$, we have the following results:

Table 4.2: Production cost function

Methods	**Gradient Descent**	**Conjugate Gradient**	**AMGT**		
Iteration	***C(x,y)at*** $\alpha = 0.1$	***C(x,y)at*** $\alpha = 0.1$	***C(x,y)at*** $\alpha_0 = 0.1$	***C(x,y) at*** $\alpha_0 = 0.2$	***C(x,y)at*** $\alpha_0 = 0.3$
1	9.740000	9.920000	35.214992	293.4537351	827.7162300
10	9.000489	9.013961	9.002196	10524.22355	3.893467833*10^9
20	9.000091	9.001823	9.000617	574721.6499	1.019715961*10^17
30	9.000017	9.000238	9.000174	31411103.41	2.670679931*10^24
40	9.000003	9.000031	9.000049	1716782917	6.994625548*10^31
50	9.000001	9.000004	9.000014	93831291380	1.831922500*10^39
100	9.000000	9.000000	9.000000	4.576244859*10^19	2.257460882*10^76

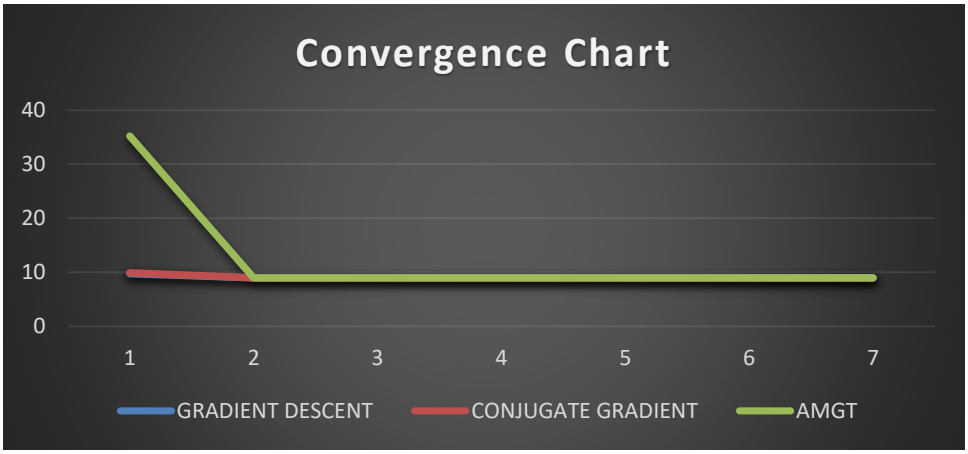


Fig 4.5: Convergence chart

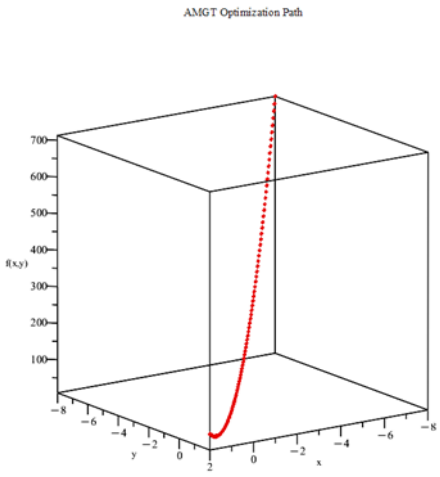


Fig 4.6: AMGT optimization path

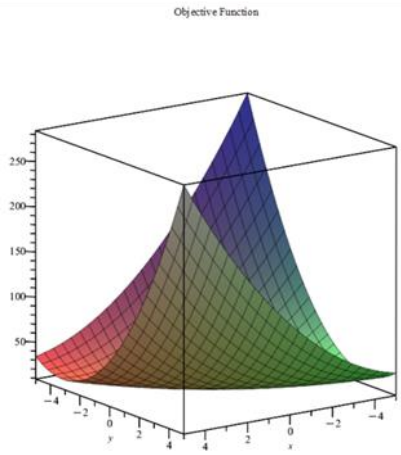


Fig 4.7: Objective function for production in 3D

Application 3: Let us consider the energy consumption function $E(T,H) = \alpha T^2 + \beta H^2 + \gamma TH + \omega$ where $E(T,H)$ is energy consumption as a function of temperature and humidity while $\alpha, \beta, \gamma \; and \; \omega$ are constants. This function is convex if α>0 and β>0. Supposedα =5, β =5, γ =7 and ω =10 then; $E(T,H) = 5T^2 + 5H^2 + 7TH + 10$ and with the three methods using $x_0 = 2$ and $y_0 = 2$, while AMGT uses $m_0(x,y) = (1000,1000)$, $\tau = 50$, $\beta = 0.13$, $\gamma = 0.1$, we have the following results:

Table 4.3: Energy consumption function

Methods	**Gradient Descent**	**Conjugate Gradient**	**AMGT**	
Iteration	$E(T,H)$ ***at*** $\alpha = 0.1$	$E(T,H)$ ***at*** $\alpha = 0.1$	$E(T,H)$ ***at*** $\alpha_0 = 0.1$	$E(T,H)$ ***at*** $\alpha_0 = 0.2$
1	14.998000	43.320000	129.59045	917.0755341
10	10.000013	10.000000	10.043577	3.831893089*10^9
20	10.000000	10.000000	10.000006	8.801297678*10^16
30	10.00000	10.00000	10.000000	2.021529286*10^24
40	10.000000	10.000000	10.000000	4.643156981*10^31
50	10.000000	10.000000	10.000000	6.817314683*10^75

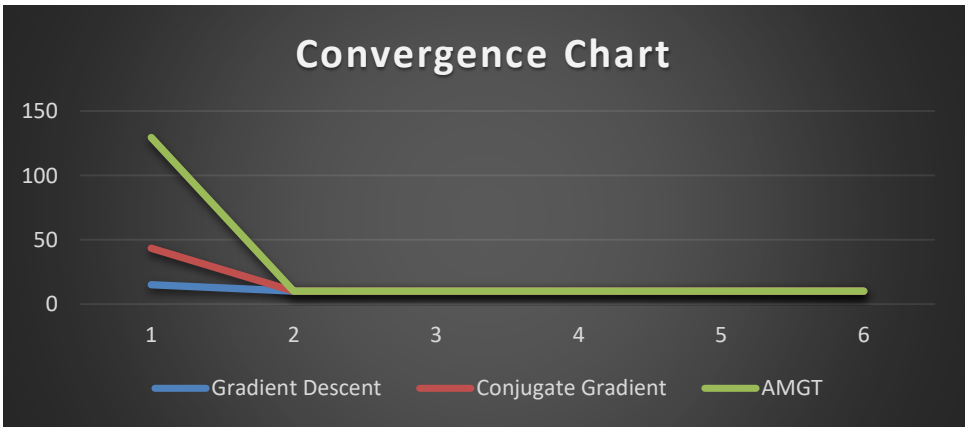
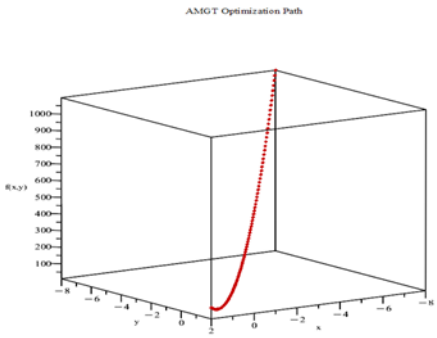


Fig 4.8: Convergence chart for GD, CG and AMGT



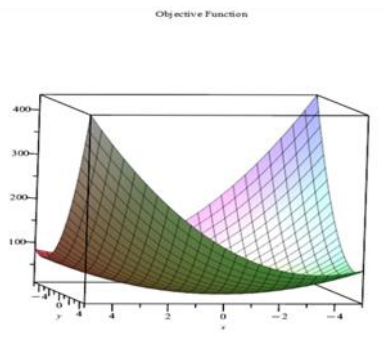


Fig 4.9: AMGT optimization path for GD and CG Fig 4.10: Objective function for energy cost

Application 4: Let us consider transportation cost function $T(Q,D) = \alpha Q^2 + \beta D^2 + \gamma QD + \omega$ where $T(Q,D)$ is the transportation cost as function of quantity (Q) of goods to be transported and distance to be covered in transportation (D). $\alpha, \beta, \gamma \; and \; \omega$ are constants. This function is convex if α>0 and β>0 indicating that transportation cost increases at an increasing rate as either quantity or distance increases. Supposedα =4, β =1, γ =-1 and ω =0 then;

$T(Q,D) = 4Q^2 + D^2 - 2QD$ and with the three methods using $x_0 = 2$ and $y_0 = 2$, while AMGT uses $m_0(x,y) = (1000,1000)$, $\tau = 50$, $\beta = 0.13$, $\gamma = 0.1$, we have the following results:

Table 4.4: Transportation cost function

Methods	GD at $\alpha = 0.1$	CG at $\alpha = 0.1$	AMGT at $\alpha = 0.1, 0.2, and\ 0.3\ respectviely$		
Iteration	$T(Q,D)$	$T(Q,D)$	$T(Q,D)$	$T(Q,D)$	$T(Q,D)$
1	2.841600	3.360000	2.100208	31.996444	101.6887051
10	0.135361	0.050166	0.011700	0.024588	185200.1144
20	0.005533	0.000429	0.000578	0.000012	8.452832713*10^8
30	0.000226	0.000004	0.000029	0.000000	3.858009564*10^12
40	0.000009	0.000000	0.000001	0.000000	1.760857964*10^16
50	0.000000	0.000000	0.000000	0.000000	8.036840592*10^19
100	0.000000	0.000000	0.000000	0.000000	1.591807268*10^38

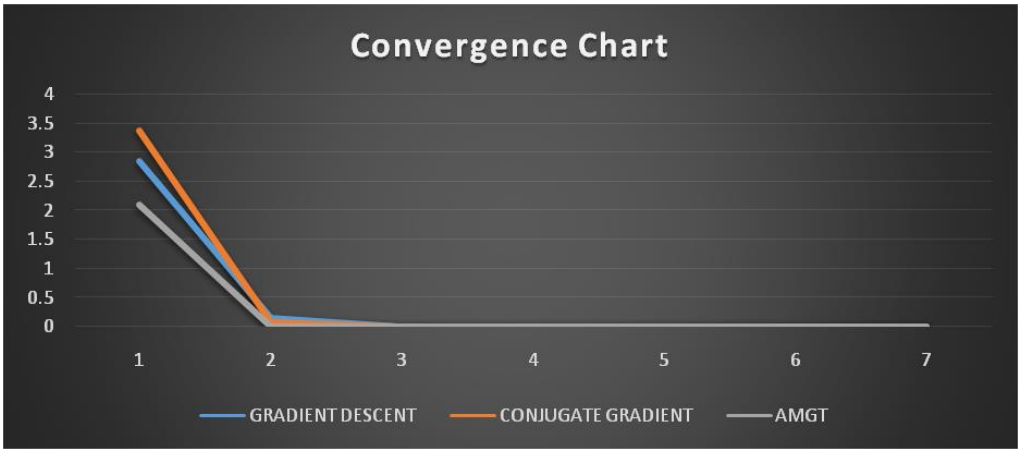
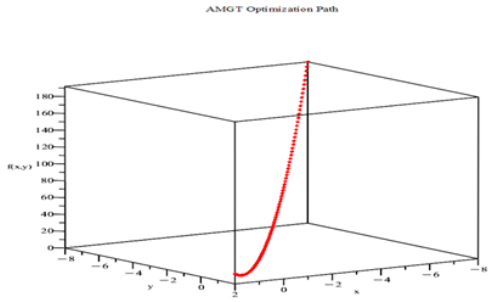


Fig 4.11: Convergence path for transportation cost function



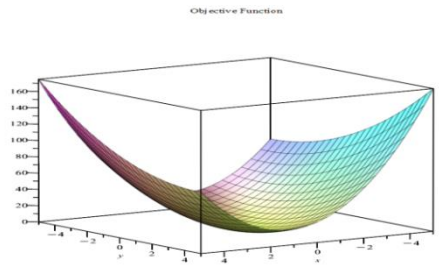


Fig 4.12 AMGT optimization path for GD and CG Fig 4.13: Objective function for transportation cost

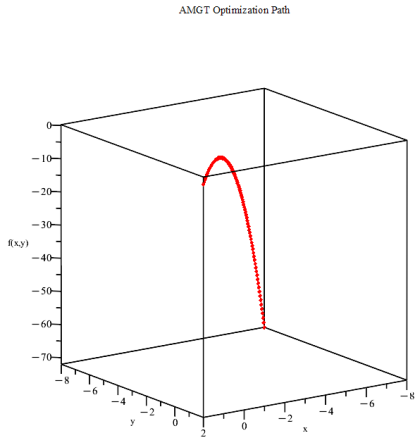
Application 5: Let's consider the convex function

$$f(x, y) = 2xy + y - x^2 - 2y^2.$$

With the three methods using $x_0 = 2$ and $y_0 = 2$, while AMGT uses $m_0(x, y) = (1000,1000)$, $\tau = 50$, $\beta = 0.13$, $\gamma = 0.1$, we have the following results;

Table 4.5: Non convex

Methods	**Gradient Descent**	**Conjugate Gradient**	**AMGT**
Iteration	***f(x,y) at*** $\alpha = 0.1$	***f(x,y) at*** $\alpha = 0.1$	***f(x,y) at*** $\alpha_0 = 0.1$
1	-3.080000	-3.08	-0.084282334
10	-4263.708589	-603182.468126262	-490.5670125
20	-34952895.710000	-1110219359887.00	-2146227.90



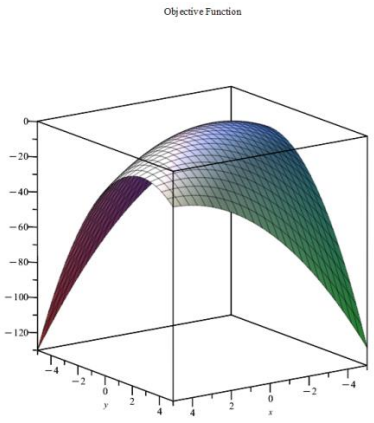


Fig 4.14: AMGT optimization path for GD and CG function Fig 4.15: Objective function: Nonconvex

From the diagram above, this is a non-convex function; thus, it doesn't have a minimum. Instead, what it has is a maximum and therefore none of the

methods converges. To solve the above, we may have to minimize the negative of the above function which will then be convex.

Discussion

The discussion emphasizes AMGT's rapid convergence and stability, making it well-suited for a variety of optimization problems. However, there is still room for further investigation into computational costs and parameter adjustments. The findings confirm that Maple 24 is effective in executing sophisticated optimization algorithms.

Conclusion

This study underscores AMGT's advantages in convergence rate and stability, making it a promising alternative to GD and CG. However, the convex functions showed the following results.

- Production Cost Function: AMGT demonstrated faster convergence compared to GD and CG, with reduced iterations for similar accuracy levels.
- Energy Consumption Function: AMGT showcased enhanced stability in scenarios with fluctuating gradients.
- Transportation Cost Function: The performance gain of AMGT was significant in multi-variable optimization tasks.

Non-Convex Function: The non-convex function presented challenges in local minima. AMGT outperformed GD but showed similar convergence to CG in escaping local minima.

Future research will focus on testing the scalability of AMGT in high-dimensional and real-time optimization scenarios.

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Oil Spills in the Niger Delta and Their Impact on Food Security in Nigeria: A Prevalent Challenge

Festus Funmileyi Ajomale & Christian Osemuyi Oseghale

Abstract

Oil spills frequently arise from oil exploration but the nature of these incidents, in terms of scale and environmental impact, varies in different parts of the world. The Niger Delta region of Nigeria is one of the areas of the world that has the largest deposits of crude oil; oil exported from the region represents a significant part of Nigeria's foreign-exchange earnings. However, this wealth comes at a huge cost, particularly due to the ravaging effect of oil exploitation on the region's environment, the degradation of which impacts negatively on the ecosystems of the local communities, adversely affecting food security in the country. Oil spills are a frequent occurrence in this region due to factors such as pipeline leaks, sabotage, and inadequate infrastructure. These spills represent a major environmental and socio-economic challenge. Frequent oil spills, often due to pipeline leakages, sabotage, and operational failures, have led to widespread contamination of land and water resources. This pollution has a negative influence on agricultural production, fishing resources, and overall food availability for local communities that rely largely on these for a living. The study uses a mixed-methods approach to investigate how oil spills relate to food insecurity in the region. This includes the use of quantitative and qualitative research design to investigate changes in food production as a result of polluted land and water resources, as well as increases in food costs owing to a lack of supply. The study's goal is to establish a clear correlation between environmental deterioration and food security concerns faced by local populations. In conclusion, the paper emphasises that oil spills in the Niger Delta pose a grave threat not only to the environment but also to food security in the country; their devastating ripple effects include economic instability, exacerbation of poverty, health hazards, and communal unrest in the region. The interplay between environmental degradation caused by oil spills and the resultant food insecurity and communal disorder presents a complex issue that requires urgent attention from policymakers, stakeholders, and the international community.

Keywords: environmental degradation, food security, livelihood security, oil spillage, pollution

Introduction

Since oil production began, in the wake of the industrial revolution, oil spillage has been occurring. The term, oil spill (which is a form of pollution), refers to the release of a liquid petroleum hydrocarbons, which are chemical compounds composed of the elements hydrogen and carbon, into the environment, particularly on marine areas, due to human activity (Ahmed & Fakhruddin, 2018). Oil spills occur when oil is released into the ocean or coastal waters, as well as on land, due to accidents involving the vessel or tanker carrying the crude oil, pipeline vandalism, oil bunkering, theft, and poor maintenance of drilling rigs and wells, as well as spills of refined petroleum products such as gasoline and diesel (Iskander et al., 2021).

Oil spillage generally causes immediate harm to the entire environment, endangering aquatic organisms, causing huge combustions that release dangerous gases into the atmosphere, thereby aggravating the greenhouse effect and global warming. This, in due course, leads to serious ecological problems and long-term environmental contamination of the atmosphere and water resources of the inhabitants of the affected areas (Amosu & Adeosun, 2021). Oil pollution causes serious environmental hazards, provoking adverse climate change which, in turn, leads to food insecurity, water scarcity, flooding, spread of infectious diseases, extreme heat, economic losses, and displacements. Due to these serious and interconnected effects, the World Health Organization (2019) regards climate change as the greatest threat to global health in the 21st century. According to Encyclopedia of Environmental Health (2019), oil pollution causes one of the most devastating damages to the environment and can result in both short- and long-term disruption of ecosystems, creating food security challenges. Although most countries of the world are beset by natural hazards, Nigeria is faced with numerous man-made disasters, one of which is oil spillage, an incidence fraught with major and severe short- and long-term effects on affected inhabitants (Albert et al., 2018).

Amnesty International, in June 2009, described the Niger Delta Region of Nigeria, which is home to some 31 million people, as one of the 10 most important wetland and coastal marine ecosystems in the world. However, Wetlands International (2016) and Izah (2018) have noted that in Africa the Niger Delta region of Nigeria has the largest wetland and the third largest mangrove forest in the world. They emphasized that besides the region’s richness in biodiversity and oil and gas resources, its wetland ecosystems also play a critical role in supporting the livelihoods of millions of people. But unfortunately the region’s environment is being degraded by unsustainable practices and a legacy of pollution and oil spills. Nigeria remains Africa's largest oil producing nation, she also houses the second largest proven oil

reserves in Africa, with its crude oil production estimated at more than 2.5 million barrels per day between 2015 and 2019 (Herman, 2020). However, The World Data Atlas (2021) had stated that Nigeria's crude oil production fluctuated substantially, decreasing through May 2020 - April 2021 period and ending at 1,372 thousand barrels per day as at April 2021.The oil sector, according to Olujobi (2021), accounts for more than 95% of Nigeria's foreign exchange earnings.

Literature Review

Oil spills have severe environmental and socio-economic consequences, particularly in sensitive ecosystems like the Niger Delta. They contaminate soil and water, which are crucial for agriculture and fishing, the primary sources of food for local communities. Oil-contaminated soils inhibit plant growth and reduce agricultural productivity, while water pollution disrupts local economies that thrive on fishing. The unique biodiversity of the Niger Delta is threatened by oil spills, which lead to habitat destruction for numerous species and food production shortages. Socio-economic consequences extend beyond environmental damage, directly affecting food security. Livelihoods are disrupted, leading to reduced income and increased poverty levels. Health issues, such as respiratory problems and skin diseases, are also exacerbated by exposure to oil pollutants. Food availability decreases due to contaminated land and water sources, resulting to food insecurity among vulnerable populations. Persistent oil pollution can also force communities to migrate, leading to overcrowding in urban areas and further complicating food security challenges (Akan et al., 2020; Efe et al., 2021; FAO, 2022; Nwankwoala et al., 2018; Ogonor & Ogbomida, 2019; UNDP, 2023).

The massive oil deposits, which have been extracted for decades by the government of Nigeria and multinational oil companies, are located in the Niger Delta region of Nigeria. The region is made up of nine states (Abia, Akwa Ibom, Bayelsa, Cross River, Delta, Edo, Imo, Ondo and Rivers) from three geopolitical zones (South-South, South-East and South-West), all of which are in the Southern part of Nigeria. The Niger Delta has remained a development oxymoron; it is characterized by widespread poverty in the midst of abundant natural and financial resources. In its 2013 report, The United Nations Development Programme (UNDP) stated that the Niger Delta was suffering from administrative neglect, crumbling social infrastructure and services, high unemployment, social deprivation, abject poverty, filth and squalor, and endemic conflict.

The era of oil production in Nigeria has negatively impacted the Niger Delta region due to unprecedented oil spillage which has been ongoing for the past

five decades, making the region one of the most polluted in the world (Kadafa, 2012; Babatunde, 2017; Joseph, 2019 & Yaguo et al., 2021). It is estimated that while the European Union experienced 10 incidences of oil spills in 40 years, Nigeria recorded 9,343 cases within 10 years (Albert et al., 2018; Allen et al., 2018 & Alejandre et al., 2021). Oil spills are wreaking environmental havoc wherever they occur. Since the discovery of enormous crude oil deposits in Oloibiri, in present-day Bayelsa State, in 1956, and the subsequent drilling and refining of this great natural resource popularly referred to as black gold, Nigeria, no doubt, has experienced rapid industrial development. But, unfortunately, oil pollution in Niger Delta Region, over the years, have so negatively impacted farmlands, crops, vegetation and water that people can no longer engage in productive farming and fishing (Iwok, 2017 & Babatunde, 2020). This environmental dislocation has adversely affected traditional livelihoods and undermined household food security in the region.

Oil Spills

Massive oil spills are common in the Niger Delta as over 40 million litres of crude oil is spilled annually, resulting in human deaths and damage to the local ecosystem (Adebayo, 2019; Ratcliffe, 2020 & Okoye, 2021). A study published by the *Journal of Health and Pollution* in 2018 found that more than 12,000 oil spill incidents occurred in the Niger Delta region between 1976 and 2014. Fifty percent of these spills were attributed to pipeline corrosion and tanker accidents while 50% occurred as a result of operational error, mechanical failure, and sabotage by mostly militant groups (Adebayo, 2019 & Ratcliffe, 2020). According to Ikporukpo (2020), between 2010 and 2018 there were 5,848 incidents resulting in the spillage of about 169,691 barrels of oil. Oil spills take place in all parts of the oil producing region of the Niger Delta; that is why the region is commonly described as the most polluted area of the planet (Ikporukpo, 2020).

Regardless of the fact that oil has generated an estimated $600 billion for Nigeria since the 1960s, the majority of Niger Delta's population live in poverty (Brown, & Evangel, 2013 and Amnesty International, 2012). Many people in the region do not have access to clean water or health-care. The poverty rate in Niger Delta, in spite of the enormous wealth generated there for the Nigerian state, is very high, making it one of the world's starkest and most disturbing examples of the "resource curse" (Amnesty International, 2009). As Ratcliffe (2020, p.1) has noted, "You just need to take a tour to understand the magnitude of the environmental abuse." Stressing further, he said, "(Bayelsa) used to be green; you could go to farm or fish. We used to have very impressive harvests. You would spend just an hour in the water and you have a lot of fish." However, the discovery of the black gold in this

region and its subsequent exploration since the late 1950s has turned this hitherto green land of plenty, where cash crops, including rubber, cocoa, oil palm and coconut, and food crops, such as cassava, yam and plantain, are produced to dry land of sorrow, pain and poverty (UNDP, 2013).

Food Security

According to the United Nations Committee on World Food Security and the Food and Agriculture Organization, food security is attained when all people, continuously, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their food preferences and dietary needs to enable them live a healthy and active life (FAO, 2009). According to the Food and Agriculture Organisation (2005), there are three components of food security: firstly, availability (the availability of appropriate and sufficient quantities of food); secondly, access (having the economic power or other resources to access food); and thirdly, utilization and consumption (having adequate dietary intake and the ability to absorb and use nutrients in the body).

On the basis of scholarly prediction that global population would reach 9.2 billion by 2050, Fukase & Martin (2017) and Silva (2018) projected a corresponding increased food demand of 59%-102%. In the light of this reality, it seems obligatory to increase agricultural production by about 60%–70% to provide food for the global population in 2050 (Silva, 2018). To improve the availability of food and achieve food security globally, the agricultural sector needs to play a strategic role in achieving the feat of providing food for the global population (Wegren & Elvestad, 2018). Globally, the basic human need is food security; in Nigeria, one of the greatest challenges is fighting hunger. According to Ahungwa et al. (2018), in the colonial era and briefly after independence, the mainstay of Nigeria's economy was agriculture, which played a strategic role, as it not only boosted the economy but also provided adequate food for the population. Nigeria is now faced with a looming food security crisis, with its growing population increasingly dependent on imported foods. She has navigated from agro-based economy to petroleum-dependent economy.

According to Kralovec (2020), climate change compounds the challenges confronting agriculture. Oil spillage in the Niger Delta is a major cause of climate change, as hitherto green lands suitable for agricultural production were turned into terrains that yield little or no farm products. The global oil industry's track record has shown that punctures and oil spills are common; they occur wherever oil is drilled either as large spills, like the 1989 Exxon Valdez accident, or small and more frequent spills that don't always capture global attention, such as the ones that occur in the Niger Delta region of

Nigeria. The March 24, 1989 Exxon Valdez oil spill accident in Alaska's Prince William Sound was a man-made disaster that occurred when Exxon Valdez, an oil tanker owned by the Exxon Shipping Company, spilled 11 million gallons of crude oil into the ocean. This was the largest single oil spill in U.S. waters at the time (Evanisko, 2020). Babatunde (2017) emphasized that the degraded environment in the Niger Delta has contributed in no small way to food scarcity and an astronomical increase in the price of food, placing it beyond the reach of a vast majority of the local people. Most local people lack access to sufficient wholesome food which they need for their daily nutritional requirements.

The Exploration and Exploitation of Crude Petroleum

The exploration and exploitation of crude petroleum in Nigeria positioned petroleum products as the mainstay of the nation's economy, especially during and after the oil boom of the 1970s. A report by the Nigeria Bureau of Statistics (NBS) showed that crude oil export accounted for N3.74 trillion or 70.84 per cent of total exports in the third quarter of 2019, while its contribution to the Gross Domestic Products (GDP) stood at 9.77%. The effect of the oil boom slowly but surely created a shift of focus by the Nigerian government from agriculture to crude oil exploration, which created more wealth for the country and more environmental and socio-economic crisis for the Niger Delta region (Sanchez, et al., 2021). The harmful effects of petroleum spillages lead to severe environmental degradation; they pose a threat to human survival and to virtually all aspects of the natural environment. Despite this threat, the spill of oil and its accompanying environmental hazards remain frequent realities in the Niger Delta (Raimi et al., 2019; Okoyen et al., 2020).

Since the discovery of crude oil in Nigeria in 1956, about 600 million gallons of crude oil, poorly managed by the oil companies, have been spilled in the Niger Delta region (Raimi et al., 2019 & Okoyen et al., 2020). These spills have polluted vast areas of land, damaging farmlands, killing fishes, causing food scarcity and severe suffering for the people. According to Amnesty International (2018), as at 2011, Shell accounted for 17.5 million litres of oil spillage while Eni recorded 4.1 million litres of oil spillage as at 2014; however, according to statistics posted by the Nigerian government, these two company's spilled almost twice the above figures during the period. This statistical disparity indicates how difficult it is to measure accurately amounts of oil frequently spilled in this region of Nigeria practically 'swimming in oil' (Amnesty International, 2018). Akinwumiju et al. (2020), utilizing ArcGIS mapping, found that 6400 oil wells with over 1143 km of pipeline networks are located in the Niger Delta. On the level of oil spillage going in the region, Akinwumiju et al. (2020) stated that between 2006 and 2019, there was a total

of 7943 oil spill incidents in the Niger Delta, with 62% linked to corrosion issues and 7% due to equipment failure. The highest number of oil spills occurred in Rivers State, which recorded over 3770 oil spill incidents (Akinwumiju et al., 2020).

Statement of the Problem

Oil accounts for at least 90% of Nigeria's foreign exchange and more than half of government revenue. Nigeria is the largest exporter of oil in Africa; crude oil exports accounted for 70.84% of Nigeria's total exports in the third quarter of 2019, contributing to 9.77% of her GDP (Statista, 2024). In spite of these economic benefits accruing from crude oil, the problem of oil spills in the Niger Delta region has remained a recurring decimal that continually ruins fishing habitats, swamps, agricultural land, groundwater and waterways. Over two million barrels of oil in 2,976 separate spills have resulted from the exploitation of Niger Delta oil reserves by international oil companies since 1976. About 300 oil spills occur in the region every year. In 2011, a spill at Shell's Bonga oil fields released 40,000 barrels, affecting over 350 farming communities and forcing 30,000 fishermen to abandon their means of subsistence.

The people of the Niger Delta are practically watching their resources drain away due to oil spillage. The level of contaminants and pollution can seriously harm living creatures, including humans, animals, plants, and all forms of agricultural production. Despite extensive scholarly attention, cleanup and remediation efforts and conflict resolution strategies, the environmental issues of the Niger Delta have not been successful addressed. It is crucial for peace and conflict resolution scholars to adopt empirical and community-based approaches in their studies in order to understanding the peculiarities of every affected community within the Niger-Delta region and work out suitable solutions. Food security is a significant component of human security; food scarcity due to environmental degradation is a frequent problem, but little scholarly attention has been paid to the issue of food security in the Niger Delta.

Objectives of the Study

The first objective of the study is to quantify and analyze the frequency and severity of oil spills in the Niger Delta region. This involves collecting data on historical spill incidents, their geographical distribution, and the volume of oil spilled. By establishing a comprehensive database, researchers can better understand how widespread these incidents are and identify patterns over time.

Another critical objective is to evaluate the environmental consequences of

oil spills on local ecosystems. This includes studying soil contamination, water quality degradation, and impacts on biodiversity. The research aims to determine how these environmental changes affect agricultural productivity, particularly focusing on crops that are staples for local communities.

The study also investigates the socioeconomic ramifications of oil spills on communities in the Niger Delta. This includes assessing how spills affect livelihoods, particularly for those dependent on agriculture and fishing. Surveys and interviews with local populations can provide insights into changes in income levels, food availability, and overall community well-being.

An essential goal of this research is to develop actionable policy recommendations aimed at mitigating the impact of oil spills on food security. This could involve suggesting improved regulatory frameworks for oil extraction companies, enhanced disaster response strategies, or community-based initiatives that promote sustainable agricultural practices despite environmental challenges.

An additional objective is to raise awareness among stakeholders – including government agencies, NGOs, and local communities – about the ongoing challenges posed by oil spills in relation to food security. By disseminating findings through reports, workshops, and public forums, the study seeks to foster a collaborative approach towards addressing these issues.

Methodology

The techniques that will be used in this study are qualitative and quantitative methods of data collection and analysis. This type of mixed-methods research design will enable the researcher to combine elements of qualitative and quantitative research approaches such as the use of qualitative and quantitative viewpoints, data collection, analysis, and inference techniques for the comprehensive purposes of extensiveness and depth of understanding and corroboration in the study area.

Theoretical Framework

The Niger Delta region of Nigeria is one of the most ecologically sensitive areas in the world; it is heavily impacted by oil spills due to extensive oil exploration and production activities. These spills have profound implications not only for the environment but also for local communities, particularly concerning food security. Therefore, to analyze and interrogate this complex issue effectively, integrating Ecological Theory and Governance Theory came handy as it provides a comprehensive framework for the study topic. Ecological Theory emphasizes the impact of environmental changes on

ecosystems and human societies. Oil spills in the Niger Delta can disrupt biodiversity by destroying habitats, altering food webs, and affecting local fishing communities. Hydrocarbons introduced into aquatic ecosystems can lead to declines in fish populations and soil contamination, affecting agricultural productivity. The degradation of ecosystems can also lead to health issues among local populations, exacerbating food insecurity. The lack of effective work or farming skills among affected individuals can further exacerbate the situation. Therefore, it is crucial to address these environmental impacts to maintain ecological balance.

Governance Theory on the other hand is a framework that focuses on how institutions manage resources and address collective challenges through policies and regulations. It is particularly relevant to oil spills in the Niger Delta, where effective governance involves creating robust policies to regulate oil extraction activities and ensure accountability for environmental damage caused by oil companies. Stakeholder engagement is crucial for ensuring that policies reflect the needs of those most affected by oil spills. Governance theories can also help develop dispute resolution mechanisms for conflicts between communities, government entities, and corporations. Monitoring and enforcement of environmental regulations is also essential, highlighting areas of ineffective enforcement. With the use of Governance Theory, stakeholders can identify strategies to improve regulatory frameworks that protect both the environment and food security in affected regions.

Using Ecological Theory alongside Governance Theory provides a multifaceted approach to understanding the impacts of oil spills on food security in Nigeria's Niger Delta region. This integration allows for a thorough examination of both ecological consequences and institutional responses necessary to mitigate these challenges effectively. Both theories collectively offer insights into environmental impacts as well as policy implications related to food security.

Data Analysis

Descriptive and Inferential Statistics Analysis of Questionnaire Responses on Oil Spills

To analyze the data collected from the questionnaire regarding the effects of oil spills, we will utilize both descriptive and inferential statistics. The responses provide insight into public perception regarding environmental impacts, agricultural consequences, and social issues related to oil spills.

1. Descriptive Statistics

Descriptive statistics summarize the basic features of the data. Here we will calculate frequencies, percentages, and some measures of central tendency where applicable.

1.1 Agreement on Environmental Effects of Oil Spills

- Total respondents: 381
- Agree: 365
- Disagree: 16

Percentage agreeing: Percentage = (365/381) × 100 = 95.79%

1.2 Environmental Consequences on Ecosystems and Livelihood

- Agree: 353
- Disagree: 28

Percentage agreeing: Percentage = (353/381) × 100 = 92.64%

1.3 Agricultural Output Decline Due to Contamination

- Agree: 377
- Disagree: 4

Percentage agreeing: Percentage = (377/381) ×100 = 98.95%

1.4 Pollution of Rivers Affecting Fishing

- Agree: 375
- Disagree: 6

Percentage agreeing: Percentage = (375/381) × 100 = 98.43%

1.5 Community Leadership Tussles Related to Oil Bunkering

- Agree: 350
- Disagree: 11

Percentage agreeing: Percentage = (350/381) × 100 = 91.83%

2. Inferential Statistics

Inferential statistics allow us to make conclusions about a population based on sample data.

2.1 Hypothesis Testing

We can set up hypotheses for each question to test if there is a significant agreement among respondents.

Null Hypothesis (H0): There is no significant agreement that oil spills have devastating effects.

Alternative Hypothesis (H1): There is significant agreement that oil spills have devastating effects.

Using a one-sample proportion test for each question:

For example, for the first question:

- Sample proportion (p) = p = 365/381= 0.96 (approximately)

Assuming a significance level ($\alpha = 0.05$), we can use a Z-test for proportions:

The standard error (SE) can be calculated as: $SE = p(1-p)n = 0.96(0.04)381 = 0.0313$ (approximately)

Calculating the Z-score: $Z = \hat{p}-p0SE = 0.96-0.50.0313 = 14.53$ (approximately)

Given that this Z-score is far greater than any critical value from Z-tables at $\alpha = 0.05$, we reject H0 for all questions indicating strong evidence that respondents agree with the statements regarding oil spills.

Inference: The analysis indicates overwhelming agreement among respondents regarding the negative impacts of oil spills on the environment, agriculture, and community dynamics in sensitive ecosystems like the Niger Delta.

Summary of Findings Obtained from Respondents:

- High levels of agreement were observed across all statements.
- The lowest percentage was approximately 91.83, while the highest was 98.95.

Thus, it can be concluded that there is a strong consensus among respondents about the detrimental effects of oil spills the Niger Delta.

Overall Summary of Findings

The quantitative research design utilized a questionnaire to gather data regarding perceptions of oil spills in the Niger Delta and their effects. The findings indicate a strong consensus among respondents, with high levels of

agreement across all statements presented in the questionnaire. Specifically, the lowest percentage of agreement was approximately 91.83%, while the highest reached 98.95%. This range suggests that nearly all respondents recognize the negative impacts associated with oil spills in this region. The results highlight a significant concern regarding environmental degradation and its broader implications for communities within the Niger Delta. Given that these percentages reflect a robust agreement, it can be inferred that there is a widespread acknowledgment of the detrimental effects of oil spills on local ecosystems, health, and occupations.

In juxtaposition to the quantitative findings, qualitative research conducted through key informant interviews (KII) further supports these conclusions. All 20 respondents interviewed expressed unanimous agreement that oil spills have severely impacted food security in Niger Delta and indeed Nigeria. This qualitative data complements the quantitative results by providing deeper insights into how oil spills affect not only environmental conditions but also socio-economic factors such as food availability and safety.

The qualitative responses likely elaborate on specific mechanisms through which oil spills disrupt food security, including contamination of water sources, destruction of agricultural land, and adverse health effects on local populations that hinder their ability to produce or access food.

Both quantitative and qualitative research designs converge on the understanding that oil spills in the Niger Delta pose significant challenges not only to environmental integrity but also to food security in Nigeria. The strong consensus observed in both methodologies underscores the urgency for policy interventions aimed at mitigating these impacts and addressing community concerns.

Discussion of Findings

The Niger Delta region in Nigeria, a major oil-rich area, is facing significant environmental degradation due to oil spills. These spills, primarily caused by operational failures, sabotage, and inadequate infrastructure maintenance, result in extensive contamination of land and waterways. Between 1976 and 2018, over 2 million barrels of oil were spilled, with a significant portion occurring in the last decade. The ecological consequences of these spills are severe, leading to habitat destruction, loss of biodiversity, and long-term soil contamination. Mangrove forests, crucial for fish breeding, are particularly vulnerable, causing fish populations to decline, directly impacting local fishing communities. The challenge is not only environmental but also socio-economic, undermining food security for Nigeria's most vulnerable populations. To address this issue, comprehensive strategies must be

implemented, including stricter regulations on oil companies; improved infrastructure maintenance practices, community engagement initiatives focused on sustainable agriculture, and enhanced support systems for affected communities.

Agriculture is a primary source of income for many households in the Niger Delta. However, oil spills severely affect crop production through soil contamination and water pollution. Contaminated soils can lead to reduced crop yields or complete crop failure due to toxic substances absorbed by plants. Studies have shown that crops such as cassava and yam exhibit stunted growth when grown in contaminated soils. Furthermore, water sources used for irrigation become polluted with hydrocarbons from oil spills. This not only affects crop health but also poses health risks to farmers who consume contaminated produce or use polluted water for irrigation. The result is a cycle of poverty where farmers face declining incomes due to reduced agricultural output.

Fisheries are another critical component of food security in the Niger Delta. Oil spills contaminate rivers and coastal waters, leading to killing of fish and a decline in fish populations. The Nigerian Institute for Oceanography and Marine Research has reported significant declines in fish catches that could be attributed to pollution from oil activities. The loss of fish stocks directly impacts food availability and nutrition for local communities that depend heavily on fish as a primary protein source. Additionally, fishermen face economic hardships as their catch diminishes; this further exacerbates food insecurity as families struggle to afford alternative sources of nutrition.

The health implications associated with oil spills also contribute indirectly to food insecurity. Exposure to pollutants can lead to respiratory issues, skin diseases, and other health problems among local populations. Poor health reduces individuals' ability to work effectively in agriculture or fishing sectors, thereby diminishing household incomes and exacerbating food scarcity. Moreover, contaminated water supplies can lead to gastrointestinal diseases which further strain community resources as families must allocate funds towards healthcare instead of food purchases or agricultural investments.

The Nigerian government has implemented various policies aimed at addressing oil spill incidents; however, enforcement remains weak due to corruption and lack of accountability among oil companies operating in the region. While initiatives like the National Environmental (Pollution Abatement) Regulations exist, they often fall short in practice due to insufficient funding and lack of political will. Community-led efforts have emerged as vital responses; however, they often lack adequate support from

governmental bodies or international organizations, and such support is needed for effective remediation efforts.

Conclusion and Recommendations

Conclusion: Oil spills in the Niger Delta have severe environmental and socio-economic consequences. Crude oil contaminates soil and water bodies, causing habitat degradation, fish population declines, and unsuitable farming land. This is especially alarming for people in the Niger Delta, where agriculture is the principal source of income. The socioeconomic consequences are grave, as fish populations drop and agricultural output falls, leading to food insecurity. Households who struggle to provide proper nourishment experience greater poverty rates. Oil spills increase existing vulnerabilities by restricting access to food sources and increasing reliance on high-cost imported goods. Direct contact to spilt oil causes health difficulties, as do indirect consequences from tainted food sources. Communities around oil spills may face breathing issues, skin illnesses, and other health complications caused by harmful chemicals contained in crude oil.

Consumption of polluted seafood or crops might result in chronic diseases. Efforts have been undertaken at different levels, including government, non-governmental organisations (NGOs), and community groups, to address these concerns through legislative reforms aiming at strengthening environmental rules and encouraging sustainable practices. However, enforcement remains ineffective owing to corruption and a lack of political will. Community resilience techniques are critical in reducing the impact of oil spills on food security. Initiatives that concentrate on alternative livelihoods such as aquaculture or agro-ecological techniques can assist communities in adapting while minimising reliance on conventional fishing and farming ways. Addressing these issues requires a comprehensive approach that includes strong regulatory frameworks to avoid spills, remediation activities to repair damaged habitats, and support networks for impacted populations to strengthen their resistance to food scarcity.

Recommendations: Here are some vital recommendations that cover some major areas of concern:

Strengthening Regulatory Frameworks: The Nigerian government should improve current rules controlling oil exploration and production operations. This includes greater enforcement of environmental rules designed to avoid oil leaks.

Investment in Remediation Technology: There is an urgent need to invest in innovative technology that can efficiently clean up oil spills. Collaborations with international environmental organizations can help you gain access to

best practices in spill response.

Community Engagement Programs: Local communities should be actively involved in monitoring oil operations and spill responses. Empowering these communities through education about their rights and environmental stewardship can lead to better outcomes.

Diversification of Livelihoods: To mitigate the impacts of oil spills on food security, programmes aimed at diversifying income sources for local populations should be developed. This could include promoting alternative agricultural practices or supporting small-scale fisheries.

Health Monitoring Initiatives: Establishing health monitoring systems for communities affected by oil spills will help address health-related issues stemming from exposure to pollutants while providing necessary healthcare support.

International Collaboration: Engaging with international bodies can provide technical assistance and funding necessary for both immediate response efforts following spills as well as long-term sustainable development initiatives aimed at restoring food security.

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On Boundedness and Solution Size in Rational Linear Programming and Polyhedral Optimization

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Abstract

This paper delves into the theoretical and practical aspects of boundedness and structural properties in rational linear programming (LP) and polyhedral optimization. It provides a comprehensive analysis of conditions under which the optimization of linear functions over rational polyhedra remains bounded and establishes explicit constraints on solution size when optimal solutions exist. By exploring the interplay between polyhedral geometry, integer hulls, and rational LP systems, this study sheds light on fundamental principles that underlie modern optimization techniques. Key findings include equivalence conditions for boundedness between rational polyhedra and their integer hulls, as well as precise bounds on the numerical representation of optimal solutions. These results not only enhance the theoretical understanding of LP and polyhedral optimization but also have significant implications for computational efficiency, algorithm design, and numerical stability in solving real-world optimization problems. The discussion is rooted in rigorous mathematical foundations and extends to practical applications in areas such as mixed-integer programming, computational geometry, and combinatorial optimization**.**

Keywords: rational linear programming, polyhedral optimization, boundedness conditions, integer hull, solution size bounds, rational coefficients, computational geometry, optimization algorithms, numerical stability.

I. Introduction

Linear programming (LP) has had a significant and enduring influence, deeply connected with the evolution of optimization theory and computational methodologies. Scholars have extensively traced the origins of LP back to the 1930s, highlighting Leonid Kantorovich's groundbreaking work in formulating optimization problems to address resource allocation challenges in economic planning (Kantorovich, 1939). Kantorovich's pioneering contributions established the foundation of linear optimization and

were later recognized with the Nobel Prize in Economics, underscoring the lasting impact of his work.

The practical relevance of LP has surged during and after World War II. Researchers, notably George Dantzig, have developed the simplex algorithm to optimize military logistics and supply chains, a milestone in the application of mathematical optimization (Dantzig, 1947). The simplex algorithm has remained a cornerstone in solving LP problems, celebrated for its practical efficiency and ease of implementation, despite its potential exponential time complexity in the worst-case scenarios.

The study of rational linear programming, characterized by constraints and objectives expressed using rational coefficients, has gained prominence with advancements in computational methodologies. Researchers have extensively analyzed rational LP systems, focusing on their numerical properties, solution size, and computational feasibility. During the 1980s, Karmarkar's introduction of the polynomial-time interior-point method has revolutionized the field, providing an alternative to the simplex algorithm and emphasizing the significance of numerical stability in optimization (Karmarkar, 1984).

Polyhedral optimization, a core area of mathematical optimization, has bridged critical concepts in combinatorics, geometry, and optimization. Scholars have explored the geometric properties of feasible regions defined by linear inequalities, offering theoretical and practical insights for solving complex problems. The study of polyhedra has uncovered deep structural relationships essential for various optimization tasks, including vertex enumeration and facet identification.

Among the impactful concepts in polyhedral optimization is the integer hull, representing the convex hull of all integer solutions within a polyhedron. This concept has substantially advanced the theory and algorithms of integer programming and mixed-integer programming, as emphasized by Nemhauser and Wolsey (1999). By enabling the transition from an infinite search space to a finite and structured geometric framework, the integer hull has simplified the analysis of discrete variable problems.

Recent advancements in polyhedral optimization include the construction and analysis of rational polyhedra on boards. Laisin et al. (2024) have demonstrated the practical effectiveness of polyhedral techniques in modeling and solving problems involving integral polyhedra, offering applications in combinatorial optimization and computational geometry. Their work has exemplified how modern techniques can address both theoretical challenges and real-world applications.

This paper examines two fundamental aspects of rational LP and polyhedral

optimization:

i. Conditions under which the optimization of a linear function over a rational polyhedron is bounded.

ii. Bounds on the size of optimal solutions.

Building on classical results from Schrijver (1998) and others, the analysis provides refined bounds and structural insights critical for advancing both theoretical understanding and practical applications in optimization.

II. Preliminaries and Definitions

Definition 2.1: Sub-determinant

Let $\boldsymbol{A}$ be an integral matrix. A sub-determinant of $\boldsymbol{A}$ is $|\boldsymbol{B}|$ for some square sub-matrix $\boldsymbol{B}$ of $\boldsymbol{A}$ (defined by arbitrary row and column indices). We write$\Xi(\boldsymbol{A})$ for the maximum absolute value of the sub-determinants of $\boldsymbol{A}$.

Definition 2.2: Polyhedron

Linear Programming deals with optimizing a linear objective function of finitely many variables subject to finitely many linear inequalities. So the set of feasible solutions is the intersection of finitely many half spaces. Such a set is called a polyhedron.

Definition 2.3: Polyhedron in $\mathbb{R}^{\boldsymbol{n}}$

It is a set of type

$$\boldsymbol{P} = \{\boldsymbol{x} \in \mathbb{R}^{\boldsymbol{n}} : \boldsymbol{Ax} \leq \boldsymbol{b}\}$$

for some matrix $\boldsymbol{A} \in \mathbb{R}^{\boldsymbol{m}\times\boldsymbol{n}}$and some vector $\boldsymbol{b} \in \mathbb{R}^{\boldsymbol{m}}$. If A and b are rational, then P is a rational polyhedron. A bounded polyhedron is also called a polytope.

We denote the rank of a matrix A by $\boldsymbol{rank}(\boldsymbol{A})$. The dimension dim X of a nonempty set:

$$\boldsymbol{x} \subseteq \mathbb{R}^{\boldsymbol{n}}$$

is defined to be $\boldsymbol{n} - \mathbf{max}\, \boldsymbol{rank}(\boldsymbol{A})$

$$\{\boldsymbol{rank}(\boldsymbol{A}) : \boldsymbol{A} \textbf{ is an } \boldsymbol{n}\times\boldsymbol{n} - \textbf{matrix with } \boldsymbol{Ax} = \boldsymbol{Ay} \textbf{ for all } \boldsymbol{x}, \boldsymbol{y} \in \boldsymbol{X}\}$$

A polyhedron $\boldsymbol{P} \subseteq \mathbb{R}^{\boldsymbol{n}}$ is called full-dimensional if $\mathbf{dim}\, \boldsymbol{P} = \boldsymbol{n}$

Equivalently, a polyhedron is full-dimensional if and only if there exist a point $\boldsymbol{x}^*$ in its interior. (Genova and Guliashki, 2011).

Proposition 2.1: Nonempty polyhedron: Let

$$P = \{x : Ax \leq b\}$$

be a nonempty polyhedron. If c is a nonzero vector for which

$$\boldsymbol{\delta := \max\{cx : x \in P\}}$$

is finite, then $\{\boldsymbol{cx : x = \delta}\}$ is called a supporting hyperplane of P. A face of P is P itself or the intersection of P with a supporting hyperplane of P. A point x for which {x} is a face is called a vertex of P, and also a basic solution of the system $\boldsymbol{Ax \leq b}$ (Genova and Guliashki, 2011).

Proposition 2.2: Let

$$P := \{x : Ax \leq b\}$$

be a polyhedron and $\boldsymbol{F \subseteq P}$. Then the following statements are equivalent:

(a) F is a face of P.

(b) There exists a vector c such that $\boldsymbol{\delta := \max\{cx : x \in P\}}$ is finite and

$$\boldsymbol{F = \{cx = \delta : x \in P\}}$$

(c) $\boldsymbol{F := \{x \in P: A'x = b'\} \neq \emptyset}$; for some subsystem $\boldsymbol{A'x \leq b'}$ of $\boldsymbol{Ax \leq b}$ (Genova and Guliashki, 2011).

Corollary 2.1: Let P be a polyhedron and F a face of P. Then F is again a polyhedron.

Furthermore, a set $F' \subseteq F$ is a face of P if and only if it is a face of F (Genova and Guliashki, 2011).

Proposition 2.3: Let $\boldsymbol{P = \{x: Ax \leq b\}}$ be a polyhedron. A nonempty subset $\boldsymbol{F \subseteq P}$ is a

minimal face of $\boldsymbol{P}$ if and only if it is a face of;

$$\boldsymbol{F = \{x: A'x = b'\}}$$

for some subsystem $\boldsymbol{A'x \leq b'}$ of $\boldsymbol{Ax \leq b}$ (Akif and Cihan, 2008)

Proposition 2.4: For any rational square matrix A we have

$$size\ det\ A \leq 2size(A)$$

Proposition 2.5: If $\boldsymbol{x, y \in \mathbb{Q}^n}$ are rational vectors, then

$$\boldsymbol{size(x + y) \leq 2(size(x) + size(y))}$$

$$\boldsymbol{size(x^T y) \leq 2\big(size(x) + size(y)\big)}\textbf{(Laisin } \boldsymbol{et\ al.}\textbf{, 2024)}.$$

Definition 2.4: Integer programming problem (IPP)

The IPP is a special class of linear programming problem (LPP) where all or some of the variables in the optimal solution are restricted to assume non-negative-integer values. Thus the general IPP can be stated as follows:

Optimize the linear function

$$\textbf{Optimize } Z = \sum_{i=1}^{n} c_i x_i \qquad \ldots(1)$$

Subject to the constraints.

$$\sum_{i=1}^{n} a_{ij} x_i \leq b_i, \quad j = 1, 2, \ldots, m \qquad \ldots(2)$$

$x_i \geq 0$ and some x_i are integers.

There are two types of the Integer Programming Problems (Elmuti, 2003; Genova and Guliashki, 2011).

Definition 2.5: All integer programming problem

An IPP. is termed as all IPP or pure IPP if all the variables in the optimal solution are restricted to assume non-negative integer values.

Definition 2.6: Mixed integer programming problem (MIPP)

An IPP is termed as mixed MIPP if only some variables in the optimal solution are restricted to assume non-negative integer values while the remaining variables are free to take any non-negative values (Gupta *et al.*, 2014).

Importance of IPP

Quite often, in business and industry, we require the discrete nature or values of the variables involved in many decision making situations. For example, in a factory manufacturing trucks or cars etc. the quantity or number manufactured can be a whole discrete number only as a fraction of truck or car is not required. In assignment problems and travelling salesman problems etc. the variables involved can assume integer values only. In allocation of goods, a shipment must involve a discrete number of trucks etc. in sequencing and routing decisions we require the discrete values of variables. Thus we come across many integer programming problems and hence need some systematic procedure for obtaining the exact optimal integer solution to such problems (Elmuti, 2003; Genova and Guliashki, 2011).

III. Main Results

Lemma: (Boundedness equivalence)

Let $\boldsymbol{P = \{x: Ax \leq b\}}$ be some rational polyhedron whose integer hull is nonempty, and let $\boldsymbol{c}$ be some vector (not necessarily rational). Then

$$\mathbf{max}\{\boldsymbol{cx}: \boldsymbol{x} \in \boldsymbol{P}\}$$

is bounded if and only if $\mathbf{max}\{\boldsymbol{cx}: \boldsymbol{x} \in \boldsymbol{P_1}\}$ is bounded.

Proof:

Suppose $\mathbf{max}\{\boldsymbol{cx}: \boldsymbol{x} \in \boldsymbol{P}\}$is unbounded. Then Corollary 3.2.8 says that the system

$$\boldsymbol{yA = c.\, y \geq 0}$$

has no solution. By Corollary 3.26 there is a vector $\boldsymbol{z}$. With $\boldsymbol{ez} < 0$ and $\boldsymbol{Az} \geq \boldsymbol{0}$. Then the

$$\boldsymbol{LP}\ \mathbf{min}\{\boldsymbol{cz}: \boldsymbol{Az} \geq \boldsymbol{0}, -\| \leq \boldsymbol{z} \leq \|\}$$

is feasible. Let $\boldsymbol{z}^*$ be an optimum basic solution of this $\boldsymbol{LP}$. $\boldsymbol{z}^*$ is rational as it is a vertex of a rational polytope. Multiply $\boldsymbol{z}^*$ by a suitable natural number to obtain an integral vector $\boldsymbol{\omega}$ with $\boldsymbol{A\omega} \geq \boldsymbol{0}$ and $\boldsymbol{c\omega} < 0$. Let $\boldsymbol{v} \in \boldsymbol{P_1}$ be some integer vector. Then $\boldsymbol{v - k\omega} \in \boldsymbol{P_1}$ for all $\boldsymbol{k} \in \mathbb{N}$, and thus $\mathbf{max}\{\boldsymbol{cx}: \boldsymbol{x} \in \boldsymbol{P_1}\}$ is unbounded. The other direction is trivial.

Theorem (Rational matrices and vertices of polytopes)

Consider the rational linear programming (LP) problem:

$$\boldsymbol{LP}: \boldsymbol{max}\{\boldsymbol{c^T x}: \boldsymbol{Ax} \leq \boldsymbol{b}\}$$

where A and b are rational. Suppose this LP has an optimum solution. Then the following hold:

(i) Bounded Size Solution: There exists an optimum solution x such that:

$$\boldsymbol{size(x) \leq 4n(size(A) + size(b))}$$

(ii) Special Case (Unit Vector b): If $\boldsymbol{b = e_i\ or\ b = -e_i}$ for some unit vector $\boldsymbol{e_i}$ there exists a nonsingular submatrix $\boldsymbol{A'}$ of A and an optimum solution x such that:

$$\boldsymbol{size(x) \leq 4n(size(A) + size(b))}$$

with each component of x satisfying:

$$\boldsymbol{size(component\ of\ x) \leq 4(size(A) + size(b))}$$

(iii) Reduced Submatrix Case: If $\boldsymbol{b = e_i \ or \ b = -e_i}$ for some unit vector $\boldsymbol{e_i}$, then there exists a non-singular submatrix $\boldsymbol{A'}$ of A and an optimum solution x such that:

$$\boldsymbol{size(x) \leq 4n \cdot size(A')}$$

Proof

The proof of Theorem 4.3 relies on these definitions 2.1, 2.2, 2.3, 2.4 and 2.5 respectively, to analyse the structure and properties of the LP problem.

Task 1: to show that, for a given LP, there exists a Solution with Bounded Size.

By the fundamental theorem of linear programming, there exists an optimum solution $\boldsymbol{x^*}$ at a vertex of the feasible polytope $\{\boldsymbol{x}: \boldsymbol{Ax \leq b}\}$.

- Vertex Characterization:
  A vertex $\boldsymbol{x^*}$ corresponds to a subset of constraints in $\boldsymbol{Ax \leq b}$ that are active (i.e., satisfied as equalities). By Corollary 2.1. the maximum is attained in a face $\boldsymbol{F}$ of
  $$\{\boldsymbol{x : Ax \leq b}\}.$$
  Let $\boldsymbol{I \subseteq \{1, 2, \dots, m\}}$ denote the indices of active constraints, and let $\boldsymbol{A_I}$ denote the submatrix of A corresponding to these constraints. At a vertex, the system can be written as:
  $$\boldsymbol{A_I x = b_I}$$
  where $\boldsymbol{b_I}$is the corresponding sub vector of b.

- Non-Singularity of $\boldsymbol{A_I}$:
  For $\boldsymbol{x^*}$ to be a vertex, the matrix $\boldsymbol{A_I}$ must be non-singular (invertible), and $\boldsymbol{| I | = n}$.

- Size of Solution:

  Solving $\boldsymbol{A_I x = b_I}$
  $$\boldsymbol{x = {A_I}^{-1} b_I}$$
  Using bounds on the size of $\boldsymbol{A_I}$ and $\boldsymbol{b_I}$, and the fact that $\boldsymbol{A_I}$ is rational, the entries of are bounded in terms of $\boldsymbol{size(A_I)}$. Specifically, the size of x is bounded by:
  $$\boldsymbol{size(x) \leq 4n(size(A) + size(b))}.$$

Task 2: to show that for a give LP has a Special Case ($\boldsymbol{b = e_i \; or \; b = -e_i}$)

If $\boldsymbol{b = e_i \; or \; b = -e_i}$, where$\boldsymbol{e_i}$ is a unit vector, the LP corresponds to finding the maximum value of $\boldsymbol{c^T x}$ along a specific axis defined by $\boldsymbol{e_i}$.

- Existence of a Non-singular Submatrix:
  As in task 1, there exists a vertex solution $\boldsymbol{x}^*$, and the active constraints correspond to a nonsingular submatrix $\boldsymbol{A'}$ of A.

- Bound on Solution Size:
  Similar to the general case, the size of x is bounded by:

$$\boldsymbol{size(x) \leq 4n(size(A) + size(b))},$$

  with the size of each component of x further bounded by:

$$\boldsymbol{size(component\ of\ x) \leq 4(size(A) + size(b))}.$$

Task 3: to show that for a give LP has reduced submatrix: Let $\boldsymbol{F' \subseteq F}$ be a minimal face. By corollary 2.1$\boldsymbol{F' = \{x : A'x = b'\}}$ for some subsystem $\boldsymbol{A'x \leq b' \; of \; Ax \leq b}$.

Then, in the special case where $\boldsymbol{b = e_i \; or \; b = -e_i}$, let $\boldsymbol{A'}$ denote the nonsingular submatrix corresponding to the active constraints at the optimum.

Now, we may assume that the rows of $\boldsymbol{A'}$ are linearly independent. We then take a maximal set of linear independent columns (call this matrix $\boldsymbol{A}$") and set all other components to zero. Then

$$\boldsymbol{x = (A")^{-1} b'},$$

filled up with zeros, is an optimum solution to our LP. By Cramer's rule the entries of $\boldsymbol{x}$ are given by

$$\boldsymbol{x_i = \frac{\det A'''}{\det A''}},$$

where $\boldsymbol{A'''}$ arises from $\boldsymbol{A''}$ by replacing the $\boldsymbol{j-th}$ column by $\boldsymbol{b'}$. By propositions 2.4 and 2.5 respectively, we obtain

$$\boldsymbol{size(x) \leq n + 2n\big(size(A''') + size(A'')\big) \leq 4n\big(size(A'') + size(b')\big)}.$$

If $\boldsymbol{b = \pm e_i}$ then $\boldsymbol{|\det(A''')|}$ is the absolute value of a sub determinant of $\boldsymbol{A''}$.

The size of x can then be further bounded as:

$$\boldsymbol{size(x) \leq 4n \cdot size(A')}.$$

This follows because $\boldsymbol{A'}$ has fewer rows and columns compared to the full matrix A, reducing the maximum size contribution. Q.E.D.

Utilizing results from Schrijver (1998) and Cook *et al.*, (1986), we derive

bounds on the size of optimal solutions by analyzing the bit-length of vertices of and properties of rational systems.

IV. Applications: Production Scheduling Problem

i) **Integer Programming**: The equivalence of boundedness conditions simplifies complexity analyses for mixed-integer programming problems

Problem Setup

A factory produces two products, A and B, using two resources, labor and material. The available resources are limited to 100 hours of labor and 80 units of material. The profit for producing one unit of A is \$50, and for B, it's \$40. The problem is to determine the production quantities $\boldsymbol{x_1}$ (units of A) and $\boldsymbol{x_2}$ (units of B) to maximize profit, subject to the following constraints:

Labor constraint: $\mathbf{2}\boldsymbol{x_1} + \mathbf{1}\boldsymbol{x_2} \leq \mathbf{100}$,

Material constraint: $\mathbf{1}\boldsymbol{x_1} + \mathbf{2}\boldsymbol{x_2} \leq \mathbf{80}$.

This is a linear programming (LP) problem. However, if the production quantities $\boldsymbol{x_1}$ and $\boldsymbol{x_2}$ must be integers (e.g., you cannot produce fractional units), the problem becomes a mixed-integer programming (MIP) problem.

Rational Polyhedron and Integer Hull

- The feasible region defined by the constraints is a rational polyhedron P, containing all real-valued solutions that satisfy the constraints.
- The integer hull $\boldsymbol{P_I}$ is the convex hull of all integer solutions within P. It represents the feasible region for the MIP problem.

Boundedness Analysis

1. Boundedness of P: The polyhedron P is bounded since it is enclosed by the constraints $\mathbf{2}\boldsymbol{x_1} + \mathbf{1}\boldsymbol{x_2} \leq \mathbf{100}$ and $\boldsymbol{x_1} + \mathbf{2}\boldsymbol{x_2} \leq \mathbf{80}$, which intersect in the positive quadrant.
2. Boundedness of $\boldsymbol{P_I}$: The integer hull $\boldsymbol{P_I}$, being a subset of P, is also bounded. This follows from the equivalence of boundedness conditions: if $\boldsymbol{max}\{\boldsymbol{c^T x}: \boldsymbol{x} \in \boldsymbol{P}\}$ is bounded, then $\boldsymbol{max}\{\boldsymbol{c^T x}: \boldsymbol{x} \in \boldsymbol{P_I},\}$ is bounded.

Simplifying the Analysis

Instead of analyzing the MIP problem directly, the equivalence of boundedness conditions allows us to focus on the polyhedron P to verify boundedness. Once P is confirmed to be bounded, we can conclude that $\boldsymbol{P_I}$,

is bounded, avoiding the need for exhaustive checks over all integer solutions.

Solving the Problem

The integer solutions can then be obtained by applying integer programming techniques, such as branch-and-bound or cutting planes, which operate within the bounded integer hull $\boldsymbol{P_I}$, . Thus, reducing the boundedness check to P, the analysis simplifies significantly, saving computational effort and making the problem more tractable.

ii) **Computational Geometry**: Solution size bounds assist in designing efficient algorithms for convex hull and vertex enumeration.

Application Context

Consider the problem of computing the convex hull of a set of points in $\mathbb{R}^{\boldsymbol{n}}$. Convex hull algorithms, such as QuickHull or Graham's scan, rely on numerical representations of the points and may involve large computations when the coordinates of the points have a high bit-length. Efficient algorithms benefit from guarantees about the size of intermediate and final solutions, which directly impacts computation time and memory usage.

Problem Setup

Let $\boldsymbol{P} = \{\boldsymbol{x} \in \mathbb{R}^{\boldsymbol{n}} : \boldsymbol{Ax} \leq \boldsymbol{b}\}$ be a rational polyhedron defined by m linear inequalities, where $\boldsymbol{A} \in \mathbb{Q}^{\boldsymbol{m}\times\boldsymbol{n}}$. The goal is to compute the convex hull of the integer points in P, denoted $\boldsymbol{conv}(\boldsymbol{P_I})$.

Solution Size Bounds

From theoretical results, if an optimal solution x to a linear program over P exists, its size is bounded as:

$$\boldsymbol{size}(\boldsymbol{x}) \leq \boldsymbol{4n}(\boldsymbol{size}(\boldsymbol{A}) + \boldsymbol{size}(\boldsymbol{b})).$$

This means each vertex of the convex hull $\boldsymbol{conv}(\boldsymbol{P_I})$has coordinates with a bit-length constrained by this bound.

Application to Convex Hull Algorithms

a. Numerical Stability:

   - Algorithms like QuickHull require operations on vertex coordinates, such as comparing slopes or calculating determinants. Knowing the bounds on the size of x ensures that these operations remain numerically stable and feasible on finite-precision systems.

b. Efficient Data Structures:

   - Solution size bounds guide the choice of data structures. For example, if the bound indicates small bit-lengths, lightweight data structures (e.g., arrays with fixed-width integers) can be used, reducing memory overhead.

c. Algorithm Design:

   - When enumerating vertices of $\boldsymbol{conv}(\boldsymbol{P_I})$, solution size bounds restrict the search space, enabling pruning strategies in branch-and-bound algorithms. For example, if a candidate vertex exceeds the size bounds, it can be discarded without further computation.

Application in $\mathbb{R}^2$

Suppose P is a polygon defined by:

$$\boldsymbol{P} = \{\boldsymbol{x} \in \mathbb{R}^{\mathbf{2}} : \mathbf{2}\boldsymbol{x_1} + \boldsymbol{x_2} \leq \mathbf{10},\ \boldsymbol{x_1} + \mathbf{3}\boldsymbol{x_2} \leq \mathbf{15},\ \boldsymbol{x_1}, \boldsymbol{x_2} \geq \mathbf{0}\}.$$

The integer points in P are $(\mathbf{0}, \mathbf{0}), (\mathbf{1}, \mathbf{0}), (\mathbf{2}, \mathbf{0}), \ldots, (\mathbf{4}, \mathbf{3})$.

- The convex hull of these points forms a polygon whose vertices are subsets of the integer points.
- Using the size bounds, we confirm that all integer solutions $\boldsymbol{x} = (\boldsymbol{x_1}, \boldsymbol{x_2})$ satisfy $\boldsymbol{size}(\boldsymbol{x}) \leq \mathbf{4}(\mathbf{2} + \mathbf{2}) = \mathbf{16}$, ensuring efficient computations.

iii) **Impact on Algorithms**: With these bounds:

- Vertex Enumeration: We avoid considering infeasible points with excessively large coordinates.
- Convex Hull Computation: Ensures that the algorithm's runtime is proportional to the actual feasible vertices, reducing unnecessary overhead.

This example demonstrates how solution size bounds provide theoretical guarantees that directly improve the efficiency and practicality of convex hull and vertex enumeration algorithms. Thus, it improves the bounds that contribute to better prerecession and numerical stability in LP solvers.

V. Conclusion

This paper establishes critical theoretical results in rational linear programming and polyhedral optimization, emphasizing boundedness equivalence and solution size constraints. By proving the equivalence of boundedness between rational polyhedra and their integer hulls, as well as

deriving explicit bounds on the size of optimal solutions, this work contributes to a deeper understanding of the structural and numerical properties of optimization problems. These findings are not only of theoretical interest but also pave the way for advancements in computational optimization, particularly in improving algorithmic efficiency and ensuring numerical stability.

VI. Recommendations

Future work may explore extensions to non-convex settings, where the feasible regions are no longer polyhedral, presenting new challenges in understanding boundedness and solution representation. Another promising direction involves generalizations to cases with irrational coefficients, which require advanced techniques to address the complexities introduced by non-rational systems. Furthermore, integrating these theoretical insights into practical optimization software and exploring their impact on real-world applications, such as logistics, network design, and machine learning, could significantly enhance the utility and scope of rational LP and polyhedral optimization. Such efforts would bridge the gap between theoretical advancements and their practical implementations, fostering innovation in both academic and industrial domains.

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Relationship between Housing Management and Housing Conditions in Imo State Housing Corporation Estates in Owerri, Nigeria

Nnanyere N. Chukwu, Chukwunonso O. Umeora & Charles C. Munonye

ABSTRACT

Housing conditions are acknowledged as important factors that determine the habitability of buildings. This was why this study investigated the relationship between housing management and housing conditions in Imo State Housing Corporation (IMSHC) estates in Owerri Capital Territory, Imo State, Nigeria, with a view to obtaining vital feedback which can be used for gauging and improving housing conditions in the study area. A survey design method was applied with a focus on five IMSHC estates randomly selected from the research population following a stratification based on housing type. Three hundred and five occupied housing units were randomly sampled from the selected estates. Data were collected from these using questionnaires. The variables, 'Flaking/Peeling wall finish' and 'Availability of procedures for maintenance operations', representing housing condition and housing management system respectively, were selected for this analysis. The two variables are of nominal variable category; therefore, the Chi-square test of independence analysis tool was applied towards examining the significance of the relationship. It was established that there is a significant relationship between Flaking/Peeling wall finish' and 'Availability of procedures for maintenance operations' in the study area. It is recommended that for prompt maintenance of facilities in buildings, the residents should undertake it. For maintenance of facilities in the neighbourhood, IMSHC should undertake that. Moreover, there should be a legal provision to enable residents of IMSHC estates to enforce maintenance activities in the environment. The time taken to respond to residents' complaints should be improved upon by ensuring prompt response to grievances.

Keywords: buildings, habitability, housing conditions, housing management, maintenance

INTRODUCTION

Before the colonisation of Nigeria, there was no need for housing estates because residential buildings were constructed mainly to quarter family members who dwelt in huts within the family compound. Umeora (2018) noted that the colonial masters introduced housing estates to house their employees near their places of work in cities. When Nigeria gained independence, government and other organised bodies continued with this urban housing development and expanded the number of housing estates all over the country. The management and maintenance of these estates have come under scrutiny by professionals in the housing sector.

Developing countries such as Nigeria have witnessed high rates of urbanisation but these have not been accompanied by adequate increases in the rate of economic development. This fast but inadequately managed urbanisation has created a huge demand for urban housing which could not be met by the government and the organised formal sector in major Nigerian cities. As a result, 20 to 35 percent of urban housing in Nigerian cities is either dilapidated or in dire need of major repairs due to the poor housing conditions in the various housing programmes (Bello & Egresi, 2017; Muhammad & Bichi, 2014). Owerri, the Capital Territory of Imo State, is not left out in urbanisation and population growth. From 2006 to 2016, Owerri has experienced an average population growth rate of 4.04% (United Nations, 2022). The resultant effect of this population growth are evident in the urban housing crisis which has affected the housing conditions as the supply of housing stock manifestly lags behind the needs of the populace. This was corroborated by Aotearoa (2009) as cited in Umeora (2020a).

Housing condition is a vital influential factor of the habitability of buildings as it shows the level of resident's well-being. Isma'il et. al. (2015) posited that there are severe housing shortages in urban centres caused by poor housing conditions. This manifests in the high number of people living in public quarters that lack basic physical and social amenities. Housing conditions refer to the sum of external effects (natural and man-made) that make the housing units comfortable for the inhabitants. They play a major role in the health status of occupants as they impact the physical, social, economic, and mental well-being of occupants (Turunen et. al, 2010). The World Health Organisation (WHO) also stated that housing should be able to minimise the following for the occupants: physical injury, protracted diseases, as well as reduce psychological and social stresses to the barest minimum.

The Imo State Housing Corporation (IMSHC) was established under Section 3 Edict No. 14 of 1976. IMSHC has the mandate to design and supervise the construction of houses, the acquisition of houses, the management of housing

estates, rental to the members of the public, maintenance of buildings, and other infrastructure needed for the proper functioning of the estates (Imo State Housing Corporation). Some of the IMSHC estates in Owerri were developed over 30 years ago, and it seems the management agency that has the responsibility of monitoring and supervising the activities of the estates has not lived up to its expectations. The managers of the estates, judged by their primary duty of ensuring that the building units in the estates and the facilities do not deteriorate, have fallen short of expectation. The dwelling units lack maintenance operations, and this has resulted to evident decay in quality of the various housing estates.

When housing estates are poorly or inadequately managed, tragic consequences, such as ill-maintained buildings, poor sanitation, and various environmental health hazards could emanate. Okoye et al. (2018) affirmed that management of waste in the environment is crucial for healthy living. Ibem et al. (2013) noted that housing enables occupants to carry out different activities – work, rest, leisure, fitness and social interactions in the neighbourhood. Muoghalu (1987), as cited in Umeora (2018), posited that of all the dimensions of housing, management is the most crucial in explaining level of satisfaction of residents. Maintenance level, empathy, responsiveness and strictness were identified as the major components of managerial competence. Therefore, proper housing management is indispensable for keeping the buildings and amenities in serviceable conditions to ensure residents' satisfaction and good housing conditions (Hui, 2005).

The Owerri Capital Territory has, over the years, witnessed the migration of people from different parts of Nigeria. Consequently, some housing estates have been put under pressure. Some of these estates lack basic amenities such as electricity, water drainages, potable water, proper waste disposal systems, and good roads; instead, what one sees there are bad roads, defaced facades, and broken roofs, among other signs of inadequate maintenance. The lack and inadequacy of these affect the housing conditions. Additionally, poor housing conditions and quality are associated with health conditions such as respiratory diseases, depression, nausea, allergic symptoms, hypothermia, and physical injury.

Some human activities in Imo State Housing Corporation estates, such as poor drainage planning, building along the drainage profile and blocking of drainage channels, and lack of coordinated maintenance management activities have also contributed to poor housing conditions. Some poor housing conditions in the estates are manifest in surface dampness on the walls, peeling of paints, and algae growth on the walls, and runoff of surface water causing erosion in the environment. Salleh et al. (2012) identified some management issues which have impact on housing conditions and residents'

level of satisfaction in housing; they include the following: occupants' selection procedures, laws implementation, time taken to respond to residents' complaints, environmental security and overall quality of maintenance carried out by the management.

This study was part of a wider research that sought to examine the effect of housing conditions on housing quality in Imo Housing Corporation estates in Owerri capital territory to provide guidelines for improving housing conditions in the study area. For this particular study, the objective was to investigate the relationship between housing management and housing conditions in Imo State Housing Corporation Estates in Owerri, Nigeria. A null hypothesis was put forward which sought to establish the significant relationship between housing management system and housing conditions in the estates. It stated that there is no significant relationship between housing management and housing conditions in Imo State Housing Corporation Estates in Owerri, Nigeria.

Area of Study

The area of study, Owerri Capital Territory, is situated in Imo State, Nigeria. Owerri is the capital of Imo State, Nigeria. It was created by the military administration of General Murtala Ramat Muhammed on February 3rd 1976. Nigeria is a country in West Africa that is situated in the northern latitudes between 4^{o} and 14^{o} and between 3^{o} and 15^{o} of the eastern longitudes. It borders Niger in the north, Chad in the northeast, Cameroon in the east, and Benin in the west. Nigeria covers an area of 923,769 square kilometres, with a population of over 211 million (National Population Commission, 2006). Figure 1 shows the map of Nigeria showing 36 States and the study area.

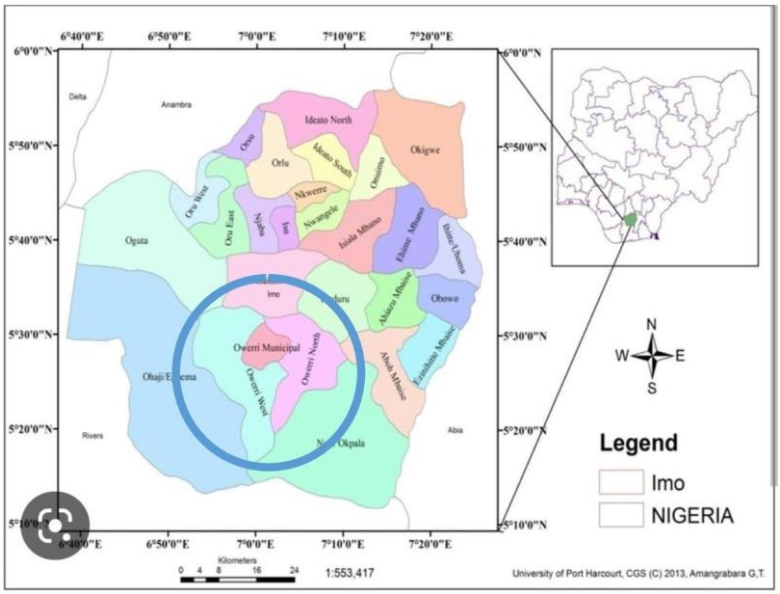

Figure 1: Map of Nigeria showing Imo State and the study area (Owerri Capital Territory) *Source*: Chukwu (2024)

Owerri Capital Territory is approximately 100 square kilometres in area. It is located along the crossroad of major commercial routes in Southeast Nigeria, which are Onitsha-Owerri Express Road, Owerri-Port Harcourt Express Road, Owerri-Umuahia Road and Owerri-Aba Road. Owerri Capital Territory comprises the following local governments in Imo State: Owerri Municipal, Owerri West, Owerri North and parts of Mbaitoli, Aboh Mbaise, Ngor Okpala, Ohaji/Egbema and Ikeduru Local Government Areas. Owerri Capital Territory is located between latitudes 05˚25' and 05˚32' North and longitudes 06˚57' and 07˚07'. Rainfall is the greatest climatic variable with an annual total mean of 2190mm (Chukwuocha, Ngah, & Chukwuocha, 2017). Other climatic data of the study area include an average annual high temperature of 32˚ C (89.96˚ F), an annual low temperature of 23.19˚ C (73.74˚ F), average annual precipitation of 229.07cm and humidity of 74.78% (Nigerian Climatic Classification, 2023). Weather parameters are paramount in this era of climate change. Also, relative humidity, amount of sunshine and wind speed, among others, are weather parameters which play a role in determining the amount of rainfall received in an area.

LITERATURE REVIEW

There is a consensus that management/institutional framework plays a key role in housing policy formulation and implementation (Ibem, 2011). Management is usually inspired by the need to be cautious in the usage of assets and judicious in the usage of time in attaining pre-stated objectives. Obodoh (2009) defined management as the scheduling, coordination, and control of the essential resources for the achievement of stated goals. The relationship between the management system of housing and the residents exerts a great impact on housing quality. If there is a cordial relationship between them, matters of maintenance of infrastructure will be addressed timely to reduce dilapidation. Issues under management variables are the type and quality of services rendered by the managers, time taken by the managers in treating residents' complaints and ensuring environmental sanitation.

The Imo Housing Corporation has the mandate to control and manage the development of housing units and perform such other functions as the Commissioner of Housing and Urban Development may direct. Those functions may also include to design and supervise housing programmes for the state government; award contracts for the development of housing estates, assess infrastructure needed in layouts of housing estates owned or managed by the corporation; oversee the maintenance of buildings, roads, footways, bridges, drains, sewers and water courses for or in connection with housing estate owned or managed by the Corporation (Imo State Housing Corporation, n.d.).

To assist the harmonisation between residents in running some of the shared facilities of housing, a certain level of organisation from the management is necessary. Although there is mounting interest in research examining the effects of management on housing performance, few works have looked at the correlation between housing management systems and housing condition (Aotearoa, 2009). Given that most housing schemes are constructed to stipulated standards, the buildings and facilities in the estates generally perform optimally at that new state, until they start to deteriorate when subjected to inhabitation and usage. Therefore, appropriate maintenance and management of amenities in the housing estates are crucial for keeping the amenities in functional conditions to ensure residents' satisfaction (Hui, 2005).

Some of the stipulated standards of housing condition address: aesthetics, sanitation, drainage, age of the building, access to basic housing facilities, burglary, spatial adequacy, noise level within the neighbourhood, sewage and waste disposal, air pollution and ease of movement, among others. Lanrewaju (2012) noted poor housing condition in public housing programmes in maintenance of facilities within the estate as well as poor management approach towards residents' problems in the estate. Salleh, Yosuf, Salleh and Johari (2012) identified management issues which have impacted housing conditions in housing estates, including the sociability of the managers, residents' selection procedures, implementation of bye-laws, time taken to respond to residents' complaints, security of the neighbourhood and quality of maintenance works done by the managers.

METHODOLOGY

The research design for this study was survey design, and it was accomplished through the use of a questionnaire to collect data from respondents in the study area. The research population was the completed IMSHC estates within Owerri Capital Territory, built and inhabited between 1976 and 2016 when the last housing estate was completed. Stratified sampling of the estates based on building type was adopted as the sampling method for this study. In the first stage, the list of the 14 estates completed and occupied in the study area was generated as shown in Table 1.

Table 1: List of Imo State Housing Corporation Estates in Owerri Capital Territory

S/N	NAME OF ESTATE
1	Aladimma
2	Prefab
3	Prefab Extension I
4	Prefab Extension II

5	Uratta Road
6	Trans-Egbu
7	Umuguma Area 'S'
8	Umuguma Area 'X'
9	Umuguma Area 'XA'
10	Tavron Prefab Estate
11	City Garden Estate MCC Road
12	Redemption Housing Estate 1 Avu/Obinze
13	Exclusive Garden Estate Phase I&II Nekede
14	Oforola Housing Estate Oforola

Source: Imo State Housing Corporation, n.d

In the second stage, the categorisation of the estates based on building type was done. The categorisation of the estates is 1 - Bungalows; 2 - Bungalows and Duplexes; 3 - Bungalows and 3-storey blocks of flats. Table 2 describes the categorisation based on the above-stated criteria.

Table 2: List of Imo State housing corporation estates in Owerri categorised by house type in the estates

S/N	**Bungalow**	**Bungalow and Duplex**	**Bungalow and 3 Storey Block of Flats**
1	Redemption Estate	Prefab Estate	Trans-Egbu Estate
2	Aladimma Estate	Umugwuma Estate	
3	Uratta Road Estate	Oforola Estate	
4	Tavros Estate	City Garden estate	
5		Nekede Exclusive Garden Estate	

Source: Fieldwork, 2022

Following the categorisation, random sampling by balloting was carried out and the following were picked to represent the various building types:

i. Bungalows: Aladimma Estate and Uratta Road Housing Estate

ii. Bungalows and Duplex combined: Prefab estate and City Garden Estate

iii. Bungalow and 3 Storey Block of Flats: Trans-Egbu.

Sampling size was derived using the Cochran formula for finite population: from Kothari (2004)

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

Where n = size of sample for finite population; N = research population = 1484 housing units; σ p = standard deviation of population assumed = 0.5; e

= significance level (precision/acceptable error) chosen = 0.05; Z = standard variate at a given confidence level = 1.96 for a confidence level of 95%.

A sample size of 305 respondents was derived and distributed to the estates in ratio to their contribution as shown in Table 3.

Table 3: Respondents Population in Sampled Estates

	Aladimma Estate	**Uratta Road**	**Prefab**	**City Garden**	**Trans-Egbu**
Housing Units	556	310	267	10	341
Sampled	114	64	55	2	70

Source: Fieldwork, 2022

A systematic random sampling was used in the selection of housing units in each street of the housing estates. After the first house, every fourth house was surveyed. In each house, in the case of a multi-family unit, one household would be administered the questionnaire.

Pearson's Product Moment Correlation analysis was used to test the significant relationship between the two Interval variables selected from the research data using Statistical Package for Social Sciences.

RESULTS AND DISCUSSION

Analysis of aggregated data on the Availability of procedures for maintenance operations in the estate

From the data gathered, 90.2% of the respondents indicated that there was no available procedure for maintenance operations in the estates. This could be part of the reasons why there was a decline in the housing quality in the area (See Table 4).

Table 4: Aggregated Data on Availability of procedures for maintenance operations in the Estate

Value label	Frequency	Valid Percent	Cumulative Percent
Yes	28	9.8	9.8
No	259	90.2	100.0
Total	287	100.0	

Source: Fieldwork, 2023

Analysis of aggregated data of Management of maintenance of facilities in the estate

The data analysed revealed that most of the respondents pointed out that management of maintenance of facilities in the estates was handled by the

residents while 7% showed that IMSHC managed the facilities. See Table 5 for details.

Table 5: Aggregated Data on Management of maintenance of facilities in the Estate

Value label	Frequency	Valid Percent	Cumulative Percent
IMSHC	2	.7	.7
Residents	270	94.1	94.8
Both parties	15	5.2	100.0
Total	287	100.0	

Source: Fieldwork (2023)

Analysis of aggregated data of Communication channels in the estate

The results collected indicated that most of the respondents communicated with the housing corporation by visiting the office. A few of the respondents stated that they communicated with the IMSHC either by phone calls or SMS. Table 6 shows this.

Table 6: Aggregated Data on Communication Channels in the Estate

Value label	Frequency	Valid Percent	Cumulative Percent
SMS	1	.3	.3
Phone calls	16	5.6	5.9
Visit to office	241	84.0	89.9
Internet	1	.3	90.2
All of the above	28	9.8	100.0
Total	287	100.0	

Source: Fieldwork (2023)

Analysis of aggregated data of Duration to react to Resident's complaints in the estate

The data analysed indicated that it took between 4-6 days to react to resident's complaints as noted by the majority of the respondents. 36.9% of the respondents agreed that it took more than six (6) days for IMSHC to react to their complaints. Table 7 shows this.

Table 7: Aggregated Data on Duration to React to Resident's Complaints in the Estate

Value label	Frequency	Valid Percent	Cumulative Percent
1-3 days	17	5.9	5.9
4-6 days	164	57.1	63.1
more than 6 days	106	36.9	100.0
Total	287	100.0	

Source: Fieldwork (2023)

Analysis of aggregated data on the Regularity of Corporation visits to the estate

From the data gathered, it could be seen that most of the respondents (35.9%) confirmed that the regularity of the corporation's visit to the estate was twice a year while 31.0% agreed that the regularity of the corporation's visit to the estate was quarterly and 18.8% of the respondents accepted once a year. This is illustrated in Table 8.

Table 8: Aggregated Data on Regularity of Corporation Visits to the Estate

Value label	Frequency	Valid Percent	Cumulative Percent
Monthly	10	3.5	3.5
Bi-monthly	24	8.4	11.8
Quarterly	89	31.0	42.9
Twice a year	103	35.9	78.7
Once a year	54	18.8	97.6
Others	7	2.4	100.0
Total	287	100.0	

Source: Fieldwork (2023)

Analysis of aggregated data on the Availability of Security in the estate

The investigation revealed that 57.1% of the respondents confirmed the availability of security measures in the estates within the study area as shown in Table 9.

Table 9: Aggregated Data on Availability of Security in the Estate

Value label	Frequency	Valid Percent	Cumulative Percent
Yes	164	57.1	57.1
No	123	42.9	100.0
Total	287	100.0	

Source: Fieldwork (2023)

Analysis of aggregated data of Arrangement of Security in the estate

It could be observed that the majority of the respondents indicated that the arrangement of security in the estate was handled by residents (individuals). Few of the respondents noted that security arrangement was done centrally by the estate (See Table 10).

Table 10: Aggregated Data on Arrangement of Security in the Estate

Value label	Frequency	Valid Percent	Cumulative Percent
Estate Central	56	19.5	19.5
Individual	209	72.8	92.3
Both	22	7.7	100.0
Total	287	100.0	

Source: Fieldwork (2023)

Analysis of aggregated data of Management of Central Security in the estate

The data collected showed that the majority of the respondents stated that management of central security in the estate was done by the residents. A few of the respondents stated that IMSHC managed security in the estates while a minute percentage (1.7%) stated that the government managed security arrangements. Table 11 shows this.

Table 11: Aggregated Data on Management of Central Security in the Estate

Value label	Frequency	Valid Percent	Cumulative Percent
IMSHC	6	2.1	2.1
Estate Residents	276	96.2	98.3
Government	5	1.7	100.0
Total	287	100.0	

Source: Fieldwork (2023)

Analysis of aggregated data on the state of repair of external walls

The state of repair of walls was examined and the results showed that a greater percentage (41.5%) of the external walls were in a bad state of repair while the external walls in a good state of repair were less at 38.3%. Table 12 shows the details. This means that the buildings in a bad state of external wall repairs were in a poor state, and they were not fit for human inhabitation.

Table 12: Aggregated Data on the State of repair of external walls in the buildings

Value label	Frequency	Valid Percent	Cumulative Percent
Very good	15	5.2	5.2
Good	110	38.3	43.6
Not sure	30	10.5	54.0
Bad	119	41.5	95.5
Very bad	13	4.5	100.0
Total	287	100.0	

Source: Fieldwork (2023)

Analysis of aggregated data on the state of repair of the roof

From the data gathered and analysed, roofs in bad state of repair were greater in number with 47.7% of the respondents indicating so while the ones in good state of repair were 34.1%. This implies that most of the roofs were in a bad state and needed urgent repairs and improvement. Figure 2 illustrates this.

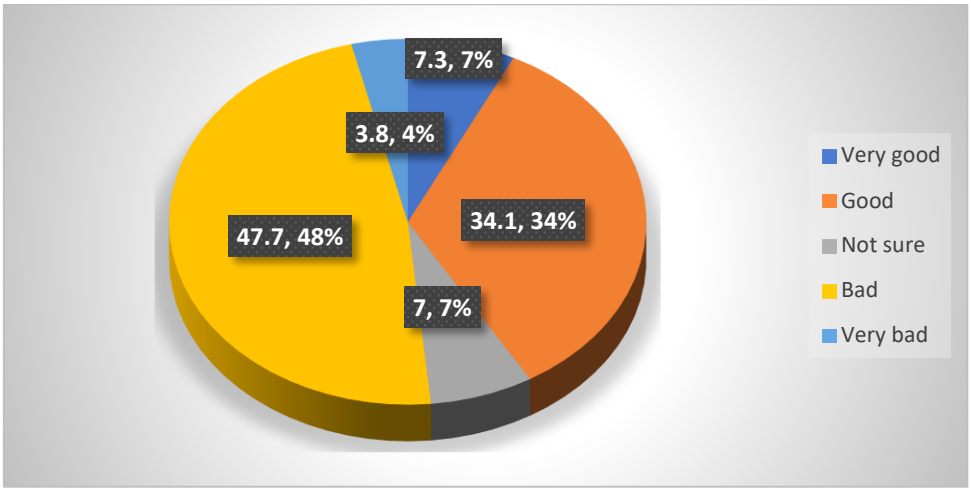

Figure 2: Aggregated Data on the State of repair of roofs in the buildings
Source: Fieldwork (2023)

Aggregated data analysis of waste disposal facilities in the estates

From the analysis, there was a high level of inadequate waste disposal facilities in the estate, as reported by 31.7% of the respondents; 21.3% of the respondents reported that waste disposal facilities were adequate. Table 13 displays the result.

Table 13: Aggregated Data on Waste Disposal Facilities in the Estate

Value label	Frequency	Valid Percent	Cumulative Percent
Very inadequate	19	6.6	6.6
Inadequate	91	31.7	38.3
Undecided	106	36.9	75.3
Adequate	61	21.3	96.5
Very adequate	10	3.5	100.0
Total	287	100.0	

Source: Fieldwork (2023)

Analysis of aggregated data of State of repair of buildings

It can be observed from Table 14 that most of the respondents stated that the buildings in the estates were in a bad state of repair and 26.8% of the respondents stated that the buildings were in a good state of repair. This revealed that most of the buildings were in poor condition and unfit for human dwelling.

Table 14: Aggregated Data on the State of repair of building in the buildings

Value label	Frequency	Valid Percent	Cumulative Percent
Very good	14	4.9	4.9
Good	77	26.8	31.7

Not sure	69	24.0	55.7
Bad	115	40.1	95.8
Very bad	12	4.2	100.0
Total	287	100.0	

Source: Fieldwork 2023

Analysis of aggregated data of Flaking/Peeling wall finish used in the housing estates

Most of the respondents indicated that the paint on the internal walls was peeling off. This implies that a greater proportion of the buildings have their paint peeling off as shown in Figure 3. It implies that most of the buildings need to be repainted to improve their aesthetic appearance.

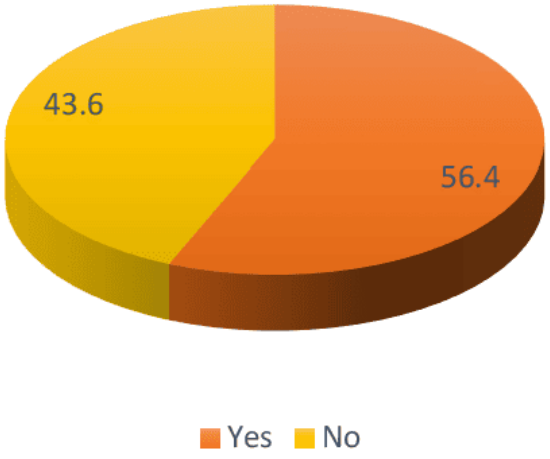

Figure 3: Data on Flaking/Peeling wall finish used in the Housing Estates. *Source*: Fieldwork (2023)

Test of Hypothesis

The variables 'Flaking/Peeling wall finish' (PWF) and 'Availability of procedures for maintenance operations' (APMO) were selected for this analysis. The two variables are of nominal variable category; therefore, the Chi-square test of independence analysis tool was applied towards examining the significance of the relationship.

The result from the analysis carried out showed 0.776 as the Chi-square value, with a Df value of 1 and a p-value of 0.038 as presented in Table 15. This p-value of 0.038 is less than the chosen α-value (i.e., acceptable significance level) of 0.050 for this research, implying therefore that it is accepted as significant. It is established, hence, that the relationship that exists between the two investigated variables can be stated to be statistically significant for this study. The alternate hypothesis, which states that *'There is significant relationship between Flaking/Peeling off wall finish and 'Availability of procedures for maintenance operations in Imo State Housing*

Corporation (IMSHC) estates in Owerri Capital Territory', is thus accepted.

Table 1: Result of Chi-square test of independence analysis of relationship between *PWF* and *APMO*

		Availability of procedures for maintenance operations
Flaking/Peeling wall finish	Chi-Square	0.776[a]
	Df	1
	P-Value	.038

Source: Fieldwork (2023)

CONCLUSION AND RECOMMENDATIONS

The study showed that the housing management affects housing condition in Imo State Housing Corporation (IMSHC) estates in Owerri Capital Territory. Obodoh (2009) stated that the relationship between managers of housing estates and the residents exerts a great impact on housing quality. If there is an amiable relationship between them, issues of maintenance will be addressed timely to reduce dilapidation. Hui (2005) stated that a proper management system is essential for keeping the housing in serviceable conditions to ensure good quality at all times.

No system can function adequately without a proper management system, housing estates inclusive. The management can be made up of administrative and technical staff. The latter, which should be made up of professionals in the building industry, should be included in the planning and design of the estates. The former should see to the running of the estates by ensuring that the guidelines established are kept to by residents. They should carry out supervisory roles in conjunction with technical staff to get feedback from the residents. While investigating the management systems and housing conditions in the area of study, it was proven that there is significant relationship between flaking/peeling off of wall finish and the Availability of procedures for maintenance operations in Imo State Housing Corporation. It is also noted that the availability of procedures for maintenance operations had significant correlation with the state of repair of external walls. Therefore, it is recommended that:

i. For prompt maintenance of facilities in buildings the residents should undertake it. For maintenance of facilities in the neighbourhood, IMSHC should undertake that. There should be a legal provision to enable the residents to enforce maintenance activities in the environment by IMSHC. To lessen abuse of the residents, there should be a provision to enable the residents to withhold rent or annual development fee paid to compensate for maintenance executed by them in the event of delays by the estate managers.

ii. The time taken to respond to residents' complaints should be improved upon by ensuring prompt response to complaints. From the analysis done, it was evident that it takes more than a week to respond to residents' complaints. This situation should be reversed by taking into consideration other means by which the IMSHC could attend to various complaints by the residents. This may be by having a liaison office within the estate where residents can also drop comments and suggestions. Leveraging on this, the feedback system is guaranteed, leading to a working partnership between IMSHC and the residents, which is useful.

These recommendations, if implemented, could lead to an increased level of housing quality in the IMSHC estates.

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Exploring the Impact of Integrative Artificial Intelligence Tools on the Writing Proficiency of University Students in Kano State

Mudassir Hassan & Adebayo Abubakar Funsho

Abstract

The integration of artificial intelligence (AI) tools in educational context has significant implications for students' writing skills, often resulting in detrimental effects. Current scholarship highlights that while AI tools offer certain advantages, overreliance on them can lead to cognitive offloading, which in turn diminishes critical thinking abilities and stifles creativity. This study aims to assess the impact of AI tools on university students' academic writing skills, as well as to examine the ethical concerns surrounding the adoption of AI technologies in writing processes. Employing mixed-method approach in the study, data were collected from three hundred and twenty (320) university students and fifty (50) language teachers via questionnaire, pre-test and post-test scores from essay writing tasks. Data collected through questionnaire were analyzed descriptively, while inferential analysis was employed to address the stated hypotheses. Findings of the study reveal that the presence of AI tools reduces students' capacity to produce high-quality academic discourse and promotes unethical practices. Therefore, the study reveals significant negative impact of AI on students' writing capabilities and the prevailing manifested trend of cognitive offloading. Based on the findings, it is recommended that teachers and relevant stakeholders adopt AI tools as complementary resources, while reinforcing traditional writing methods that nurture critical thinking, creativity and students' expression.

Keywords: Artificial Intelligence, cognitive offloading, ChatGPT, writing proficiency, creativity

Introduction

The significant advancement in information and communication technology (henceforth, ICT) that has uniquely defined the 21st century creates an environment that encourages human-like thought or cognitive-like content

produced by artificial cognitive systems. This major shift suggests that the era of unchallenged human cognitive supremacy is no longer predominant, particularly when it comes to content generated through human thought processes. In fact, this transformation has been largely driven by the recent emergence of artificial intelligence (henceforth, AI). While scientists applaud this remarkable achievement in Science and Technology, this revolutionary trend has simultaneously sparked extensive discussions among scholars. In the context of teaching and learning, there is an increasing concern about the potential negative effects of this technology on students' ability to engage actively in academic endeavours related to self-generated intellectual discourse, creativity and critical thinking.

Some scholars argue that the absence of comprehensive preventive measures to regulate students' indiscriminate use of AI-generated content, which they present as their original work, is pedagogically detrimental. In addition, the widespread adoption of AI technology has the potential to diminish students' writing skills, creativity and critical thinking. On the other hand, other scholars maintain an optimistic view of AI's role in enhancing students' writing capabilities. They contend that advancements in AI can be effectively harnessed to augment and complement human efforts, regardless of the specific context in which they are applied. As a result, the applications and complementary functions of AI are diverse. These different perspectives have led to renewed interest in assessing the positive contributions of AI technology in education. Therefore, the primary focus of this study is to examine the potential threats posed by AI technology and its associated online platforms, such as ChatGPT, on the writing abilities of university students in Kano State, Nigeria.

Aim and Objectives of the Study

The present study seeks to investigate the potential effects of AI on students' writing proficiency. Specifically, it explores the influence of AI tools and technologies, including Automated Writing Assistants and Language Generation Technologies (henceforth, LGT), on the writing skills of university students. In addition, the study has the following objectives:

1- To examine the impact of AI technology on university students' writing skills in Kano State.

2- To assess the ethical implications related to the use of AI tools on students' writing skills.

Research Questions

The following research questions are set to guide the study:

1- What is the difference between the learning outcome of university students taught writing through the AI technology and those taught using the traditional approach in Kano State?

2- How does the application of AI tools in students writing processes affect ethical standard?

Research Hypothesis

HO_1: There is no significant difference between the learning outcome of university students taught writing through AI technology and those taught using the traditional approach in Kano State.

HO_2: There is no significant impact of ethical issues associated with the use of AI tools on students' writing skills.

Review of Previous Related Studies

The inclusion of AI within educational context has attracted considerable scholarly attention in recent years, particularly concerning its implication for students' writing proficiency. Empirical studies and scholars' views show divergent perspectives. Some suggest that the integration of AI technologies can effectively support and enhance multiple facets of writing skills by offering positive personalized feedback, providing linguistic assistance and promoting creativity, as well as enhancing language usage (Yarima, 2024). On the other hand, others believe that AI technologies have significant negative impact on students' ability to write excellent academic discourse. The primary concerns regarding AI effect on students' writing include detrimental over-reliance on AI tools, erosion of critical thinking and creativity, undermining of fundamental writing skills, harmful impact on academic integrity, as well as possible overall decline in students' writing ability (Hassan, 2024).

Studies conducted by Idham, Rauf & Rajib (2024), Zafrullah, Meisya & Ayumi (2024), Psatama & Hashuti (2024), Risang (2023), Ramadhan et al. (2023), Cascidy (2023 in Yarima, 2024) and Bhutoria (2022) indicate that AI-based writing assistance tools such as grammar checker and Automated Content Generators facilitate and enhance various aspect of students writing proficiency. Idham, Rauf & Rajib (2024) report that AI tools provide useful personalized feedback and instruction which are significantly useful in providing tailored suggestions for improving students' writing skills. In addition, Zakrullah, Meisya & Ayumi (2024) indicate that AI tools enhance

writing capacity of students, while Psatama & Hashuti (2024), Risang (2023) and Ramadhan et al. (2023) argue that AI tools, not only improve students writing skills, but motivate students' active practical participation in writing processes which is a radical positive departure from the traditional teacher-centered approach. Moreover, Malik et al. (2023) explores the impact of AI technologies in academic essays writing using a case study design. The study involved 245 undergraduate students from 25 tertiary institutions in eastern and central Indonesian provinces. Data for the study were collected through online questionnaire instrument. Findings of the study reveal that AI tools enhance students' writing abilities, develop self-efficacy and academic integrity. Furthermore, studies conducted by Aljuaid (2024), Teng & Wang (2023) and Zhao et al. (2023) indicate that AI tools improve students' writing proficiency, and boost their confidence and productivity during the writing process.

One of the primary concerns regarding AI on students writing is the risk of students developing an over-reliance on AI-based Writing Assistance Tools (ABWAT), such as grammar checkers and automated content generators. Studies by Basha (2024) and Perkins (2023) indicate that AI technologies ChatGPT can generate unique and logical content that can evade detection, giving rise to significant concern over academic integrity. In addition, it is indicated by the findings that AI tools negate the development of basic foundation skills, critical thinking and make students inactive in academic performance. Similarly, studies by Budai & Backer (2020 in Yarima, 2024), Borenstien & Howard (2021), Kyoungwon et al. (2021 in Yarima, 2024) and Abd Rahman et al. (2023 in Yarima, 2024) reveal that students who depend heavily on AI tools, experience a significant decline in their ability to write. Besides, AI tools provide a false proficiency level of students, thereby disallowing teachers to locate students' deficiency. In a recent study conducted by Yarima (2024), it is revealed by the findings that AI tools make students less motivated to engage in the repetitive process of writing, as they perceived AI tools as a shortcut to producing polished writing without investing the necessary effort. In the same vein, it is affirmed by Turner (2024) that when students use AI tools to generate ideas and compose entire texts, originality and innovative thought in writing become stifle. In addition, Adamu (2024) argues that AI tools can lead to shallow analyses and weakened argumentative writing skills. Besides, findings of the studies conducted by Lydia (2023 in Yarima, 2024) and Derrida (2022 in Yarima, 2024) reveal that AI tools diminish students' ability to write, render them less attentive to grammar usages, spelling, correct use of punctuations, erosion of critical thinking, originality, as well as encourage unethical problem of plagiarism.

Based on the scholars' assessments and the results of studies conducted on the impact of AI tools on the writing proficiency of students, it is clear that the new technology has a significant impact on students' writing skills – positively and negatively. Parts of the positive impact include the provision of real-time feedback on grammar, style and structure and provision of effective guide to students on how to improve their writing efficiency. The technology does not only provide students with opportunity to generate ready-made written content, which support brainstorming, but facilitates personalized learning opportunities, offering tailored suggestions that help students improve their writing proficiency. On the negative perspectives, the technology reduces students' critical thinking ability due to over-reliance on AI technology for assistance. Though AI can be a powerful tool for enhancing writing skills, it should not be used in conjunction with traditional learning methods to ensure a well-rounded development, as well the development of critical thinking skill which is one of the cardinal objectives of writing skills (Hassan, 2024). What is more, with AI associated language problems of a learner cannot be exposed, as the writing is not done by him. Therefore, deficiencies in language usage cannot be seen and corrected by teachers.

The clear gaps identified in the previous studies on the effect of AI technology on students' writing skills include the fact that most studies, if not all, were carried out in Europe and Asia, with only a handful conducted in African nations. Besides, majority of the studies focus on learners of English as a Foreign Language (EFL). In contrast, this study is conducted in Kano State, located in North-West Nigeria, within the West African sub-region. Additionally, this study involves learners of English as a Second Language (henceforth, ESL)

According to Catherine (2023 in Yarima, 2024) writing ability refers to "the capacity to communicate effectively through written language, allowing students to express their ideas, thought and feeling by demonstrating good command of language usage and organizational skill." Writing ability enables university students to excel both academically and professionally, while also enhancing their personal lives (Yarima, 2004). Writing encompasses a series of sequential activities leading to continuous learning process. Through traditional learning methods, students are consciously and deliberately exposed to different writing activities aimed at developing their critical thinking, creativity, language usage and organizational skills, as well as the ability to develop and articulate their own ideas, rather than relying on content generated by AI tools. From a pedagogical perspective, within the context of English as a Second Language (ESL) education, writing reveals specific areas in which learners may struggle with the target language. This allows teachers to identify such deficiencies and provide the necessary

support to help students overcome the challenges associated with language learning in the ESL context for proficiency.

According to Febrina and Kartolo (2022 in Yarima, 2024), the teaching of writing is done to achieve several objectives: promoting students to engage in writing with honesty and responsibility, utilizing language with caution, integrity, and sensitivity; stimulating students' imagination, creativity and cognitive abilities; and producing written works or essays that are well-organized, precise, clear, structured and adhere to formal conventional norms. Similarly, Hassan (2024) asserts that university students are expected to produce writing that is formal and devoid of any informal language usage (Hassan & Sanusi, 2023). In addition, it is anticipated that students at the university level will generate exemplary academic discourse in their capacity as members of the formal discourse communities. However, the advent of AI technology appears to pose a potential threat capable of undermining the objectives and expectations.

METHODS

Research Design

The study employs a mixed-methods design; a quantitative approach using a quasi-experimental design was employed. A pre-test was administered to assess the initial skills levels of the participants in both the control and experimental groups. Following this, the experimental group had the opportunity to use AI tools to generate ideas for writing narrative essays for two weeks, while the control group received instruction through the traditional methods without the integration of AI technology. To evaluate the effectiveness of these strategies, a post-test was conducted simultaneously for both groups. The post-test scores were compared with the pre-test scores in order to assess the impact of AI technology on students' writing skills. In addition, a qualitative approach was also used in the study, with data collected through a questionnaire and analyzed descriptively.

Population and Sample

The study population consisted of participants from four selected universities in Kano State. A sample size of one hundred and sixty (160) participants for each group, namely the control and experimental groups, was determined using Taro Yamane guidelines for appropriate sample size selection. A Purposive Sampling technique was employed to select the sample of the study.

Research Instrument

The study collected data from students' essays that were given during the pre-test and post-test phases. The students' writings were assessed using a set of scoring criteria for evaluating students' writing and for giving feedback, Writing Assessment Rubric (WARU), developed by Spack & Burden (2015). The rubric is widely used by researchers as criteria for assessing writing. It provides a comprehensive and all-encompassing guideline for assessing and scoring writing including content, organization, mechanics, language use and vocabulary as presented in Table 1 below:

Table 1: Criteria for Scoring Writing Skills Proficiency

SN	Score	Criteria (Items that are marked)
1	Content	Topic Sentence, Uniting Ideas, Development
2	Organization	Logical Sequencing and Transition, Cohesion, Paragraphing
3	Mechanics	Spellings, Punctuations, Capitalization
4	Language Use	Fluent Expression, Grammar (tenses, concord, parallelism etc.), Complex Construction, Formal Usage, Clarity
5	Vocabulary	Words Choice and Usage, Word Form Mastery, Appropriate Use of Register, Idioms and Figurative Expressions

Spack & Burden (2015)

A ten items structured questionnaire was also distributed to forty (40) randomly selected lecturers across the four designated universities – ten from each of the universities. The questionnaire was designed in Likert format. The items in the questionnaire sought to elicit data on the ethical concern of using AI tools, as well as the impact of the technology on the writing skills of selected university students in Kano State, Nigeria.

Data Collection and Analysis

Data collected through questionnaire instrument and from the scores obtained from the writing tasks (pre-test and post-test scores) were analysed by employing inferential and descriptive methods.

RESULTS

Data Presentation and Analysis

Impact of AI Technology on the Writing Skills of University Students in Kano State

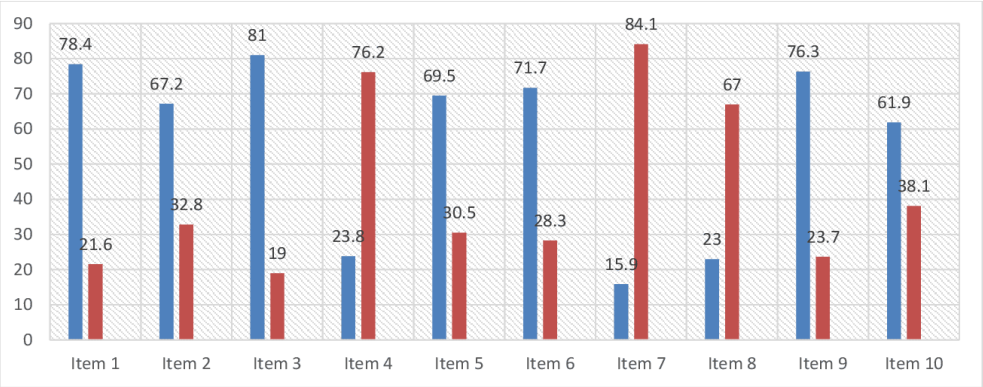
The Descriptive Result

Table 2: Differences in the Scores of University Students Taught Writing Using AI Technology and those Taught Using Conventional Approaches

	Pre-test Scores					Post-test Score				
Approaches	**N**	**Mean**	**SD**	**%Pass**	**%Fail**	**N**	**Mean**	**SD**	**%Pass**	**%Fail**
Traditional	160	6.2	10.2	24.0	76.1	160	7.9	1.1	96.1	3.9
AI integrated	160	5.9	8.6	11.3	85.9	160	8.9	7.7	60.3	39.7

As shown in Table 2, the pre-test score of the control group shows that majority of the students in the group scored low, as the highest percentage of 76.1% failed, while the low percentage of only 24.0% scored high. Also, the mean score of the result is 6.2. On the other hand, the academic performance of the students in the pre-test treatment for those in the experimental group shows that 85.9% performed academically low, while only 11.3% scored high. The mean of the group is 5. 9, the standard deviation of the pre-test scores is 10.2 for the conventional group and 8.6 for the experimental group. This means that the results of the two groups are the same; as majority in the two groups performed poorly. On the other hand, the results of the post-test indicate that majority of the subjects in the control group of 96.1% scored high, while only 39.7% scored low. Equally, majority of the students, 60.3% scored high, while 43.8% scored low. By comparing the two results, it is evident that the results of the post-test for those in the control group is better as 96.1% passed, while only 60.3% in the experimental group passed. The disparity in the two scores is facilitated by the scoring criteria, which necessitated the removal of certain expressions and usages considered as AI generated. Therefore, teaching writing using traditional approach is most effective in facilitating students' writing skills.

Teachers' response on the ten questionnaire items on the impact of AI technology on students' writing skill is presented below



As shown in the analysis, majority of the teachers agreed that AI technology negates students' ability to write good academic discourse (78.4%), discourages creativity (67.2%), motivates students' over-reliance on AI content-generated materials (81%), does not facilitate effective grammar usage (76.2%), encourages laziness (69.5%), encourages plagiarism (71.7%), does not improve students' proficiency in the use of words (84.1%), fails to guide students' ability to use punctuations (67%), negates students' expressive and organizational skills (76.3%) and impedes teachers' effort to identify areas of learners' deficiencies in the target language. Conversely, the response patterns of 21.6%, 32.8%, 19%, 23.8%, 30.5%, 28.3%, 15.9%, 23%, 23.7% and 38.1% show the opposite. Therefore, AI technology negates university students' ability to write good academic discourse.

The Non-descriptive Result

Pre-test Score

Table 3: Independent Sample t-test on the Academic Performance of University Students Taught Writing Using AI Technology and those Taught Using Conventional Approaches

Approaches	N	Mean	SD	df	t-calculated	t-critical	sign. (2 tailed)	Decision
Traditional	160	6.4	2.3					
				20	0.5	2.086	.05	Retained
AI Integrated	160	9.4	2.9					

Table 3 shows that there is no significant difference between the academic performance of students' score in the Control and Experimental Groups as the calculated t-value of 0.5 is less than the t-critical value of 2.086 for a two-tailed test at the .05 level of significance for 5 degrees of freedom. Therefore, the stated null hypothesis is retained, concluding that the two scores of the pre-test of the two groups did not differ. This means that the pre-test scores show no significant differences of the academic performance between the two groups before their exposure to treatment.

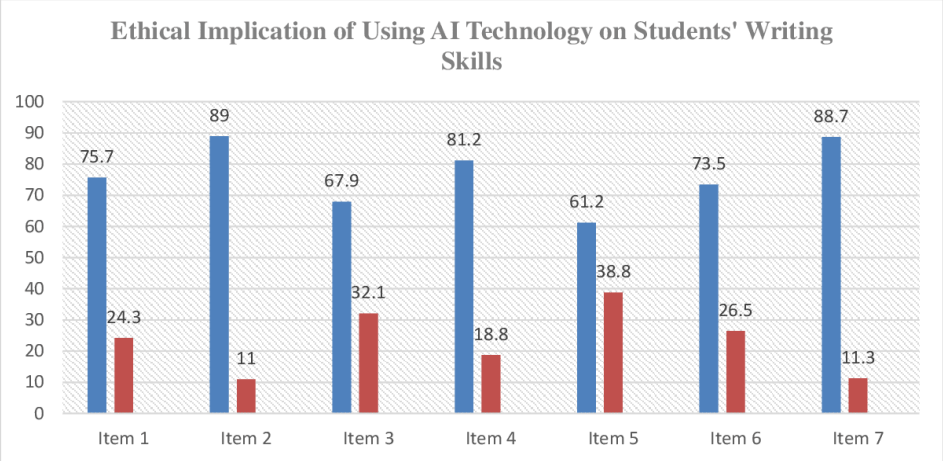
Post-test Scores of the Control and Experimental Groups

Table 4: Independent Sample t-test on Academic Performance of University Students Taught Writing Using AI Technology and those Taught Using Conventional Approaches

Approaches	N	Mean	SD	df	t-calculated	t-critical	sign. (2 tailed)	Decision
Traditional	160	9.7						
			2.9	21	2.43	2.080	.05	Rejected
AI Integrated	160	9.4						

Table 4 shows that there is significant difference between the academic performance of students' scores in the post-test of the Control and Experimental Groups as the calculated t- value of 2.43 is greater than the t-critical value of 2.080 for a two-tailed test at the .05 level of significance for 21 degrees of freedom. Therefore, the stated null hypothesis is rejected, concluding that the two scores of the post-test of the two groups differed.

Possible Ethical Implications Associated with the use of AI on University Students' Writing Skills.



Majority of the respondents indicate that the use of AI tools by students facilitate increasing concerns on ethical standard, as AI usage inhibits originality. This is because students unconsciously replicate styles suggested by AI hindering their ability to develop their own unique styles. In addition, AI degrades students' capacity for independent thought and critical analysis. Furthermore, issues related to plagiarism and lack of adequate input from the students are parts of the ethical consideration indicated by the majority of the respondents.

Table 5: Independent Sample t-test on the Ethical Standard in University Students' Writing

Method	N	Mean	SD	df	t-calculated	t-critical	sign. (2 tailed)	Decision
Traditional	160	19.6						
			5.8	237	9.3	2.4	.05	Rejected
AI Integrated	160	49.3						

Table 5 shows that there is significant difference between the academic performances of the two groups: Control and Experimental Groups in ethical consideration, as the calculated t- value of -2.82 exceeds the t- critical value

of 1.96 for a two-tailed test at the .05 level of significance for 237 degrees of freedom. Therefore, the stated null hypothesis is rejected, indicating that there is a significant difference in ethical consideration in the writing of those students in the control group and experimental group respectively.

Discussion on the Findings of the Study

The findings of the study indicate that students who were taught writing using traditional approaches to teaching without the integration of AI tools demonstrated better academic performance than those who used AI tools in their writing processes. This observation reaffirms concerns expressed by many scholars and language teachers regarding students' overreliance on AI writing tools; grammar checkers and automated essay generators as a result of their significant negative impact on critical writing skills, particularly, in terms of critical thinking and creativity. In addition, findings of the study suggest that students who employed AI tools allowed the facilities to dictate their writing structures, content, choice of words, grammar and paragraphing, which negated their capacity for original thought and proficiency. On the other hand, students who were taught based on the traditional approaches, without the integration of AI tools, attained a better understanding of the various stages of the writing process, while those using AI tools missed vital opportunities for comprehensive engagement through the stages, thereby undermining their understanding of writing as a complex process. In addition, it is evident that AI tools create a detrimental psychological barrier that negates students' abilities to exhibit high levels of critical thinking, creativity, originality and aesthetic presentation of ideas. Moreover, findings suggest that students who rely on AI tools are engaging in cognitive offloading, which negates the effectiveness of their critical thinking abilities and reduce their creative capacities. Similarly, students' dependence on AI tools affects their foundational writing skills and capacity to construct coherent discourse, thereby undermining their overall writing proficiency. Therefore, the study's findings demonstrate another significant concern: the indiscriminate use of AI tools is causing students to develop a superficial understanding of the conventional writing processes. Likewise, the reliance on AI-generated content leads to decreased engagement and negates originality in students' writing; all these are attributed to the down-to-earth simplicity and convenience of such technology-based tools.

It is also indicated by the findings of the study that the integration of AI tools in students' writing raises several ethical concerns that require careful consideration, particularly, regarding academic integrity, authenticity and the cultivation of critical thinking skills. The ease with which students generate essays using the AI tools can make them to submit work that is not truly their own, thereby encouraging plagiarism and compromising the core values of

honesty in learning contexts.

Conclusion and Recommendations

Based on the findings of the study, it can be concluded that AI writing tools offer substantial advantages in areas like grammar correction and content creation. But, it is important to recognize their potential negative effects on students' writing capabilities. Excessive dependence on these resources can impair understanding of the writing process, reduce involvement in critical thinking and impede writing proficiency. Consequently, teachers need to find a harmonious approach that combines the use of AI with the cultivation of fundamental writing skills through conventional practices. Indeed, a strategic incorporation of technology along with a commitment to skill enhancement is vital for developing both proficiency and competence in students' writing skills.

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Rethinking Motifs in Selected Children's Literary Texts

Blessing Ekpe Okpapi & Prof (Mrs) Enajite Ojaruega

Abstract

This study evaluates various motifs in selected children's literary texts against the backdrop of exposing negative and anti-social conducts among children and members of the society. It also foregrounds the artistic merit in the use of various literary tropes by authors of children's literature in enhancing their appeal to the audience. The primary texts for this study are James Ene Henshaw's *This is our Chance* and Chinua Achebe's *Chike and the River*. They are selected because they best exemplify the critical use of motifs in achieving the required message that this study is geared towards. The sociological approach to literature which concentrates on the extrinsic elements that examine the relationship between literature and society is applied to determine the artistic elements and motifs in the selected texts. The paper shows that the themes treated in children's literatures are often those that children are concerned with at various stages of their life – such as heroism, adventure, risk, mischief, fantasy, love, overcoming restiveness, jealousy and so on. The paper, therefore, concludes that since heroism and adventure constitute the major fulcrum of Nigerian children's literature, authors of children's literature should choose a principal character who is going to be the hero or heroine in their works. Thus, the development of the story is the development of the hero/heroine until the end of the story where he/she overcomes the conflict.

Keywords: children's literature, motifs, thematic preoccupations, literary texts

Introduction

Children's literature, which is often illustrated, consists of all literary creations for readers and listeners in their teenage or younger years. It is literature meant and intentionally written for children in elementary/primary schools as well as those in junior secondary schools to read and understand. The children, through their encounter with the texts, get involved with the events, setting, actions, intrigues, characters and ideas in the books. In other words, children literature offers the young ones the opportunity to explore

situations and feelings in literary texts they may have not yet encountered in real life.

Although critics of children's literature believe that the characteristics of children's literature are its short length, limited characters, action, condensation of plot and incident, linear story-line and simple language style, the most important and endearing aspect of children's literature is its photo illustrations. Children's literature is important because it provides pupils with opportunities to respond to literature. It makes them appreciate their own cultural heritage as well as those of others. It helps develop emotional intelligence and creativity. It nurtures growth and development of their personality and social skills; and it transmits important literature and themes from one generation to the next.

Various forms of children's literature abound. They range from biographies, children's poetry, children's stories, fables, fairy tales, fantasy, to science fiction, among others. These various forms are well propagated in books, VCDs and animated film stations. Since one of the functions of children's literature is to promote morality in children, children's books usually feature well-illustrated pictures relevant to the text to broaden the children's knowledge and sensitize them on current socio-political and scientific issues. In this regard, books with themes of greed, dishonesty, injustice, hunger, industry and heroism are well illustrated to portray negative and positive traits that the children should imbibe or discard. The graphic illustrations play a great role in books intended for young readers – texts some critics refer to as "Beginner's Books", especially when they are written for pre-literate children between ages 0-5. These illustrated pictures remain in the memory of the children for a long time. According to Lesnik-Oberstein (1994, p.6), "even after children attain sufficient levels of literacy to enjoy the story without illustrations, they continue to appreciate the occasional drawings found in chapter books".

Nigerian children's literature are fictional narratives that treat various themes that revolve around heroism, adventure, bravery as well as others that are meant for the edification of the young ones. However, Acholonu (2012, p.23) raises concern about the overriding exploitation of the themes of crime and violence in some so-called children's books with the portraiture of young children involved in criminal acts. This, to Acholonu, is inappropriate because it makes a child or the reader of these texts, relive the harrowing experiences that the protagonist goes through. In essence, themes of violence and crime in children's literature should be toned down. To this end, Acholonu, in discussing the use of motifs, primarily focuses on language and its appropriateness, while recommending positive themes, such as heroism, the use of images and various literary devices that enhance the message and aesthetic quality of children's books.

Furthermore, while some of the existing scholarship on Nigerian

Children's literature have contributed to the understanding of moral aspects of children's literature, little studies have been done in the area of heroism and the artistry inherent in creative works that constitute Nigerian children's literature, which is what this essay sets out to investigate. In order to achieve this, the paper focuses on James Ene Henshaw's *This is Our Chance* and Chinua Achebe's *Chike and the River.* The choice of these texts derives from the fact that they best exemplify the themes of heroism, bravery, adventure, etc. which constitute the pedagogical fulcrum of this paper.

Diverse Themes in Achebe's *Chike and the River* and Henshaw's *This is our Chance*

Multiple themes are explored in the two texts selected for investigation in this essay. They include the themes of heroism/bravery, love, and adventure. Other favoured themes are jealousy and hatred. These themes are significant because they express the general experience of children in relation to the environment and human society. Children's literature, therefore, comments on both the positive and negative aspects of society, with the aim of orientating the children to learn from the experiences of persons portrayed in the stories.

The theme of heroism is a favoured one in the genre of children's literature in Africa. According to Dandatti Abdulkadir (1981, p.31), the term 'hero' in Africa is used to describe "courage and endurance man exhibits in his struggle for survival, or in his pursuit of honour". He states further that "these actions involve great risk and are considered heroic by the conventions and values of his community". With specific reference to children's literature which thrives on the children's quest for adventure, the thematic orientation foregrounds elements of valour and bravery. The children in their quest to achieve certain goals encounter various ordeals (physical, supernatural and metaphysical) which are also reflected in the texts. These themes are utilized by writers of children's literature in ways that make their books interesting.

Chinua Achebe's *Chike and the River*, for instance, explores the themes of heroism/bravery. In the text, Chike, as an 11-year old child, had never left his village, Umuofia. Then, one day, his mother told him that he would be going to Onitsha to live with his uncle. This gives him a sense of joy as he had earlier received from his uncle's servant, Michael, highlights of the good things that he is sure to encounter in Onitsha. "He was tired of living in a bush village and wanted to see a big city" (p.1). With this mindset, Chike is poised for adventure in this new city. At the point of departure, we find the young Chike hesitant to leave home. However, Chike embarks on his adventure into the city, where he soon finds out that the city may indeed glitter, but it is not all gold. Firstly, the child-hero is exposed to the values of the village before embracing the city and all its challenges. But Chike soon

makes friends and is forced to mature quickly in an intimidating metropolis where all manner of dangers lurks.

Rather than destroy his innocent disposition, the events help in propelling him towards an intriguing adventure that is set ahead of him. For instance, his first challenge which eventually constitutes the conflict in the story revolves around his quest to cross the River Niger through ferry to Asaba. This ambition made him to pass through various ordeals especially his curiosity to survive among his new classmates and friends in Onitsha. His brave quest to cross the River Niger to Asaba is to show to his friends that he has achieved a feat which in the estimation of his friends is the hallmark of a city boy. As the writer puts it, "Anyhow, Chike was happy about one thing. He could now talk like the rest of his companions" (p.56). It should be well stated here that Chike's adventure to cross the River Niger constitutes an act of heroism, a feat he must achieve in order to be accepted into the fold of his companions.

> During the journey Chike felt as proud as Mungo Park when he finally reached the Niger. Here at last was the great River Niger. Chike stuck out his chest as though he owned the river, and drew a deep breath. The air smelt clean and fresh (p.54).

As a proud hero, he added this feat to his name as part of his achievement as a young boy. The writer says –

> It was all like a dream. Chike wondered whether it was actually happening. 'So this is me', he thought. 'Chike Anene, alias Chiks the Boy, of Umuofia, Mbaino District, Onitsha Province, Eastern Nigeria, Nigeria, West Africa, Africa, World, Universe.' This was how he wrote his name (p.53).

Chike's bravery is also manifested when he exposes the night-watchman and the thieves who stole from a shop in the market. Chike is brave despite the man's aggression towards him. He refuses to be cowed in the face of intimidation by the night watchman who threatened to harm him should he expose him. As a little boy, he is alone in a strange land. His safety is at stake. Should anything happen to him, he will be alone at the mercy of fate. But as a brave boy, he needs to show that he has fully imbibed all the morals he received from his mother – especially the one that says, truth is golden and falsehood leads to disgrace. At the end, he becomes a hero in the process of the recovery of the stolen goods. This is why Bowra (1952) tells us that heroic literature "may be concerned with any action in which a man stakes his life on his ideal of what he ought to be" (p.48). Chike stands his ground and is able to convince the people that the night-watchman was part of the people that stole from the shop. The narrator explains it thus:

> As Chike told his story the night-watchman began to shake. He

> covered his face with his hands to hide his tears. Chike became a hero. One big man in the crowd lifted him up and placed him on his shoulders. The others applauded. They said they had never seen such bravery from such a little boy… Everywhere people spoke of Chike's adventure. His photograph appeared in the local newspapers and his name was mentioned on the radio. Then after the three thieves and the night-watchman had been tried and imprisoned Chike got a letter from the manager of the shop. He announced that the company which owned the shop had decided to award a scholarship to Chike which would take him right through secondary school (p.66).

Here, Chike's bravery is recreated as an example for the young reader to emulate. Achebe re-imagines this role for the child-hero in a manner that Chike's success will necessarily encourage other young children to stand for the truth at all time and emulate him under similar circumstances. The letter of commendation and award of scholarship from the manager of the shop is a pointer to societal acceptation of his bravery and good deeds. By this, Chike becomes a source of inspiration to all young children who aspire to become great in life.

The theme of adventure in Achebe's *Chike and the River* provides excitement for young readers because they can share in the experiences of Chike who is also young. Chike's journey from his village Umuofia and his ambition to cross the River Niger give the text an exhilarating appeal that excites the young reader; this is because of the accidental adventure that follows after Chike missed the return boat. In his desperation, Chike strays by accident into a gang of armed robbers and then he is caught up in the rapidly unfolding events. The passage goes thus:

> When the lorry stopped the man at the back climbed out. Chike opened his eyes but it was pitch dark. The three men were now talking in whispers. Then the driver reversed the lorry. For a while there was silence. Chike prayed that the men would move away for even one minute so that he could get down and hide. But they did not move. Instead, a fourth man came and joined them. From what they said Chike understood that this fourth person was the night-watchman. … Then he told the driver, whose name was Ignatius, to move out the benches from the back of the lorry. Chike was half-dead. He heard the man let down the tail-board. But he did not come in. instead he returned to the front of the lorry to get a flash light. In the twinkling of an eye Chike slipped out and began to walk away. He had no idea where he was going. It was too dark to see. But he continued walking as quietly as a cat. Unfortunately, his foot kicked against a tin and made a noise. The driver shouted: 'Who dat?' Chike turned sharply to his left and ran. His eyes were now used to the darkness and he could see vaguely. He saw something like a door and walked in (p. 61-62)

The above episode underscores the scary nature of the accidental adventure that the child-hero goes through in his quest to survive in a strange land. The use of suspense and introduction of actions that make the curious reader to pray on behalf of Chike that he should not be caught adumbrates the artistic significance of the text. However, the child-hero survives the scary incidents through a dint of luck and the strength of his character and when the situation affords itself for him to display his bravery, he seizes it and becomes the hero that exposes the armed gang. This episode of Chike's adventure thus provides the opportunity for revealing his inner strengths and weaknesses. Chike therefore comes up at the end of the story wiser than before.

What endears Achebe's *Chike and the River* to the young reader is that it serves as a mirror of life for young children. Chike, the child-hero for instance, moves from naïveté and ignorance to self-knowledge and self-discovery. Life for the young child is like a series of well-planned events all geared towards his personal development and growth. But he succeeds through determination and constant hard work – in spite of temptations to go astray. Chike stuck to the lessons he learnt from home and from his mother. He is honest, truthful, courageous, and polite and these are qualities that earn him the success at the end of the story. It is significant to note that although Chike is attracted by good life, wealth, and material acquisitions, the ultimate success that Achebe allows him to achieve is the prize that gives him great self-confidence and pride which is the scholarship he wins to go to school to receive a good education, the reward for exposing and turning in the criminals. This is thus the new imagination that the story encapsulates.

Like in Achebe's *Chike and the River*, the theme of heroism and bravery are also explored in James Ene Henshaw's *This is our Chance.* At the beginning of the story, we encounter Princess Kudaro at crossroads with the customs and traditions of Koloro kingdom. As the plot develops, it becomes clear that she is poised to change the rigid system of things placed on the people of Koloro by their now anachronistic customs and traditions. The only way opened to her is to defiantly elope with the Prince of Udura (an enemy kingdom) whom she had met in her school in the city. The Princess is conscious of the consequences of her action, but as it is typical with all heroic literature where the hero cares less for his/her safety, she runs out of the palace to unite with her lover. Her action pits her kingdom against Udura. War alarms are sounded and both kingdoms square up for a showdown.

As the intrigues continue, Bambula, her private teacher, who is another youth, is fingered as the one who radicalised her into taking such a step. Bambula is taken to prison, awaiting his death. Also, the Prince of Udura is

arrested and imprisoned in Koloro kingdom. However, the conflict is amicably resolved when news comes from the kingdom of Udura that the princess had performed a heroic act by saving the life of one of the sons of Chief Mboli, the king of Udura. Of great significance is the act of bravery and heroism displayed by the young lovers in the play. Both Princess Kudaro and Prince Ndamu defy the age-long animosity between their kingdoms to get married in order to unite the kingdoms.

When the young Prince Ndamu is brought before Chief Damba, he displays critical features of a hero – fearlessness, composure and wits as revealed thus:

> Damba: (*walking around him, and examining him disdainfully.*)
> Young man, you interest me, I have two questions for you.
> Firstly, are you the young man called Vitamins? Secondly,
> where is my daughter?
>
> Ndamu: (*with princely dignity*.) My name is Ndamu, Prince of
> the village of Udura. It is true that your daughter and I
> tried to get away. Search parties were after us, one from
> this village and another from my own. I, therefore, tried
> to hide her under a bush, but before I could find a suitable
> hiding-place for myself, I was caught by your men. Oh
> I wish I knew what had happened to her: sweet, kind,
> gentle, obedient Kudaro. Oh…. (p.23).

From the above conversation, the reader is exposed to the fact that King Damba's knowledge is at variance with contemporary realities. He is hooked on the past, hence he mistakes Prince Ndamu with the notion of vitamin which his daughter's home teacher had espoused in his several discussions with him. However, further interrogation opens a cultural dimension to the discourse - elopement is alien to African culture. But in the play, Henshaw uses position as tool towards solving identified problems in the society. These problems are from all indications still the problems of our time. That is, cultural enmity which according to the author must be changed, even if it means total disregard for the old and obsolete cultural principles.

Of significant import is the cultural perspective that the playwright tries to advocate with the boldness of Prince Ndamu in defending his attempt to elope with the king's daughter. Herein lies new imagination in the text – multiculturalism can make people of diverse cultures to live together as one as well as intermarry without any hindrance. This concept is given voice in the manner in which the playwright articulates the intrigues in the play where the Princess's life is necessarily hanging in the balance should the king continue to defend traditional values against the new imagination which is

constitutive of cultural change and assimilation.

Similar display of bravery and heroism is shown in the action of Ayi, Kudaro's young maid who defies the status of the king and questions the place of tradition over humanity. She tells the king bluntly that:

> Ayi: But, Sir, where would principles be without men to observe them? And where would men be without human heart beating within them? (p.30)

When it becomes obvious that the elders of Koloro kingdom will not yield to the voice of reason, as exemplified by the children, Ayi confesses to the king thus:

> Ayi: (*interrupting*). Damba, Sir, I have lived here with you to learn. But all I knew was from your good wife. I beg you, permit me to leave this village. Where I will go I do not know. No matter what happens I shall always treasure the memory of your wife and her last words – "tell Damba, for the children's sake, for the women's sake, let there be no war…" (p,32).

The young maid, Ayi, is brave in telling the truth to the leaders of Koloro kingdom. To the children, therefore, time has changed and it has come to the point when their education has exposed them to the reality of things. They can no longer cope with primitive customs and traditions that reduce their humanity. In the restoration of the Koloro kingdom from the path of self-destruction, it is the actions of the children that represent the voice of reason and triumph over those of the elders who are brash, divisive and insensitive to reality. The elders dwell in the past and make custom and tradition a fortress that retards their progress. This is why Betiang believes that Henshaw's plays, written somehow in the Shavian tradition of the problem play, were and are an 'invitation to action' towards solving these identified problems in the society. (p.123). According to Fanon, a writer from a colonized culture who writes for his people "ought to use the past with the intention of opening the future, as an invitation to action and a basis for hope" (p.187). The children become the basis of hope in the society.

What the author has done with the theme of love in this play is to capture the invasion of love bred in the comfort of Western education against the African traditional love arrangement. He exposes the battle facing every dare-to-break conventional rule in the pursuit of a new culture that encourages humanity and freedom of choice. As he puts it himself in the preface to the play, there is "the need to preserve good traditions, and at the same time to graft upon them,where appropriate, the best from other countries" (p.5). At the end of the play, education and modernity win against tradition and ethnocentrism.

For instance, Chief Damba submits to the caprices of the children and accepts the fact that modernity has triumphed over mundane sentiments. He says: "But is this the price of education that our children should dislike what their fathers love, and place high values on what we loathe. Perhaps it is the will of our Fathers' spirits that it must be (p.31). Peter P. Ekeh (1989, p.8-12) articulates this phenomenon as a conflict between the demand of the 'primordial culture' and that of the 'civic culture'. The primordial culture, according to him, is kin-group specific and built around the 'notional' and 'substantive' concepts of ethnic groups. This type of culture is pre-colonial and based on tribe and carries the tribal ethos and controls. The civic culture, on the other hand, is a colonial contact culture which contains social formations, ideas, values and institutions that arise from the Nigerian nation state. Civic culture is, therefore, Western, modern and urban based.

The Use of Various Literary Motifs in Achebe's *Chike and the River* and Henshaw's *This is our Chance*

In the articulation of the themes of heroism/bravery in Henshaw's *This is our Chance* and Achebe's *Chike and the River,* the writers adopt various motifs and styles with which they address contemporary issues which constitute thematic fulcrum of this essay. These motifs are examined to bring out the salient indices of bravery, fantasy, mischief, love, and others in the works. As has been noted above, the themes prevalent in many of the children's literature relate to events in the cultural, political and economic milieu of the children. The formation of the right characters, narrative techniques, and appropriate themes in children's literature is thus the primary concern of the writers of children's works.

In *Chike and the River,* for instance, Achebe exhibits the same simple style that is famous in his adult novels. He shows through the adventures of Chike that despite the use of a single character around whom the activities revolve he could still deepen our insight and illustrate deeper levels of human nature. For example, at the beginning of the novel, the writer presents a vivid and graphic description of Chike's mood when he hears the news of his going to Onitsha to stay with his uncle; the author also contrasts the village setting with that of Onitsha. The story goes thus:

> Chike was now eleven years old, and he had never left his village. Then one day his mother told him that he would be going to Onitsha in the new year to live with his uncle who was a clerk in one of the firms there. At first Chike was full of joy. He was tired of living in a bush village and wanted to see a big city. He had heard many wonderful stories about Onitsha. His uncle's servant, Michael, had told him that there was a water tap in the very compound where they lived. Chike said this was impossible but Michael had sworn to its

> truth by wetting his first finger on his tongue and pointing it to the sky. Chike was too thrilled for words. So he would no longer wake up early in the morning to go to the stream. The trouble with their village stream was that the way to it was very rough and stony, and sometimes children fell and brake their water-pots. In Onitsha Chike would be free from all these worries. Also he would live in a house with an iron roof instead of his mother's poor hut of mud and thatch. It all sounded so wonderful. (p. 1-2).

The narrative above appeals to boys and girls because the author manages to localize the story in an identifiable environment through the use of familiar activities. This narrative motif endears the story to the young children. Besides, the young reader can see the contrasting pictures of the rural and urban environments. The former lacks modern amenities, good water supply, electricity, and modern infrastructure, but it is safe and serene and had the human touch and human face. The urban centre, on the other hand, has physical structures and amenities, but life in them is relatively unsafe. There are frequent drug abuse and fraud. But the beauty of the work is that Achebe is careful to show through the experiences and actions of the child-hero in the text that if a child holds on to his or her good upbringing he can survive in any environment.

Chike and the River is an adventure story. However, the plot revolves around Chike's ambition to cross the River Niger in a boat. It is this desire that nearly makes him deviate from his good upbringing as he tries to get money through a magician known as Prof. Chardus who swindles him thereby depriving him of his three kobo. Chike is so desperate to sail across the river that he begs his uncle for some money but the man looked so stern that he had to run from him. Nevertheless, his wish is fulfilled when he goes to the riverside to wash cars for people and is rewarded with one naira.

The adventure takes a different turn when Chike fulfills his ambition and he is enamoured by Asaba that he forgets to return to the riverside to catch the last boat to Onitsha. The author contrives the story interestingly to include a patriotic act by Chike who sleeps in a lorry that is used for robbery. Chike helps the police in tracking down the three thieves thereby exposing a thief known as Peter Nwana the miserly trader. This final act is the crux of the didactic message in the novel. The author uses the message as a motif to teach the simple lesson that all good acts are rewarded. By making Chike famous through his brave act, the author is encouraging other boys and girls to emulate him. This is the didactic aspect of the novel that is invaluable.

However, within the story, Achebe also discusses issues relating to the moral consciousness of children. He indicates this motif in the novel through Chike's abhorrence to filthy environment. In the house in which Chike lives there are two latrines for about fifty people, one for adults and the other for children. Both are filthy but the children's own is worse. It swarms with flies

bigger than any Chike had ever seen at Umuofia. They revolt him, and so he learns that a big town is not always better than a village. The juxtaposition of Onitsha, the town and Umuofia, a village is used to inform the reader that a village has certain virtues that can be absent in a town. Achebe is thus changing the erroneous concept that a town is filled with only the good things of life.

In the same manner, the novelist tells the story of Ezekiel, the spoilt child, in order to illustrate a different behaviour from that of Chike which must be condemned by all good children. This juxtaposition of the two characters is important. Ezekiel is an only son but due to over-pampering he "was developing into a lawless imp." (p.15). Ezekiel formulates a plan in school through which he writes to some pen-friend boys in England asking for money and promising to send them leopard skins. Ezekiel has no plan to send them the leopard's skin because he simply wants their money. His act encourages other boys to send similar letters too. The bad boys are punished when the headmaster discovers their criminal acts.

Most of the activities in this novel are structured to reflect the importance of good behaviours. The manner in which Chike fords a river when he travels with his mates to convey the luggage of a missionary to Okikpe gives him confidence. Achebe uses that incident to stress that most obstacles that seem insurmountable could yield to brave confident children. This incident is juxtaposed with the incident of some boys who take brain pills to enable them pass examinations. These boys lack confidence in themselves and they break down before the day of examinations thereby losing even the little knowledge they would have been able to produce on the examination day.

The most important aspect of Achebe's didacticism in *Chike and the River* is the illustration that a town possesses several influences that could turn a child from his or her good upbringing. He therefore points out some of these problem areas thereby aiding the children in understanding what is good and also helping parents in ensuring that their children are not influenced by bad boys and girls.

Furthermore, the various literary motifs used by Achebe in the novel make it rewarding for children. There are familiar folksongs, idioms and code mixing, humourous anecdotes, games that children play for entertainment and amusement, children's pranks and slangs, children's fantasies and day-dreaming, children's nicknames for each other, and children's perceptions of the adult world, which they discuss among themselves in their peculiar types of dialogue. For example, Chike's classmate, Samuel, who is a good footballer gives himself a nick name, S.M.O.G in place of his full name. The novelist puts it thus:

> S.M.O.G. was Samuel's nickname which he gave himself. His full name was Samuel Maduka Obi: so his initials were S.M.O. Then one

> day he saw that if he added a 'G' to his initials he would become S.M.O.G, He immediately did so. In Onitsha the letters S.M.O.G. were said to bring good luck because they stood for Save Me O God (p. 4).

Similarly, Chike is called 'ChiksThe Boy' by his peers. When he eventually crosses the River Niger, in excitement Chike rills out his full name and includes his nickname thus:

> It was all like a dream. Chike wondered whether it was actually happening. 'So this is me,' he thought. 'ChikeAnene, alias Chiks the Boy, of Umuofia, Mbaino District, Onitsha Province, Eastern Nigeria, Nigeria, West Africa, Africa, World, Universe.' This was how he wrote his name (p. 53).

The use of idioms, slangs and humourous anecdotes are evident in the headmaster's statement in front of the assembly when he scolded Ezekiel and his friends who sent letters to other children in England requesting gifts from them. Such idioms and slangs like *scallywag* and *nincompoops* were strange to the children and they laughed. The event is well captured thus:

> 'That is what these *nincompoops* here have done to you.' There was laughter again at *nincompoops*, another strange word (p. 15).

Folksongs in the novel are used to express happiness and excitement in the children. Chike becomes excited when he makes the money to take the ferry boat to Asaba, however, he becomes impatient when the boat seems to take long time in coming. He resorts to singing to keep himself happy. This interesting scenario is captured by the narrator, thus:

> Chike's dream had come true; at last he could go to Asaba. He jumped up and down several times and sang 'One more river to cross'. It was one of the songs he had learnt at the C.M.S. Central School, Umuofia (p. 51).

All these literary motifs and aesthetic devices are used to reinforce the authenticity of the story and the reality of the children's world created in the text.

In *This is Our Chance,* Henshaw uses the medium of dramatic literature to foreground the role of children as a stabilising feature in any society. Here the author juxtaposes the modern vision and ideas of the children about the ever-changing society against archaic traditional disposition of the adults. The children represent modern civilization which they have acquired through western education while the adults foreground the tenets of retardation dictated by customs and traditions and abhor good neighbourliness. The morals that the author passes across to the society is that exposure through

education will open society to freedom and progress.

Through the characters of the young children: Princess Kudaro, Prince Ndamu and Ayi, the reader is brought into the world of the powerful versus the weak. With clear and simple words, Henshaw takes the reader through children's travail in the hands of the adults who take pleasure in upholding the ancient customs and traditions which are unknown to the children. Here, the author pits Ayi who represents those ideals of the children against Damba and Ajugo who oppose them. This idea is aesthetically recreated:

> Ayi: How would you like your daughter killed and your dead?
>
> Damba: Don't trifle with my wife.
>
> Ayi: I trifle not, but I must speak my mind. For long I have seen her serve and love you as never a woman has. I have seen her organise the women of this village in their farms and in their homes. I have seen her trying to do everything to make you, and the village, worthy of her. And yet as she lies dying, tortured by all that your stubbornness has brought to her, you sit here and talk of principles, of Customs and Traditions, and listen to the advice of a man who has no feelings at all. *(looking at AJUGO)*.(p.30)

Through clarity of expression, Henshaw projects the nuances of the characters in the text. Through the use of language, the text lends itself to the theme of oppression. From the beginning of the text to almost the end, the language use expresses the tension between the forces of retardation typified by the adults and progress represented by the children. The simple but emphatic statement by Kudaro that she plans to run away and get married to Ndamu already gives the reader and the story a sense of wonder as to what comes next. It brings some presence to the text itself. The statement raises many other questions and makes the reader interested in paying more attention to the text. As the plot develops, the thematic preoccupation continues to be unraveled. Throughout this period, the tone of the language is high.

The play, therefore, creates a frame to express the oppression of children characters. Kudaro, Ayi and other children in Koloro Kingdom who are victimized by the insensitivity of adults yearn for freedom. Kudaro expresses her inner feelings to Ayi thus:

> Kudaro: (*lowering her voice*). Ayi, my girl, I have a secret for you, it is not that I do not like my home, but I have a handsome young man in the town where I used to go to school (*Then she smiles as she speaks.*) He promised to marry me. But how can he marry me when I am locked up in this village? (*She almost weeps.*) (p. 12)

The children are pictured constantly in one form of discomfort. The children are not given the carefree and naïve characteristics usually associated with

children. Rather, the children are portrayed as emotionally and physically strong, though disturbed. Through various literary motifs, the text lends itself to an aesthetic ideal.

Conclusion

The aim of this essay is to demonstrate that the aesthetic goal of the creators of children's literature is to compose stories that appeal to young adults through the themes treated and literary motifs used. The analysis establishes the fact that children's literature thematises issues of heroism, bravery, adventure, jealousy and triumphs whose appeal derives essentially from the alluring use of various motifs. Thus, the peculiar use of language in the selected texts and other literary motifs are artistic tropes used by writers to make children's literature in Nigeria aesthetically appealing to the reader.

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