

## ASSESSMENT OF THE IMPACT OF STRESS ON THE PERFORMANCE OF CONSTRUCTION PRACTITIONERS IN KADUNA STATE

**Yusuf, I**

Department of Quantity Surveying,  
School of Environmental Technology,  
Federal University of Technology,  
Minna, Nigeria

**Ola-Awo, A. W.**

(Department of Quantity Surveying,  
School of Environmental Technology,  
Federal University of Technology,  
Minna, Nigeria

### **Abstract.**

In today's workplace, across different industries, stress has become one of the world's most common health concerns requiring considerable attention. Therefore, this study assessed the impact of work stress on the performance of construction practitioners with a view to suggesting strategies for effective management of stress. 201 questionnaires were administered to the research population and 200 were retrieved representing a response rate of 95.5 %. Analysis of the data was carried out with the use of Percentages, Mean Item Score (MIS), and Pearson product correlation. The study found that poor working conditions (MIS = 3.72); and work overload (MIS = 3.72) are the most prevalent factors contributing to stress among practitioners in the construction industry. Findings from the study also revealed that reduced job satisfaction (MIS = 3.90) is the most significant impact stress has on construction practitioners performance while task performance (MIS = 3.80) and technical performance (MIS = 3.76) are the most commonly used performance measures for construction practitioners. The study also found that work stress has a significant positive and slightly strong relationship with performance of construction practitioners with a value of 0.393. It was therefore concluded that workplace stress is a double edge sword and has both positive and negative impacts on the performance of professionals in the construction industry. The major recommendation from the study was that management should ensure that personnel are up-to-date and get sufficient training in order to effectively execute their jobs and track their progress.

**Keywords:** Construction practitioner, Performance, Stress,

## Introduction

The building construction industry as witness transformations across the globe in the last few decades. Continuous changes in the development of building process, pace and complexity of work and increasing demand for higher productivity have become common features of the construction industry (Wong *et al.*, 2010). In addition, practitioners and other work force in the industry operate in an extremely competitive environment where projects are designed, constructed and delivered within tight budgets and a short duration. The whole processes have made works in the industry mentally and emotionally demanding and stressful (Wahab, 2010). According to Daniel (2019), an average employee in the construction industry spends almost one third of his life on work, and sometimes has to face a lot of stress during his/her job. Daniel (2019) further lamented that stress in a workplace has touched almost all professions, from executive to workers who are directly engaged in the production. Job stress ultimately affects the physical as well as mental health. Stress has impact considerable impact on the lives of individuals. Although stress is a common concept, it is often misunderstood by many individuals. Stress is the way in which an individual respond to a range of environmental stressors. It is individualistic in nature and affects different people in different ways. Thus, what affects one person may not affect another (Blonna, 2012).

Lath (2010) asserted that although every person including a child, an adult, employed or unemployed faces stress in his/her everyday life. He defined stress as any challenge that exceeds the coping abilities of the individual. According to Patching and Best (2014), stresses a manifestation of different psychological factors such as an individual's personality type, their ability to be flexible, their understanding and use of avoidance and/or coping mechanisms, an individual's sleep and behaviour patterns, as well as their cognitive style, and how they learn. Lath (2010) opined that stress is the physical and emotional responses that occur when workers perceive an imbalance between their work demands and their capability to meet such demands.

The causes and effects of psychological and occupational stress varies across different sectors of the economy. In the construction industry, professionals are exposed to stressful working conditions (Edwards and Irani, 2010). Sommovigo *et al.* (2019) added that construction related jobs are complicated, dynamic, crisis-ridden and involves high speed. These make construction employees vulnerable to occupational and psychological disorders and this has effects on themselves and the industry.

In education sector, Yusoff and Khan (2013) emphasized that stress is due to imbalance between job demands and their ability to respond. Employees are under pressure due to heavy workload, job demands and publication efforts given rise to tiredness, sleeping problem and concentration which are more visible when more workload is expected to attract external research funds. Similarly, Nithyajothi (2019) said that work life in the telecom industry is both challenging and stressful. Thus, employees are exposed to experiencing damage to critical

brain structures and circuitry (McEwen and Morrison, 2013), reduced ability to cope with future stress and expanded nervousness and constant discouragement (Miller and Hen, 2015). . Globalization and changes in the nature of work has necessitates people to deal with increasing work-related stress. Furthermore, Farber (2012) believes that we cannot eliminate stress but we can try to manage or cope with it at an optimal level. As such, understanding the causes is important in order to manage it. In developed economies, people are becoming more familiar with what work-related stress is and how to manage it. However, in developing countries like Nigeria.

Since the human resource is an important resource to construction related organizations, efforts must be made to guard against any threats to this resource. It is important to understand the stress factors and make an effort to reduce those stressors in order to make effective and efficient use from of human resource (Sharma and Devi, 2011), and for them to be retained within the organization. Therefore, this study assessed the impact of work stress on the performance of construction practitioners with a view to suggest strategies for effective management of stress.

The following objectives were formulated in order to minimise stress within the construction sector in the study area:

- i. To assess factors contributing to stress among practitioners in the construction industry;
- ii. To examine ways of assessing performance of stressed workers in construction sector; and
- iii. To assess the impact factor of stress on construction practitioners' performance.

## **Literature Review**

### **Factors Contributing to Stress among Construction Practitioners**

Employees experience and feel stressed due to a set of various reasons and therefore the reactions to stress at the workplace are not a separate aspect (Fairbrother, and Warn, 2003). Increasingly, the stress level is changing rapidly among the employees due to various reasons, such as work overload, over crowdedness at the workplace, of loud noises generated by machines and arousal of conflicts among the employees and the employer due to poor or inadequate decisions (Richardson, 2014). Stress can arise because of transitions made in our personal lives. Personal issues that contribute to stress are domestic problems in the house, like losing loved ones, financial problems and divorce. These could be categorized as individual causes that lead to stress. On the other hand, there is also stress that is caused by organizational factors; these factors are those faced by the employees at the workplace. Issues such as role uncertainty; that is not being able to know exactly what one is supposed to do and

what others expect from us and also having too much work at hand with little time to accomplish it, can cause stress at the work place.

Further, organizational factors that causes stress are poor working conditions where the employee is often too distracted, where there is noise, where it is chilly or too hot and where the workplace is often filled with people running here and there. Whereas issues that contribute to stress are lack of control, suddenness, and ambiguity; especially role ambiguity is the foremost reason of stress at work (Richardson, 2014). Some organizational factors that can be considered as stressors mostly depend on the types of job and specification of works. These play important role regarding the issues related to stress, for instance, if the job is high-stress prone. High stress jobs are the kind of jobs that require plenty of time, and put the employees under the pressure of work. It is also notable that, often the employees suffer from poor working situation, if the work is performed in an unpleasant environment (Bloisi *et al.*, 2007). Scholars have stated that a large number of features of occupational life, is connected to stress. Okeke *et al.* (2016), concluded their study by conducting a sample study of 7,099 employees from 13 different companies and occupations. They reported that a significant statistical relationship between workplace factor and negative symptoms of health or disorder of mental situation such as, anxiety, depression and irritation. Employees usually feel stress at their jobs due to the following reasons (Okeke *et al.*, 2016);

- a) Work overload
- b) Misuse of power
- c) Inadequate decisions or leader behavior
- d) Overcrowd and noise.

Work and workplace in them are stressful phenomenon and therefore, various aspects of work situations are connected to stress (De Silva *et al.*, 2017). According to Boschman *et al.* (2013), the factors related to roles in a work environment are namely existence of low-level power, role indefiniteness or role dispute. They added that increase in physical conditions at the workplace such as concurrent permanent noise, overcrowding and lack of secrecy, are associated to stress. The behaviour of the leader or chief can also affect the level of stress (Fairbrother, and Warn, 2003).

### **Impact of Work Stress Factors on Construction Practitioner's Performance**

The findings of the investigation regarding the consequences of work stress experienced by employees at Khairun University showed a negative and significant effect on employee performance (Nur, 2013). Research conducted Ramli (2017) and Yang and Hwang (2014) have tried to test the impact of work stress on employee performance whose findings turned out to show that organizational performance is an element that collectively will be born from the achievement of each employee's performance. According to Barlian (2016) if we can find

out the causal relationship between the achievement of employee performance with organizational performance, it will be able to assist managers in directing the limited organizational resources in the right direction, which is the cause of improved employee performance, so that Organizations with workforce will be more satisfied and more efficient. Job stress according to Basri (2012) can be explained as a negative feeling and arises because of an individual's inability to face the weight of a workload that has an inappropriate capacity or encounters pressure at work.

According to few of the researches the productivity is considered to be at the peak with moderate level of work stress, but as it goes beyond that certain level, the productivity starts decreasing with increasing rate (Kakkos & Trivellas, 2011). It also has been found that the performance of employees remains poor at very low level of stress as well as at very high level of stress, because at low level of stress employees may not be sufficiently energized and may not be whole-heartedly dedicated to their job, resulting in low productivity. And at the peak of stress, employees want to get out of that stressful situation, result in no concentration on work. Job stress can be viewed as an individual's reactions to characteristics of work environment that are perceived to be emotionally and physically threatening to the individual (Shahriari *et al.*, 2013). It points to a poor fit between the individual's capabilities and his work environment, in which excessive demands are made of the individual or the individual is not fully prepared to handle the situation (Shahriari *et al.*, 2013). In general, the higher the imbalance between the demands and the individuals' abilities, the higher will be experienced job stress (Jamal, 2007).

Job performance can be viewed as an activity in which an individual is able to accomplish successfully the task assigned to him, subject to the normal constraints of the reasonable utilization of available resources (Shahriari *et al.*, 2013). At the conceptual level, four types of relationships were proposed earlier to exist potentially between the measures of job stress and job performance; a negative linear relationship, a positive linear relationship, a curvilinear / u-shaped relationship and no relationship between the two. Since the nature of the relationship between job stress and job performance, to the best of our knowledge, has not been empirically examined under a two-dimensional model of job stress, a brief review of the four relationships is warranted. A negative relationship between job stress and performance was conceived by those who viewed job stress as essentially dysfunctional for the organization and its employees (Tourigny *et al.*, 2016).

Job performance can be considered as "an activity in which an individual is able to accomplish successfully the task/goal assigned to him, subject to the normal constraint of the reasonable utilisation of available resources (Goswami, 2015). Job stress is often described as closely associated with performance and have serious implications on individual and organizational performance. Stressed employees are most probably unhealthy, poorly motivated, less productive and less safe at work (Goswami, 2015; Lopes & Kachalia, 2016; Park, 2007).

Sources of job stress contribute to reduced job satisfaction, reduced quality of labour, high worker's turnover, absenteeism, reduced worker overall performance and reduced organizational performance. Too much stress is clearly evidenced by a substantial decline in performance and organizational effectiveness (Manderson, 2014).

### **Measures of Performance of Stressed Construction Practitioners**

A systematic literature review of 213 studies published in reputed journals or a period of only three years (2006-09) revealed 207 different measures used for assessing performance. There are various ways of assessing performance in construction sector, few of these ways are discussed below:

#### **i. Technical Performance**

Technical Performance Measurement is a process by which project management can measure the risks inherent in a given project. Technical Performance Measurements provide insight as to the parameters of the specific design elements of the system. Technical Performance Measurement is used by project management to define the measures of performance and acceptable variables during project implementation (Ahmad *et al.*, 2016). Use of Technical Performance Measurement benchmarks should be limited to factors which negatively effect the primary measures of performance, which are schedule and budget. Project management should not use Technical Performance Measurement to measure typical project goals, but strictly as a preventative measure to ensure that the project is delivered on time, and for the targeted budgetary goals. Studying these technical performance measurements provides the opportunity for management to develop tolerable risk ranges to evaluate the parameters of the project (Dziekonski *et al.*, 2018).

#### **ii. Social Performance**

Social performance of construction projects reflects the extent to which the lifecycle of construction projects meets the demands of anticipated or existing social demands. Therefore, social performance of construction projects could be obtained by analyzing social impacts of construction projects and the requirements for social sustainability by diverse stakeholders. Shen *et al.* (2007) explored the indicators for social sustainability performance evaluation of different stages. Valdes-Vasquez *et al.* (2012) identified 50 processes for social sustainability consideration during planning and design phase of construction projects, and these processes were categorized into six categories, namely stakeholder engagement, user considerations, team formation, management considerations, impact assessment, and place context. Zuo *et al.* (2012) interviewed domain experts and 26 criteria of social sustainability were identified, which were further discussed from three dimensions, i.e., macro level, external stakeholders, and internal stakeholders. Almahmoud *et al.* (2015) studied social core functions (SCFs) of a construction project from perspectives of diverse stakeholders. Capital performance, health and physical comfort, accessibility, integration, usability psychological comfort, and operation

health and safety were identified as SCFs of a construction project. Liu *et al.* (2018), studied social impacts of an affordable housing project and indicators reflecting social impacts were discussed from three aspects as socio-economic effects, adaptabilities, and social risks. Wang *et al.* (2016); Shi *et al.* (2015), and Liu *et al.* (2016) also addressed the social risks of the construction projects. They suggested that the projects should not only be compliant with the regulations but also meet the requirements of diverse stakeholders, especially the end-users, which will improve project social flexibility and thereby contribute to project social sustainability.

### iii Personal Performance

Personal Performance means each employee's work performance during the performance period which may be assessed by the administrator based on one or more criteria, including, but not limited to: personal or team performance and measures such as teamwork, interpersonal skills, communication skills, employee development, project management skills, and leadership, or individual or team business objectives such as performance versus budget and attainment of safety, operational incident and environmental standards (Jin *et al.*, 2013).

### iv. Organizational performance

There are possibly many interpretations of the term organizational performance. Luo *et al.* (2012) who conducted a meta-analysis of organizational performance suggested that it should be measured in economic and operational terms: The economic performance looks at financial and market outcomes which assess the profits, sales, return on investment for shareholders, and other financial metrics.

The operational performance, on the other hand, focuses on the observable indices like customer satisfaction and loyalty, the firm's social capital, and competitive edge derived from capabilities and resources. Organizational performance is measured for different levels of hierarchy and can be assessed for individuals, groups, and the entire organization as a whole (Knies, Jacobsen and Tummers, 2016). The researchers settled on a multi-dimensional construct of organizational performance with financial performance, product market performance, and shareholder return forming three crucial aspects.

## **Research Methodology**

This study adopted quantitative research design via questionnaire survey administered on construction practitioners in Kaduna State. Questionnaire survey adopted allows large coverage since there are various professional in the construction sector, it is also convenient and relatively inexpensive. Kaduna is selected because is one of the epicenters of construction activities in North West, Nigeria with high population of construction practitioners. There are 429 construction professionals in Kaduna based on the information gotten from each professional bodies in the State (such as Nigerian Institute of Architects (NIA), Nigerian Institute of Quantity Surveyors (NIQS), Nigerian Institute of Building (NIOB) and Nigerian

Society of Engineers (NSE). Those that constitute this target population are financially up to date members of these professional bodies. A sample is a small proportion of a population selected for observation and analysis. The sample size for this study was calculated using a formula proportion as illustrated by Glenn (2013).

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

Where;

n = Sample size

N = Population size in the sample unit

e = Level of precision which is + 5% (0.05)

$$n = \frac{429}{1 + 429 (0.05)^2} = 201 \quad (1)$$

n= 201

To arrive at a sample size that served as a representative of the entire population in the study area equation 1 showed above was used and an estimated sample size of 201 was gotten. The analysis of the data was carried out using descriptive statistic such as percentage, mean item score, and Pearson product correlation. A simple random sampling technique was adopted for the study. The questionnaire was designed on a five-point Likert scale format to address issues relating to the research objectives set.

## Results and Discussion

### Factors Contributing to Stress Among Practitioners in the Construction Industry

A total of thirteen (13) stress factors were identified from literature, and respondents were asked to rank these factors as contributing to stress among practitioners based on their impact. Table 1 shows the factors contributing to stress among practitioners. It can be seen that the top three (3) are poor working conditions, work overload, and financial problems, with MIS values of 3.72, 3.72, and 3.64 ranked 1st, 1st, and 3rd, respectively. At the bottom were the domestic problems in the home, overcrowding at work, and divorce are the least prevalent (3) factors, with MIS values of 2.62, 2.44, and 2.36 ranking 10th, 11th, and 12th, respectively. The Table shows that all factors considered were considered medium and low because they fall between the MIS values of 3.72 and 2.36, respectively.

However, a close look at the results in Table 1 shows that all the identified factors contributing to stress among practitioners had an average MIS value of 3.11. This implies that, to a considerable extent, all the 13 factors contributing to stress among practitioners have the tendency to positively affect building projects. The finding of this study here agrees with Okeke *et al.* (2016) and De Silva *et al.* (2017), where it was established that employees usually



feel stressed at their jobs due to work overload, misuse of power, and loud noises generated by machines.

**Table 1: Factors contributing to stress among practitioners in the construction industry**

S/No	Factors	MIS	Rank
1.	poor working conditions	3.72	1
2.	work overload	3.72	1
3.	financial problems	3.64	3
4.	Ambiguity of tasks	3.36	4
5.	behaviour of the leader	3.36	4
6.	Economic uncertainties such as redundancy and downsizings.	3.26	6
7.	Misuse of power	3.18	7
8.	loud noises generated by machines	3.12	8
9.	Role uncertainty by the employee	3.00	9
10.	Advancement in technology	2.62	10
11.	domestic problems in the house	2.62	10
12.	over crowdedness at the workplace	2.44	12
13.	Divorce	2.36	13
	<i>General Average</i>	<i>3.11</i>	

### Measures of Performance of Construction Practitioners

Five (5) measures of performance were identified from literature, and respondents were asked to rank their level of agreement with the identified measures. Table 2 shows the result of the analysis of the measures of performance of construction professional practitioners. Task performance and technical performance are the most commonly used measures of performance for construction professional practitioners in all types of workplaces, with MIS values of 3.80 and 3.76 ranking first and second, respectively. The least used measures of performance are personal performance and social performance, with MIS values of 3.62 and 3.30, ranked 4th and 5th, respectively. Table 2 shows that all the measures of performance of construction professional practitioners had an average MIS value of 3.63. This implies that, to a considerable extent, all 5 identified types of stress were experienced by the respondents.

**Table 2: Measures of Performance of Construction Professional Practitioners**

S/No	Measures of Performance	MIS	Rank
1.	Task performance	3.80	1
2.	Technical Performance	3.76	2
3.	organizational performance	3.68	3

4.	personal performance	3.62	4
5.	Social Performance	3.30	5
<b>General Average</b>		<b>3.63</b>	

### Way by which Stress affect Construction Practitioner's Performance

In order to achieve objective three which is impact factor of stress on construction practitioners' performance) Table 3 shows that the most significant impact factor of stress on a construction practitioner's performance is reduced job satisfaction (mean = 3.90). This was followed by inefficiency in performance (mean = 3.86), absenteeism from work, reduced quality of labour, and absenteeism (mean = 3.82, 3.78, and 3.64). The least rated were creating obstacles for subordinates (3.20) and high worker turnover (2.94).

**Table 3 : Way by which Stress affect Construction Practitioner's Performance**

S/No	Impact factor	MIS	Rank
1.	Reduced job satisfaction	3.90	1
2.	Inefficiency in performance	3.86	1
3.	Absenteeism from work	3.82	3
4.	Reduced quality of labour,	3.78	4
5.	Absenteeism	3.64	4
6.	Wastage of operational resources	3.40	6
7.	Reduced organizational performance	3.24	7
8.	Reduced worker overall performance	3.24	8
9.	Creating obstacles for subordinates	3.20	9
10.	High worker's turnover,	2.94	10
<b>General Average</b>		<b>3.11</b>	

### Impact factor of stress on construction practitioner's performance

**In determine the impact of stress on construction practitioner's performance an null hypothesis was formulated:**

$H_0$ : There is no significant relationship between work stress and Performance of construction practitioners.

$H_1$ : There is a significant relationship between work stress and performance of construction Practitioners'

The responses to the administered questionnaire on question, on stress factors influence on construction practitioner's performance were correlated with the most significant measures of performance of construction professional practitioners (task performance). The analysis of the relationship between work stress and the performance of construction practitioners

revealed that there exists a positive, slightly strong, and significant relationship between work stress and task performance. The result of the Pearson product moment correlation analysis is presented in Table 4. The correlation value was positive and slightly strong (0.393). The correlation was therefore found to be significant at a 1% (0.01) level of significance ( $p = 0.00$ ). Therefore, the alternate hypothesis that states there is a significant relationship between work stress and the performance of construction practitioners was accepted. The relationship between stress and job performance or the impact of occupational stress on performance has been a topic of academic interest over the years. The findings of this study on correlation analysis agree with the findings of other studies where a relation between stress and performance has been proved in various sectors of society, such as the banking industry (Shaik *et al.*, 2013), hospital industry (Nabirye, 2010), hotel industry (Olaniyi, 2013), high-tech industries (Hsieh, Huang, & Su, 2004), business (Dar, Akmal, Naseem, & Khan, 2011) and the educational sector (Riyadi, 2015; Suandi, Ismail, & Othman, 2014).

**Table 4: Results of Pearson Product Correlation Analysis**

<b>Correlations</b>		<b>Work stress</b>	<b>Task performance</b>
Work stress	Pearson Correlation	1	.393**
	Sig. (2-tailed)		.000
	N	200	200
Task performance	Pearson Correlation	.393**	1
	Sig. (2-tailed)	.000	
	N	200	200

\*\* . Correlation is significant at the 0.01 level (2-tailed).

### Conclusions and Recommendations

The results of the analysis carried out led to the conclusions of this study. The study identified poor working conditions and work overload as the most prevalent factors contributing to stress among practitioners. The most significant ways stress impacted on construction practitioner's performance is reduced job satisfaction. Task performance and technical performance are the most commonly used measures of performance for construction professional practitioners. The most effective strategies for mitigating stress among practitioners in the construction industry are: to understand when there is a decrease in performance and absenteeism. Stress usually builds up gradually in a normal situation and more stress causes more problems. There is a significant relationship between work stress and the performance of construction practitioners. Stress has both positive and negative impacts on the performance of professionals in construction.

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**PSYCHOLOGICAL EFFECTS OF OCCUPATIONAL INFORMATION GROUP  
COUNSELING ON CAREER CHOICE AMONG SSS 3 STUDENTS IN FEDERAL  
GOVERNMENT GIRLS' COLLEGE POTISKUM, YOBE STATE**

**Dr. Ahmad Tahir Adamu Koki**

Department of Education  
Faculty of Art and Education  
Yobe State University,  
Potiskum.

**ABSTRACT**

*The study investigate the effects of occupational information group counseling on career choice among senior secondary school students in Federal Government Girls' College, Potiskum. The study has four (4) objectives with one research question and four (4) hypothesis. The research design for the study was quasi- experimental of pre-test, post-test. The population of the study comprises of all senior secondary school students of Federal Government Girls' College Potiskum. A total of one hundred (100) students were randomly selected from senior secondary students (SSS 3). Stratified random sampling was also used to select students offering science, arts, commercial and technical subjects from each department. Vocational Interest Inventory (VII) developed by Bakare (1970) was employed to collect data from the participants. Three stage was used to collect data thus, pre-treatment, treatment and post-treatment stages. The data generated was analysed using t-test and ANCOVA. The findings of the study showed that there was significant difference between students who have received career information group counseling and those who have not ( $t=7.791$ ;  $p<0.05$ ); the effect of occupational information group counseling on career choice does not significantly vary according to the gender of the students ( $t=2.971$ ;  $p<0.05$ ). The effect of career information group counseling on career choice does not significantly vary according to the age of the students ( $t=289$ ;  $p<0.05$ ); there is significant effect of occupational information group counseling on career choice according to the department of the students ( $F=9.03$ ;  $p<0.05$ ). Educational stakeholders should intensify their efforts to organize seminars/ conference on the application of career group counseling as effective intervention toward enhancing career choice among secondary school students; educational planners should introduce vocational education in secondary schools. this is worthwhile because vocational education extends the academic word to the world of work; teachers should emphaise during their lesson, the career implications of the subjects that students will see how individual subjects relate to existing career thus increasing their knowledge of occupation forms part of the recommendations.*

**KEY WORDS:** Effect, Occupational Information, Occupational Information Group, Counselling, Career, Career Choice.

## INTRODUCTION

The use of occupational information is broad in scope. One of the first and a widespread use of it; is in individual or personal decision making. This might involve such matters as choosing a job or career, entering or changing occupations, becoming vocationally rehabilitated (Ebochukwu, 2008). It has been determined that there is a need for continuous exposure of the individual to different types of occupational information throughout the stages of his vocational development and aspiration, the high school student has need for certain accurate and up to date information at this stage of his career in order to make adequate preparation and training for entry-into the world of work (Adisa, 2007). Recognizing this need and the complex occupational demands of our changing society, counsellors in schools throughout Nigeria are increasingly concerning themselves with the dissemination and use of occupational information.

Occupational information is the valid and usable data about positions, jobs and occupations, including duties, requirements for entrance, conditions of work, rewards offered, advancement pattern, existing and predicted supply of and demand for workers, and sources for further information (Akafa, 2011). In the same vein, Ebochukwu, (2008) noted that occupational information is a process which incorporates as many details as possible about the available occupational opportunities meant to help the individual to developed in to it and not only to make an effective career choice but also to adjust to and make success in it. According to Abigail (2019), under a good vocational guidance/careers education, students can be made to understand how beneficial it is to set one's aspiration in accordance with individual abilities and interests. She further notes that a good school program of careers education is of value to the teachers who can be equipped with the necessary skills on how to collect, analyze interpret and present relevant information about occupations to students. Correy (2000) notes that based on the government national policy, vocational guidance or career education should benefit vocational and technical institutions in at least\*two ways: (1) by the provision of careers guidance and counselling service (2) through job placement.

Ready access to usable career information is a crucial component of successful career decision making (Patton & McCrindle 2001). Occupational choice is the right to choose an occupation liberally without demands from external influences. This means that there should be no government conditions on the occupation one chooses to take. Restrictions can however occur on very narrow limits, such as qualifications of the individual (Richie, 2013). In addition, administrators, teachers, and policymakers use occupational information to make decisions about program offerings, curriculum, and resource allocation and about improving linkages with employers (Sommers, 2000). Therefore, there is the need for accessible, accurate, well-

organized information sources and the critical role of practitioners in guiding individuals in the interpretation and use of occupational information.

Family and friends are sources of useful occupational information and also non-college-bound students rely more on social networks than on school-based information services. In particular, parents have an important influence on career choice. However, although parents seem to understand the usefulness of career information sources for their children's career development, many may not know how to take advantage of these resources (Trusty and Watts 1996). Choice of information sources and perception of their usefulness varies depending on such factors as age, gender, socioeconomic status, family circumstances, and cognitive maturity (Jordan and Pope 2001; Patton and Me Crindle 2001; Trusty and Watts 1996).

In order for an individual to choose a proper occupation, he must first have a **true** self-concept and must know the occupations well enough to see if his abilities, interests and personality coincide with those required by the job Kagu (1999). Counsellors and teachers have the responsibility of directing the students in both of these areas. They must realize that job seekers are as important as jobs.

The class itself can be listed as part of the curriculum, or as Akafa, (2011) stated, units of occupational information can be effectively given in a social studies or English class. In this type of situation broad areas of information such as relatedness of families of occupations, the needs and trends of our own community, utilization of man power within the nation, and above all, the relationship of self-understanding and personal characteristics to that of job satisfaction can be discussed, one or two specific occupations could be studied thoroughly to illustrate the use of occupational information.

Administration of the occupational programme has a large part to play in the occupational programme, which is the central figure in the school and this administrative efforts "Will determine to a great extent the effectiveness of the guidance programme, anything that affect the counselling programme as a whole will of course affect the occupational information aspect as well. The facilities of the counsellor and his access to the area containing the occupational information can be of great help or great detriment to counsellors. The principal's selection of a competent counsellor, who is qualified in this area is-important to the programme. According to (Denga, 2001) Interest in the problem arose as the result of the course in Occupational Information which was enrolled in fall of 1967. During the course stress was placed upon securing accurate, up-to date occupational information, devising an adequate method for filing it, and using effective methods for imparting it to the student.

The choice of an occupation in the ever changing, complex society of today is the tremendous task which faces our youth (Abiola, 2014). With some 22,000 occupations from which to choose, it is evident that they need a substantial amount of reliable, up to date occupational information and assistance in relating it to themselves, in order to find their place in the world of work. Patton and McMahon (1997) observed that students are sometimes vulnerable to



unrealistic choice of occupations due to negative parental pressure and peer group influence. Agarwala, (2008) particularly observed that there is the need to expose students to occupational information and help them work towards realistic choice of careers; otherwise their parents and or peers may misguide them. Students are sometimes unable to choose appropriate subject combination that is in consonance with the occupation of their choices due to lack of occupational awareness. Ipaye (1990) observed that:

*"Often students in secondary schools through lack of adequate information fail to take the prerequisite course for their desired occupations. They discover to their dismay that at the completion of secondary education, they are unable to gain entry into appropriate higher educational institutions for skilled training that is necessary for entry into the area of their occupational choice because they were not provided with information on the required subject combinations... these students engage in juggling matches crisis-crossing from one occupation to another and this involves a lot of frustrating experiences ". (P.2)*

It is against this background that the study investigated the effect of Occupational Information Group Counselling on Career choice among SSS 3 students' in Federal Government Girls' College Potiskum, Yobe State.

### **Statement of the Problem**

It is rather very disturbing to note that career choice among secondary school students in FGC Maiduguri has been very poor, there is always a problem for an individual in choosing the right career. Majority of the students choose occupation or career which they have neither natural knowledge nor information about them. This complex problem arises because students are not sure of the occupations that are in line with their capabilities, talents, interest and aptitude and so on. These problems have over the time led students and entire citizenry of the country that constitute the potential labour force of the country to personal dissatisfaction and occupational maladjustment thereby retarding the\* socio-economic development of the country. It is also believed by many that the general laxity to work which may be portrayed by absenteeism, abandoning of duty, discontentment in the job and general labour unrest may be ascribed to the initial ignorance of students in making realistic choice of their occupational aspirations.

The current educational system of Universal Basic Education (U.B.E) provides exit at the senior secondary levels which is a terminal point of the secondary school level and is a crucial point for students. The placement of the students proceeding to the tertiary institutions is done

at the end of SS3. Students may not know the implication of this placement on their future occupational choices if they lack occupational information. Other students who may terminate their studies at this level need occupational information to be able to decide whether to go for skill acquisition or which career to choose in view of their academic qualification. In the absence of occupational information, students are often negatively influenced by their parents and or peer to be able to form the right self-concept.

Conclusively, looking at Super's vocational development theory from **the broad** perspective of self-concept and developmental approaches, occupational information is essential for a realistic choice of occupation. It is against this backdrop that the researcher investigated the effect of occupational information group counselling on career choice among SSS 3 in Federal Government Girls' College Potiskum, Yobe State.

### **Objective of the Study**

The main objective of the study was to examine the effect of occupational information group counselling on career choice among senior secondary school students in Federa Government College Maiduguri while the specific objectives were to determine whether:

1. occupational information group counselling has effect on career choice of students who have received career information group counselling and those who have not in Federal Government Girls' College Potiskum;
2. the effect occupational information group counselling varies according to gender of the students;
3. the effect occupational information group counselling varies according to age of the students'
4. the effect of occupational information group counselling varies according to various discipline, arts, commercial, science and technical of the student

### **Research questions**

To what extent does occupational information group counselling have effect on career choice among students of Federal Government Girls' College Potiskum?

### **Research hypotheses**

The following null hypothesis were tested:

- Hoi: There is no significant difference between students who have received career information group counselling and those who have not
- HO2: The effect of occupational information group counselling on career choice does not significantly vary according to gender
- HO3: The effect of occupational information group counselling on career choice does not significantly vary according to the age of the student

HO4: The effect of occupational information group counselling on career choice does not significantly vary according to the discipline of the students

### **Theoretical Framework**

The study adopts the following theories as a basis for its objectives and literature review and its compatibility in nature.

#### **Frank Parson's Trait factor theory**

This theory, being the first career counselling theory, has been used for a long time. Parsons founded the basis of career counselling by stating that the youth, instead of throwing themselves into a field of study just because of that or because it is easily accessible.

Parsons (1909) proposed that vocational guidance should be based on the three elements. The first is a clear understanding of the individual and her or his abilities, values, interests, ambitions, resources, and personality. For Parsons, this information was typically secured through a clinical interview. The second element is knowledge of the world of work. This includes knowledge of the advantages and disadvantages, compensation, opportunities, and requirements of each occupation. The third essential aspect to trait and factor theory is a rational relationship between the first two elements. By relating an individual's traits to the factors of the occupation, one may make logical decisions about the appropriateness or likely satisfaction of the person within that vocational position.

Parsons identified three elements of career selection, namely: -

(i) A clear understanding of oneself, one's aptitudes, abilities, interests, resources, limitations, and other qualities. The comprehensive knowledge of self is the basis of realizing one's potential and hence a basis for sound career decisions.

(ii) Knowledge of career requirements and conditions, advantages and disadvantages, compensation, opportunities, and prospects in different careers. For any individual choosing a career, there is need to know what career alternatives are available in society and the specific requirements of each. Further, one needs to understand what a career entails, its conditions, and its terms.

(iii) A clear and true reasoning on the relationships between the above two groups of acts, which are personality and working environment. A practice of a career is an interaction of the self and the occupation that one is involved in. When making a career choice one should understand how the two groups of facts will interact to create an enabling environment for him/her and one that encourages optimum productivity and job satisfaction.

Parsons developed counselling interviews and psychometric tests, which collected immense information during the counselling process, and which in turn placed an individual in a particular line of work. The interviews and tests served to discriminate individuals in terms of their values, interests, abilities, aptitude, and personality. Before counselling, an individual

was provided with adequate career exploration. This enabled the individual to make informed decisions about this intended career and this was the precursor to present day career information delivery systems. In combining the knowledge of self and information process, Parsons advocated for the engagement of cognitive processes and analytical skills to bring out the true reasoning on the relationship between the two groups of facts (Patton & McCrindle 2001). The process of matching the self to a suitable career was then not a mechanical exercise, but rather a cognitive and intellectual one.

### **John L. Holland's Theory of Vocational Choice**

Holland's theory based on differential psychology, and though more recent, emphasizes simplicity and practicability in matching an individual to a career. It tries to point out and describe the relationship that exists between an individual and the environment. This theory is based on the following assumptions: -

- The choice of a career is an expression of personality.
- Interest inventories are personality inventories.
- Vocational stereotypes have reliable and important psychological and sociological meanings.
- Members of a vocation have similar personalities and similar histories of personal development.
- Members of a vocation will respond in a similar way to situations and will create characteristic interpersonal environments.
- Vocational satisfaction, stability, and achievement depend on the congruence between one's personality and the environment in the workplace (Gibson & Mitchell, 2003.p 3 1 5).

### **Concept of Guidance and Counselling**

Guidance and Counselling are two inseparable activities that assist individual to identify themselves, their abilities or potentials that will enable them grow well within the environment where they live. The term guidance is like mica that glitters different colours from different angles, depending on the angles one may view it. The definition of guidance is thus, depends on which perspective one may view it. Guidance, to a lay-man is an activity involving assisting, directing, leading, steering, helping or piloting an individual, a person or group of persons, thereby prompting him into action, .behaviour, opinion, and decision that will be of benefit to him. These may be personal, social, moral, emotional, vocational and educational. Conceptually, guidance is a process or service directed towards helping individuals or group to understand themselves and the world they live. Akande (2004), citing Ipaye (1990), posited that guidance is an umbrella which covers all process through which institutions identify and

respond to individual needs of learners that will enable the learners optimally develop their potentials. It is a generic name for all the helping services within educational and community systems.

Like guidance, the term counselling has been variously defined in different ways by various scholars. Whereas some use<sup>1</sup> them as complementary terms, others viewed them as synonymous terms that can be used interchangeably; some explained counselling as a pan or subset of guidance. For example, Ipaye (1990) cited in Akande (2004) explained that counseling is a process and relationship whereby the counselee is being helped by the counsellor to maximize his cognitive and affective living potentials through interpersonal communication. This will assist in creating opportunities and creative environments for the counselee personal vocational, educational and social growth. Durotoye (2002) also viewed counselling as a special form of relationship between two parties, counsellor and counselee in search of clarification of a challenge in which the later, counselje has been entrapped. It is a personal assistance rendered mainly through interpersonal communication whereby the counsellor helps the counselee in achieving adaptive- attitudes and behaviour.

### **Concept of Information and Career**

The concept and practice of work are as old as human civilization. This is because labour is central to human survival. In the past guidance to different professions were often provided by parents, guardians, or friends. Youths were encouraged to enter the profession "Owned" by families and which are jealously guarded and surrounded by secrecy. Even today such attitude to some professions or careers in traditional African-societies, most especially in certain careers such as smiting, traditional medicine, etQ. still remains unchanged.

Nigeria, like other developing countries, is rapidly becoming more industrialised and the society more complex and dynamic than before. As the world of work is becoming more and more automated, it seems wise to encourage young people to work towards professional, semi-professional and technical skills (Abbasi, & Sarwat, 2014). Automation has brought increasing specialization into work and job, classification, creating a condition that emphasizes the new highly trained working class.

Career can be defined as one's profession or work which he does to earn a living; it involves a sequence of jobs positions or occupations engaged in the life of an individual.

According to Abbasi, and Sarwat, (2014) career is used to refer to "a person's total life pattern. which will include both work and non-work factors." Oladele (2007) defines career as "a chosen pursuit, life work, success in one's profession." From the above definitions a career is the totality of what one does in his life time, it is a profession on a person's working life usually pursued over a period of time (Super 1974:72). It involves a sequence of-jobs, Position or occupation engaged in the life of an individual.

Information is an item of knowledge, which can be communicated concerning some particular fact, subject or event. An information service is an essential element of guidance service. Aguado, Laguador and Deligero, (2015) identified three major reasons why information services are vital in the school guidance programme. Firstly, information service is fundamental if students are to be equipped with basic knowledge needed to think through important issues such as education, choice of occupation and maintenance of individuality. Thus, the goal of information, is to impart information and to stimulate students to critically appraise ideas, conditions, and trends in order to derive personal meanings and implications for the present and future. Becoming a functional member of the society requires that the individual seek out, recognize, and use all relevant information necessary for his development.

## **METHODOLOGY**

The design for this study was quasi-experimental design which is in a better position to examine the effectiveness of occupational information on career choice among Senior Secondary School students in Federal Government Girls' College Potiskum using group Counselling approach. According to Ali (2006), Quasi-experimental research design could be used in a school setting where it is not always possible to use pure experimental and control group. The experimental group will be given treatment design which is considered as disruption of school activities. Therefore, quasi-experimental is more suitable for the study because subjects were randomly assigned to groups namely through group counselling techniques, while the placebo control group will be given another or no treatment after which the two groups will be measured.

### **Population and Sample**

The population of the study comprise of all senior students in Federal Government Girls' College Potiskum. A total of one hundred students were randomly selected from Senior Secondary (SS3) students. Stratified random sampling was also used to select students offering Science, Arts, Commercial and Technical subjects. From each department 25 students were selected. As Kerlinger (1993) stated that "Experimental studies does not need large Sample for purpose of adequate attention to the treated group members, even ten subjects properly monitored is enough.

The subjects were randomly assigned to experimental and control groups respectively. The control group comprised of 25 students each for the arts, science, commercial, and technical subjects and were given placebo treatment.

The instrument used for the study was Vocational Interest Inventory (VII) developed by Professor Bakare in 1970 on occupational information for Secondary School students. The Vocational Interest Inventory is designed in a statement form and takes care of ten vocational interest areas. The instrument is used to assess student's career choice and has been used

widely in Nigeria to assess career choice among Secondary School students. The instrument has reliability of .76 according to the author. Similarly, permission was obtained from Professor Bakare's family to make use of the research instrument for this study.

The procedure for data collection covered the following stages:

### **Stage I: Pre-treatment Stage**

A pre-test which consisted of completion of vocational interest inventory consisting of 10 statements in each of the 10 interest areas, with a highest point of 50 scores and the lowest point 1 of 10 and the Jefferson test on occupational information for Secondary Schools which contained 20 items with a maximum scores of 20 and minimum scores of 0 will be administered to both the control and the experimental groups, to ascertain that the two groups were the same in their knowledge of occupational information and career choice and hence comparable for an experimental study.

### **Stage II: Treatment Stage**

The experimental group will be exposed to occupational information based on the following as expressed by Jefferson (1993).

- i. Subject combinations leading to different careers
- ii. Entry qualification into course leading to specific occupations and careers
- iii. Universities and other institutions offering such courses
- iv. Career opportunities

These areas were deliberated upon during the twelve group counselling sessions which lasted for a period of six weeks. Research assistants were employed to monitor the groups. This prevented any contamination between the experimental and the control groups during the period of study.

### **Stage III: Post-Treatment Stage**

After the treatment, Vocational Interest Inventory and Jefferson Test on Occupational information were administered to both the experimental and the control groups. The scores obtained at the pre-treatment test and the post-treatment test were compared to find out if differences exist between the responses of the two groups based on the occupational inclination provided by the researcher during the treatment stage.

### **Stage IV: Delayed Post-Treatment Test**

The Vocational Interest Inventory and Jefferson Test in Occupational Information were again administered after one month to ascertain that the results obtained at the post-treatment test were not due to chance but as a result of the treatment. This had help the researcher to know that the treatment administered had a permanent effect on the experimental group.

The data collected were calculated through the Microsoft Excel worksheet 2010, the pre-treatment test, post-treatment test and delayed post-treatment test was subjected to initial descriptive statistics of mean and standard deviation in analysing the data to answer research question, and later inferential statistic T-test and ANCOVA was used in testing hypotheses.

## RESULTS AND DISCUSSION

### Data Analysis and Presentation of Results

The data collected were analyzed and results presented in accordance with the research question and hypo theses earlier raised

#### Demographic characteristic of the respondents

**Table1: Demographic Characteristic of the Respondents Based on Gender**

Gender	Frequency	Percent	Valid Percent	Cumulative Percent
Female	50	50	50	50.00
Male	50	50	50	100.00
Total	100	100	100	

The table 1 above showed that 50% of the respondents were Female and 50% were male

**Table 2: Demographic Characteristic of the Respondents Based on Age**

Age	Frequency	Percent	Valid Percent	Cumulative Percent
16 – 19	65	65.0	65.0	65.0
20 and above	25	25.0	25.0	100.00
Total	100	100.0	100.0	

The table 2 above showed feat 65.0% of the respondents were between 16-19 years of age, 35.0% were between 20-above years.

**Table 3: Demographic Characteristic of the Respondents Based on Department**

Department	Frequency	Percent	Valid Percent	Cumulative Percent
Science	25	25.0	25.0	25.0
Arts	20	20.0	20.0	45.0
Technical	25	25.0	25.0	70.0
Commercial	30	30.0	30.0	100.0
Total	100	100	100	



The table 3 above showed that 25.0% of the respondents were in Science department, 20.0% were in Arts department, 25.0% were in Technical department and 30.0% were in Commercial department.

**H0<sub>1</sub>:** There is no significant difference between students who have received career information group counselling and those who have not

**Table 4: Paired Sample test between students' who have received career information group**

Group	N	$\bar{X}$	SD	Df	t-cal	p-value	Decision
Experimental Group	100	35.8400	6.92196	99	7.791*	.0000	Reject H0 <sub>1</sub>
Control Group	100	28.1900	7.15725				

\* Significant at  $p < 0.05$

Result in table 4 above presented the Paired Sample test between students' **who have** received career information group counselling and those who have not result showed that there significant difference between students who have received career information group counselling and those who have not ( $t = 7.791$ ;  $p < 0.05$ ). The (-calculated is 7.791 with degree of freedom 99 computed at level of significance of 0.05. This indicates that, there is significant difference between students who have received career information group counselling and those who have not. Hence, the null hypothesis which stated that, there is no significant difference **between** students who have received career information group counselling and those who have not is hereby rejected.

**H0<sub>2</sub>:** The effect of occupational information group counselling on career choicp does not significantly vary according to gender

**Table 5: Independent Sample t-test on Effect of Career information Group Counselling according to Gender of the students'**

Gender	N	$\bar{X}$	SD	Df	t-cal	p-value	Decision
Male	50	37.8200	6.47346	98	2.971*	.004	Reject H0 <sub>2</sub>
Female	50	33.8600	6.84824				

\* Significant at  $p < 0.05$

Result in table 5 above presented the independent sample t-test between male and female students' expose to occupational information group counselling on career choice, the result showed that there is significant difference between male and female students' ( $t = 2.971$ ;  $p < 0.05$ ). The t-calculated is 2.971 with degree of freedom 98 computed at level of significance of 0.05. This indicates that, there is significant difference between male and female students

who have received career information group counselling. Hence, the null hypothesis which stated that, the effect of occupational information group counselling on career choice does not significantly vary according to gender is hereby rejected.

**H<sub>03</sub>:** The effect of occupational information group counselling on career choice does not significantly vary according to the age of the student

Table 6: Independent Sample t-test on Effect of Career Information Group Counselling according to age of the students'

Age	N	$\bar{X}$	SD	Df	t-cal	p-value	Decision
16 – 19 years	65	35.6923	6.67065	98	-289	.773	Accept H <sub>03</sub>
20-above years	35	36.1143	7.45879				

Result in able 6 above presented the independent sample t-test according to the age of the students' expose to occupational information group counselling on career choice, the result showed that there is no significant difference in occupational information group counselling on career choice according to the age of the students's ( $t = -289$ ;  $p > 0.05$ ). The t-calculated is -289 with degree of freedom 98 computed at level of significance of 0.05. This indicates that, there is no significant difference on career information group counselling on career choice of students' according to age. Hence, the null hypothesis which stated that, the effect of occupational information group counselling on career choice does not significantly vary according to the age of the student is hereby accepted.

**H<sub>04</sub>:** The effect of occupational information group counselling on career choice does not significantly vary according to the discipline of the students

Table 7: Analysis of Variance for the significant effect in the mean score of students' expose to occupational information group counselling on career choice according to department

Source	Type III sum of Squares	df	Mean square	F	Sig.
Corrected Model	400.288	1	400.288	9.032	.003
Intercept	16255.169	1	16255.169	366.786	.000
Department	400.288	1	400.288	9.032	.003
Post-test	.000	0			
Error	4343.152	98	44.318		
Total	133194.000	100			
Corrected total	4743.440	99			

a. R Squared = 054 (Adjusted **R Squared** = .075)

Result in table 7 above shows the null hypothesis which state that the effect of occupational information group counselling on career choice does not significantly vary according to the

discipline of the students is rejected since the table show the F-value of 9.032 and the P-value of .003 which is less than the 0.05. This indicates that the null hypothesis is hereby rejected. Thus, the researcher upholds that there is significant effect of occupational information group counselling on career choice according to the department of the student.

### **Discussion**

The result of research hypothesis one shows that there is a significant difference between students who have received career information group counselling and those who have not. The finding has agreed with the previous studies of Joseph and OLu, (2017); Joyce and Lydia (2011); Anisa (2010) that there is significant influence of career counselling on career aspirations of secondary school students. This means that the goal of a career information guidance program is to provide student with the tools to integrate awareness about themselves, potential careers, and post-secondary education into informed decisions about their future. Therefore, career interventions need to be comprehensive and flexible to meet a wide range of changing career developmental needs, especially when working with adolescents. Career counselling in groups provides students the opportunity to explore personal issues related to career development, to reflect upon and personalize information they have received, and to apply their findings to their education and career plans (Bills 2004). The finding was also in line with the previous studies of O'Reilly, (2001); Sommers (2000) Bibatunde (2017); Babatunde (2018) whose findings reveals that group career counselling provides a number of specific advantages including cost and time effectiveness, increased opportunities for personalized feedback, augmentation of career counselling outcomes, decreased sense of isolation, promotion of affective and cognitive learning experiences, and increased member self-exploration. Career group counselling provide individuals with the opportunity to learn information about themselves and acquire knowledge and skills about the occupational decision-making process. In addition, the students' determined that the group members learned skills which will help them cope with other transitions and decisions regarding career throughout their lives. Similarly, the students' believed that the group career counselling affected the members outside of their career life and were able to apply the experience to other aspects of their life.

The second research hypothesis also reveals that, the effect of occupational information group counselling on career choice was significantly varied according to gender. The finding was in agreement with the previous findings of Babatunde (2017) that gender differences are not biological, but rather are due to socialization and discrimination. Literature portrays the historic and contemporary stereotyping of women rightfully belongs only to the home, should only work in teaching, nursing or secretarial profession, are not good bosses, are absent from work more frequently than men, become emotionally in crisis situation. Traditional beliefs once entrenched in an individual's belief system will shape his/her way of looking at the world,

the career opportunities available, as well as personal vocational aspirations, drives and efforts. Career interests and awareness have sex differences but these differences may be more due to socialisation rather than biological influences. However, there is evidence to the effect that levels of sex-based hormones such as testosterone as well as personality types such as neuroticism may be responsible for differences in career choice. Most women tend to be social and artistic, unlike men who tend to be investigative (Bradley, 2007). Men and women tend to be geared towards very different occupations, and there exists a lot of segregation in the workforce. There is also an indication that men and women value different aspects of work and therefore, make different career choices, as a result of formed occupational preferences. There are observable gender differences in the way students perceive their academic and social self-efficacy beliefs. Female students have a higher sense of efficacy and are more resistant to peer pressure than males, and this leads to higher career choice among girls. The higher sense of self-efficacy beliefs also leads to more control in females and this contributes to inhibit depression among girls (Joyce & Lydia, 2011). The belief that young girls are less useful than boys in carrying the name of the family similarly affects their career choice.

The third hypothesis also reveals that the effect of occupational information group counselling on career choice does not significantly vary according to the age of the student. The result is in consonance with the previous study of Joseph and Olu, (2017) that the age of the adolescent has implication for choosing a career. They posit that careers should be introduced to children in their early teen i.e. age 13 or 14 years. Career decisions at this time are very temporary and unrealistic. Most often, the potential of the child cannot yet be ascertained. It is still a time of career illusion and uncertainties. The usefulness of the career information at this period can only be for both awareness and counseling. It could be for helping the young adolescent to begin to have a focus for the future career he may like to engage in, and the various prerequisite qualifications for them. The age range of 13 to 14 years is a period when the child is just graduating from fantasies to the tentative period of realities. The actual age of reality begins at about age 15 years as far as careers are concerned. These days in Nigeria, especially the Southwestern parts, children in the school certificate class are on the average age of 16 years. It means students mature earlier for decision making since many of them transit into the tertiary institutions almost immediately after writing their secondary school final examinations. This presupposes that they have to take career decisions earlier than expected. This is a clear case for career counseling at about age 13 to 14 years. It is a good time to sharpen a child's perspective in respect of what the world of work portends for their future. It is a time to start thinking of what one loves to do and how to get started. The result of the fourth hypothesis also reveals that, the effect of occupational information group counselling on career choice was significantly varied according to the discipline of the students. This is therefore explaining the notion that right career choice for the students entering into the professional education (discipline) is critical having high impact on their professional life and future achievement.

This is because it is the turning point: it cannot be left, on intuition, preconceived notions, wild imaginations or popular concepts. A miss-perceived career choice directs all individual efforts and resources into wrong direction, when not aligned with the expectations; would not only be frustrating rather draining of the individual energy and wastage of resources. The re-alignment is possible, but it has serious implications in terms of time, money and motivation. The career choice of the students must need to be based on; strong knowledge, complete information, and appropriately guided, matching individual personality type and other intrinsic and extrinsic factors. The students need to be oriented on new emerging trends, future opportunities and challenges in the context of career choice options into a particular department.

### Recommendations

Based on the findings and the conclusions drawn, the following recommendations were made:

1. Educational stakeholders should intensify their effort to organize seminars/conferences on the implications of career information group counselling as effective interventions towards enhancing career choice among senior secondary school students.
2. Education planners should introduce vocational education in secondary schools. This is worthwhile because vocational education extends the academic world to the world of work. '
3. Teachers should emphasis during their lesson, the career implications of subjects so that student will see how individual subjects relate to existing careers thus increasing their knowledge of occupations.
4. Teachers and other stakeholders in the school system are to be trained on how to handle the case of students without gender bias. This will serve as collaborative efforts to assist the students in overcoming the challenges of low career choice irrespective of gender make-up.
5. The students in the school should be encouraged and trained on the effective usage of these interventions (career information group counselling). This will make the students to adopt effective attitude towards enhancing their career choice.

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## **ASSESSMENT OF NUPE CULTURAL FEATURES IN A MULTIMEDIA STUDIO IN BIDA, NIGER STATE.**

**Jiya John NINMA**

Department of Architecture,  
School of environmental technology,  
Federal University of Technology Minna,  
Niger state.

**Charles MAKUN**

Department of Architecture,  
School of environmental technology,  
Federal University of Technology Minna,  
Niger state.

### **Abstract**

The constant evolution of culture has created new hybrids between art, film, media, advertising, journalism, architecture, and many other spheres that have an impact on human culture. These hybrids sometimes call for a paradigm shift or at least challenge our cultural philosophies or ideologies. As a result of technological transformation through industrialization, most public buildings in Nigeria are beginning to lack its indigenous Architecture within their cultural context. In addition, Studies have shown that most public buildings in Nigeria are lacking indigenous people's spatial needs and cultural values and they are profound among the minority ethnic groups. As such, a public building such as a media house ought to reflect the culture of its location. This study focuses on evaluating the application of Nupe cultural features in the design of a multimedia studio in Bida. Media houses were selected randomly in Bida, Niger state to know how modernization has influenced the rich culture of the Nupe people. The research method employed in this study is the qualitative research method and the process of observation has been employed for gathering data. An observation schedule was used as an instrument for data collection and these data were sampled using the non-random sampling method. These data were analyzed through content analysis and the findings showed that the cultural feature has not been properly adopted in multimedia designs. The study concludes that a public building such as a media house should reflect the culture of its location and this can be achieved by prioritizing cultural artistic inputs on building by professionals and by extension, promoting the culture and art of its people.

**KEYWORDS:** Nupe cultural features, Hybrids, Public building, Multimedia.

## INTRODUCTION

Cities like Barcelona, Prague, Timbuktu, and Cairo are home to magnificent architectural masterpieces steeped in culture and history (Alitheia capital, 2011). In these cities as with many others, a connection exists between building form and art from the classical tradition to the energetic and spontaneous modern art. Each movement is interpreted through paintings, sculptures, and works of architecture (Arts or The Western World, n.d.). These works of architecture, often more visible in public buildings (temples, courthouses, palaces, and civic centres), reflect the connection between the traditional architecture of centuries past and today's postmodern forms, enhancing the character and heritage of these cities and making their indigenous architecture a national symbol. Culture symbolises the structures and understanding of a specific group of people, integrating linguistic similarities, beliefs, food, collective habits, songs, and arts. (Zimmerman, 2017)

Generally, Media provides an outlet for the discussion of important issues, acts as a watchdog for government, business, and other institutions, and acts as an entertainment outlet, education, and information (University of Minnesota library, 2016). The platforms available for mass media includes newspapers, radio, newspaper, magazines, books, video games, and internet media which includes blogs, podcasts, and video sharing (university of Minnesota library, 2016). All the platforms are being used by every sector of an economy all over the globe. Over time, media has affected the way we relate socially, economically and politically. In other words, we can say that the media affects our cultural values because they affect how we live and interact. It is therefore of interest to investigate and understand why indigenous architecture recognized through architectural styles, elements and building techniques which once existed from cultural and historical influences is almost extinct in Nigeria. The majority of today's building stock, especially in urban areas, are merely "functional" buildings with no reflection of the socio-cultural past. Before the coming of colonialism throughout African countries, the indigenous building forms and styles were largely a product of their environment and socio-cultural activities (Osasona, 2019). We adopted the building forms and styles and neglected our cultural values. There is a need for strategies on how cultural values can be restored through the media by architecture. Thus, the study seeks to examine the cultural features of media houses in Nigeria.

## LITERATURE REVIEW

### Concept and Definitions of Culture

Liman (2016) defined culture as the total of everything that contributes to the formation of practical, physical, and mental dimensions of a people's way of life. Muhammad (2015) on the hand believes culture encompasses social relations, and an unending past of shared relationships of individuals living within a communal environment. Atik *et.al* (2017) went further to state that culture is an intricate factor that includes awareness, trust, arts, ethics



customs, and somewhat other competencies and conducts acquired by man as an associate of the social order. When all these definitions are analysed one, begins to see those cultural considerations do not stop at social gatherings, dancing, and singing but a conscious way to shape the environment within a society for the use of man to achieve comfort while enjoying these activities therefore leading to a need to plan these places of comfort for optimum enjoyment.

### **Elements of Culture**

Lee (2016) states that language, Signs, symbols, values, norms, and social control within a society are those elements that make up culture, agreeing with this while exploring further, Franke *et.al* (2017) further posited that elements of culture refer to apparatuses, artifacts, skill, semantic, faith, learning, outlooks, ethics and social organization that make up a group. Brown (2018) on the other hand views elements of culture as beliefs, attitudes, artifacts, design, storytelling, rites, and symbolic actions. John (2016), Lee (2016), and Franke *et.al* (2017) all agree that elements of culture can be categorically grouped into Material / Non-material and primary and minor elements.

### **Material and non-material elements of culture**

Scarpaci (2016) enthused that material culture refers to the human items, possessions, and places that individuals adopt to explain preferences from others in a cultured way. They may comprise homes, localities, capitals, colleges, cathedrals, local communes, sanctuaries, masjids, places of work, workshops and plants, tools, means of production, goods, and products. Visible sides of a culture expose its members' behaviours and view it elaborates on the ways that individuals within a certain society view and interact with that society (John, 2016). Idang, (2015), Teles da-Silva, and Farbiaz (2017) further postulate that certain things can be recognized as cultural elements only when those items have successfully given relevance to an aspect widely believed to affect the lives of individuals within a community. For example, when a rock situated in a field has no worth when converted into materials that can build a home, office, or fence. Material culture plays a significant role in architecture as it helps the architect to define, regulate and shape the design process according to the influences of the material elements within his disposal.

Non-material culture refers to items, which are divine ideas that people have about their culture, including beliefs, values, rules, norms, morals, language, organizations, and institutions (Kaur and Kaur, 2016). Most times the non-material cultural concept goads toward religion, which consists of a set of ideas and beliefs about God, worship, morals, and ethics (Hicks and Beaudry, 2010). These beliefs would normally determine how people and the cultural practices within that society respond to its religious topics, issues, and events.

### **Concept of Cultural Identity**

Identity comprehensively explains how other people within a social space can view someone. Hence, identity is all the qualities, beliefs, and ideas, which differentiate someone from another in a particular group (Madan, 2006). Some definitions of cultural identity have placed the burden of identification on the state but (Hyenen, 2009, Hyett, 2011, Rapaport and Duncan 2012) all agree that to appropriately define cultural identity the condition for identification should be the common factors within the community that binds these group of people making them recognizable as one group or another. Koivunen and Marsio, (2007) view cultural identity as the link between an individual and the public. Hayrynen (2007) agreeing with this definition elaborated further that cultural identity encompasses evident, unseen, and anticipated cultural behaviors characteristic to a particular group, which might spur a person's sensitive capabilities and behavior.

### **Role of architecture in cultural identity**

There has to be an equilibrium between stability and break such as to permit the people to engross new advances and new demands without suffering from identity diffusion (Vale, 2012). While Bloom (2010), Rapoport and Duncan (2012) believe the made surroundings, can act as a tool to reflect cultural identity by adopting new technologies and developments Hetherington, (2017) prefers the society to have a fluid changing structure that is less impacted by the advent of new technologies and developments.

### **Integrating cultural identity in architecture**

Building patterns, settlement arrangements, and social gathering activities are major considerations, which shape elements used in integrating cultural identity in architecture (Mangena, 2010). Likewise, a variety of factors are known to influence that contribute to the architecture of cultures such as weather, food, and language, these factors have undergone variations creating a heritage that continue to give a more developed architectural system. Dana, (2012) rightly opined that; design has become the essence to portray ideas, and driving origination and originality to achieve cultural identity.

Architecture on the other hand is one of the means of cultural integration, achieved through designing buildings that have cultural elements reflected on them. Architecture as a means of cultural integration has adjusted more openly and speedily to variations in the world around, (Ozorhon, 2016).

Integrating cultural identity in contemporary architecture can be achieved in multifaceted ways but a prominent method is utilizing elements from traditional architecture such as the forms prominent within the people in constructing individual buildings, building materials used in such construction, and the method or pattern of roof adopted in covering the building (Asfour, 2016). Boussa, (2017) also highlights that other means include borrowing from traditional

architecture in the form of bringing to prominence historical events such as wars and arts and telling the story by painting it or making motifs of these events on the walls of the cultural centres.

### **Nupe Cultural Features**

According to isa et. al; (2015), The basic structure of the Nupe compounds is made up of several small individual courtyard units which are linked up together by alleys. A typical compound is made up entrance hut (*katamba*), sleeping rooms (*kata*), the courtyard, (*zhempa*), the animal pen (*ega*), the granaries (*edo*), the kitchen (*katagi*), the hearth (*yekun*) and the toilets and baths (*shikpata*). However, each culture has what it emphasizes as the basic requirement for fulfilling their daily spatial transaction.

The Nupe are prolific decorators, indeed! Not only does the scope of what engages their creative attention include structures not normally classified as “architecture” (e.g. granaries), it also encompasses wall openings, structural posts, and accessories like doors and windows. As with the Hausa, door and window openings are reinforced with earth moldings. These are further embellished with terracotta platelets – *giama tetengi* (Dmochowski [7]). The elaborate, generally unpainted, relief mural (both geometric and zoomorphic in motif, despite Islam being the predominant religion here, too) is hardened by the use of an infusion from locust-bean pods. (Denyer 1978). This sculptural treatment of walls is not limited to exteriors, alone: interiors – particularly wives' rooms and inner walls of encircling verandas – are similarly treated. Rooms invariably have the added dimension of enamel and porcelain plates and dishes being embedded in them. According to Osasona (2007), a particular house at Zanchita, near Bida, sports such embedded crockery around the entrance to its *katamba* (the reception-hut). Apart from the aspect of masonry sporting artwork, Nupe houses on a circular floor-plan could also display artistic ingenuity, within their formal configuration: the roof junction – an area of potential structural stress – in the process of being secured against structural failure, is usually also imbued with some form of ornamentation. Where a wooden plug is used to stabilize the junction, it could be carved – and used in conjunction with interesting weave-patterns of the thatch brought together at that point; alternatively, a terracotta pot – with surface incisions and other beautifying engravings – could be placed upside-down over the junction, to prevent rain-water seepage.

Complementing all other artistic endeavors already discussed, the Nupe also have recourse to the use of colour, the prevalent ones being black, red, and, more lately, white (Dmochowski 1990).

These pigments are traditionally sourced from various plant extracts, earth, and animal deposits.

## **METHODOLOGY**

### **Research method**

The research method employed in this research is the qualitative research method. A descriptive research design is employed which is a scientific method that can be used in observing and describing the nature of a subject.

The first phase included a desk study of relevant materials on cultural development. Thereafter, the research adopted a primary source of data collection for the case study stage. This includes the derivation of first-hand information with data obtained through physical observation. The researcher for the physical observation and extraction of data developed an observation guide. This was structured to enable the researcher to collect relevant information for analysis. Desk study for the research covers the review of relevant literature, reports, journals, and manuals by security bodies as well as literary works from experts on culture. Elements considered in structuring the observation guide are shown in the table below.

Table 1: Variables used in assessing the Case Studies

Source: Author, (2022)

S/N	PARAMETERS
1	Form of building.
2	Concept adopted.
3	Methods adopted in exhibiting the culture of the place
4	Building materials used.
5	Accessibility to the cultural centre.

A no-random sampling technique was adopted in this study, which involves the intentional selection of specific samples relevant to the subject of judgement. These samples were selected to be subjected to observation by the researcher in line with the drafted observation schedule in order to extract information relevant to this study. The following are the listed samples selected to be observed as shown in table 2 below.

Table 2: list of sample media houses

Source: Author, (2022)

S/N	PARAMETERS
1	Newsline printing press, minna
2	New Nigeria newspaper, kaduna
3	Nigeria television authority minna
4	Search fm 92.3 minna
5	Softcom head office, lagos

<b>6</b>	Heigdain world studio, Zhejiang china.
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## DATA ANALYSIS

### BUILDING FORM

The building forms involve the shape and configuration of a building on site. The media centers observed showed that the building forms used in the designs were all rectangular as shown in Table 1 and Figure 1 respectively.

Table 3: list of sample media houses

Names	Present	Absent
Newsline printing press	<input type="checkbox"/>	
New Nigeria newspaper	<input type="checkbox"/>	
Heigdain world studio	<input type="checkbox"/>	
Nigeria television authority	<input type="checkbox"/>	
Search fm 92.3 minna	<input type="checkbox"/>	
Softcom head office	<input type="checkbox"/>	

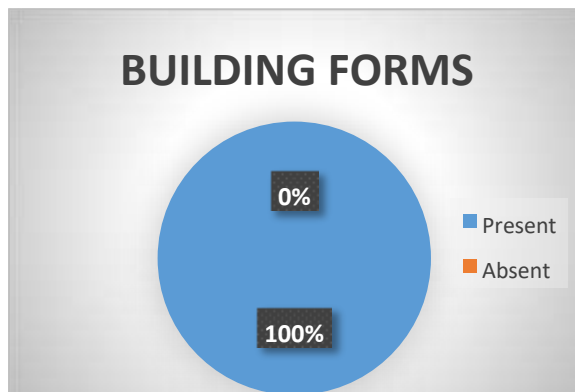


Figure 1: building form within the observed media houses.

### CONCEPT ADOPTED.

Zeyayther and Mansour, (2017) on their part postulate that concept involves the presentation of an idea in a simple and logical order. The table and figure below shows that there were no defined concept used in the designs

Table 4: list of sample media houses

Names	Present	Absent
Newsline printing press		<input type="checkbox"/>
New Nigeria newspaper		<input type="checkbox"/>

Heigdain world studio	<input type="checkbox"/>	
Nigeria television authority		<input type="checkbox"/>
Search fm 92.3 minna		<input type="checkbox"/>
Softcom head office	<input type="checkbox"/>	

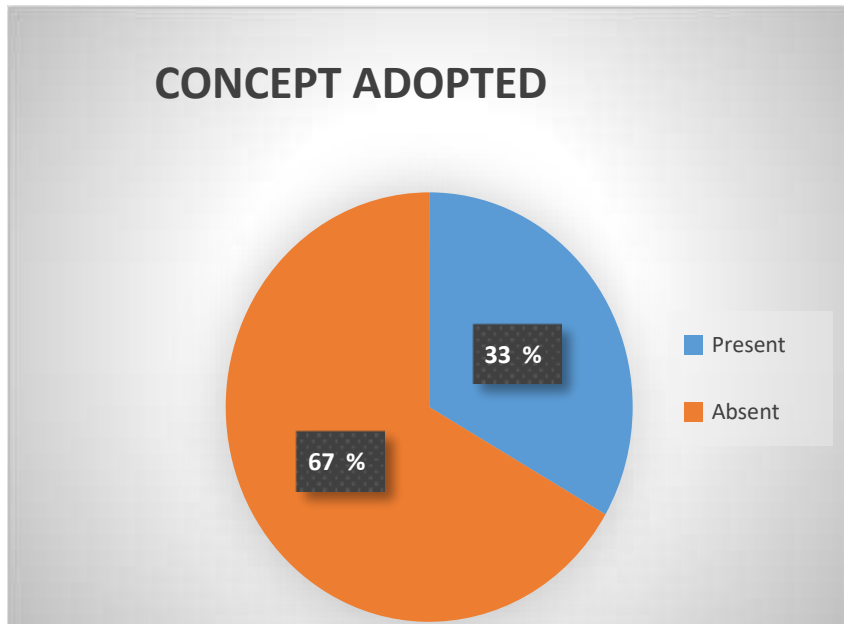


Figure 2: Building concept within the observed media houses.

#### **METHODS ADOPTED IN EXHIBITING THE CULTURE OF THE PLACE**

The cultural method adopted entails the cultural identity adopted. The table and chart below show that 67% of the buildings observed adopted the cultural identity of their location.

Table 5: list of sample media houses

Names	Present	Absent
Newslines printing press		<input type="checkbox"/>
New Nigeria newspaper	<input type="checkbox"/>	
Heigdain world studio		<input type="checkbox"/>
Nigeria television authority	<input type="checkbox"/>	
Search fm 92.3 minna	<input type="checkbox"/>	
Softcom head office	<input type="checkbox"/>	

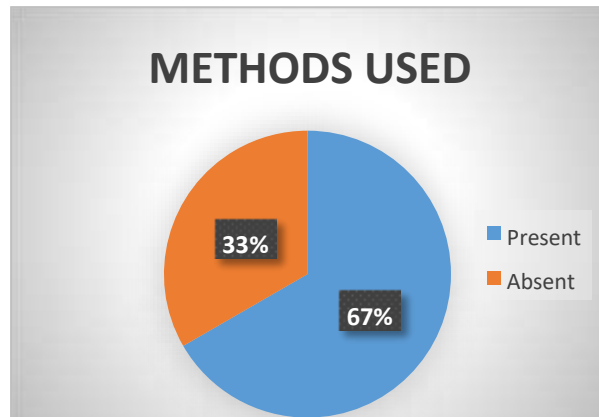


Figure 3: Building concept within the observed media houses.

**BUILDING MATERIALS USED.**

Building materials are the materials used in the construction of a building. The media house observed showed that 67% of buildings lack the usage of building material of the location. Contemporary building materials were used for construction.

Table 6: list of sample media houses

Names	Present	Absent
Newsline printing press		<input type="checkbox"/>
New Nigeria newspaper		<input type="checkbox"/>
Heigdain world studio		<input type="checkbox"/>
Nigeria television authority	<input type="checkbox"/>	
Search fm 92.3 minna		<input type="checkbox"/>
Softcom head office	<input type="checkbox"/>	

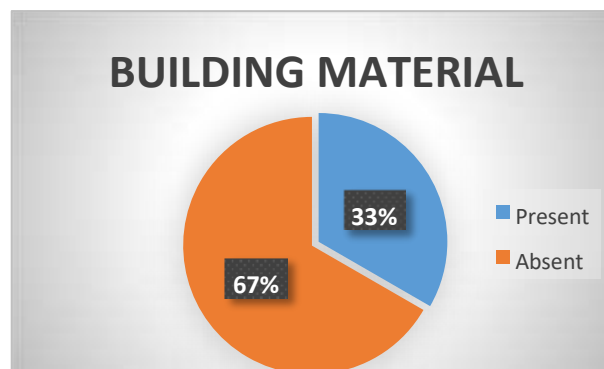


Figure 4: building materials used.

### ACCESSIBILITY TO THE CULTURAL CENTRE.

Accessibility involves the proximity of the building to people and how they can easily gain access it. It is noticed that the buildings shown in the table and chart below are quite accessible.

Table 7: list of sample media houses

Names	Present	Absent
Newsline printing press	<input type="checkbox"/>	
New Nigeria newspaper	<input type="checkbox"/>	
Heigdain world studio	<input type="checkbox"/>	
Nigeria television authority	<input type="checkbox"/>	
Search fm 92.3 minna	<input type="checkbox"/>	
Softcom head office	<input type="checkbox"/>	

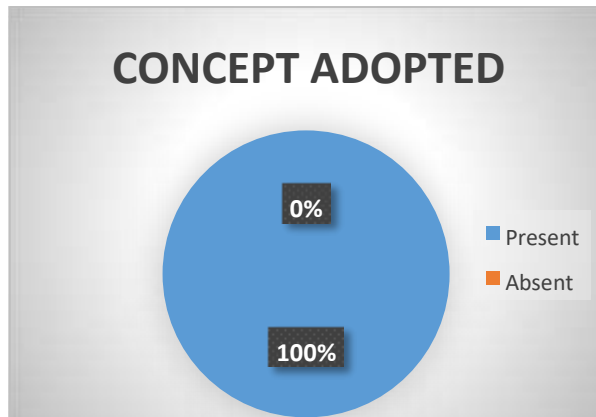


Figure 5: building materials used.

### FINDINGS

Case studies undertaken within Nigeria and other countries showed that cultural identity can be achieved in architectural proposals by adopting cultural elements such as decorations on walls i.e. motifs, symbols in the form of conceptual adoption, and building materials from the area's traditional architecture and methods of construction.

The study concluded that strategies, which can be adopted by architects to express cultural identity in their work, include integrating popular elements of the place under study. For the Nupe people, these include the circular and rectangular house form, the use of local building materials and construction techniques, the masks popular amongst the local traditions, the tribal masks and murals, and paintings on walls seen in one of the gates to the entrance of a traditional ruler.



## CONCLUSION AND RECOMMENDATIONS

It is the view of this research that the following recommendations if properly adhered to can help to develop a cultural center with a properly infused identity of the place they are to be located. I) Architects should as the case of professionalism investigate and explore the cultural elements of the place in which they intend to propose to appropriately understand and portray the culture of the place.

- Every culture should be encouraged to develop, research, and document all aspects of its culture to guide against loss of cultural identity and set a standard that can be referred to by future generations.
- Media centre which remains a place of enlightenment, and social interaction while serving as a media centre should exhibit on its façade aspects of the architecture of the past and present so that it serves as a constant reminder to the people of their culture and cultural identity.
- Cultural studies should be encouraged from the start of architecture programs in higher institutions of learning in the form of compulsory electives and group studio works to have a pool of knowledge amongst training architects who already are knowledgeable about requirements for culturally related designs.

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## MICROBIAL QUALITY OF CASSAVA AND MAIZE FLOURS SOLD WITHIN BAUCHI METROPOLIS

**Ebu Bridget\***,

Department of Science Laboratory Technology,  
Federal Polytechnic Bauchi,  
Bauchi State, Nigeria

**Ogbeba Jeremiah**

Department of Science Laboratory Technology,  
Federal Polytechnic Bauchi,  
Bauchi State, Nigeria

**Yakubu Dauda Abubakar**

Department of Science Laboratory Technology,  
Federal Polytechnic Bauchi,  
Bauchi State, Nigeria

### ABSTRACT

Cassava and maize flours are the end products obtained from a processed food crops of Cassava and maize. Both crops constitute an economically important staple food in tropical and subtropical region of the world especially in Nigeria in which it is used in various form. Microorganisms could be associated with these products at any stage in its growth, from seeding or planting stage through post-harvest and also in terms of processing and handling. Some of these microorganisms are potential pathogens which may be detrimental and constitute health hazard to consumers. Hence the aim of this work is to investigation the microbial quality of cassava and maize flour sold within Bauchi metropolis. Flour samples were collected from muda lawal market and isolates of the organisms were obtained using serial dilution, plated on duplicate plates using the pour plate method. Developed colonies were identified based on colonial morphology, microscopy on Gram's staining and biochemical reactions on indole, oxidase, nitrate, citrate, and sugar test. The result obtained revealed the presence of the following microorganisms (Staphylococcus spp, Bacillus spp, micrococcus spp, clostridium spp, Penicillium spp, and Aspergillus spp. The sample showed a total microbial count of  $2.2 \times 10^4$  and  $3.6 \times 10^4$  cfu/ml for cassava and maize respectively. Therefore, the practices of basic sanitary rules of hygiene in terms of processing, preparing and handling should be employed.

**Keywords:** Microbial, quality, cassava, maize, flours

## INTRODUCTION

Cassava (*Manihot esculenta*) and maize (*zea mays*) flours are the end products obtained from a processed food crops of Cassava and maize. Both crops constitute an economically important staple food in tropical and subtropical region of the world in which had been variously used in the production of different types of food in Africa, particularly in Nigeria. Some traditional food products of cassava and maize includes garri, fufu, lafun, abacha, tapioca etc, others include popcorn, ogi (Yoruba), akamu (igbo) or koko (hausa), and so on and so forth. The plants have been processed into many products and there are still emerging new products from cassava and maize. One of the major ways by which cassava and maize can be preserved is by processing both the tuber and the grain into flour. (Okarfo and benegbu, 2008).

Cassava is the most important food in terms of dietary carbohydrate and many household eat cassava daily in various forms (Kormawa and Akoroda, 2013). The crop has become tremendously important industrially for the production of livestock feed, starch, textile, industrial alcohol, and for the manufacture of cassava flour. Traditionally, Cassava is normally processed before consumption as a means of detoxification, preservation and modification (Oyewole, 2011).

Maize (*Zea mays*) is the third most important crop after Wheat and Rice, which serves as staple food for human, quality feed for animals as well as raw materials for starch food sweetness, beverages, infant food and more recently ethanol. Cassava contain high amount of carbohydrate, and maize also known as corn is a good source of starch (65-70), protein (8-10%), fat (3-4%) and some of important vitamins and minerals. (Akinlere, 2009). Maize and cassava can be processed into a number of ways; however, the common method is drying and milling which yields bye products such as meal (whole flour).

### Statement of problem

In processing cassava and maize flour microorganisms could be associated with these products at any stage in their growth, from seeding or planting stage through post-harvest, processing and handling. Some of these microorganisms are potential pathogens which may be detrimental and cause various diseases to consumers. They produce toxins such as enterotoxins and mycotoxins which could possibly lead to spoilage, food poisoning, intoxications, off-color and off-flavors that have varying implication for human health and economy (Oyewole *et al.*, 2012).

### Justification

However, the processing method employed for flour formation varies for different processors. Due to the variations in its processing method, hence there is need to study the microbial quality of the maize and cassava flour to ascertain their safety.

### Aim

The aim of this work is to investigate the microbial quality of cassava and maize flours sold within Bauchi metropolis.

**Objectives**

To isolate and identify microorganisms associated with cassava and maize flours.

**MATERIALS AND METHODS****Sample collection**

Cassava and Maize flour were obtained from Wunti and Muda lawan markets in cleaned sterile beakers and were labeled and transferred to the laboratory.

**Preparation of Media**

Nutrients agar and Sabourand Dextrose Agar (SDA) were prepared according to the manufacturer's instructions and then sterilized in an autoclave at 121<sup>0</sup>C 15 minutes Kaaya and Kyamuhangire, (2006).

**Preparation of Sample**

1g of the sample was diluted in a sterile test tube containing 9mls of distilled water. Serial dilution was prepared by transferring 1ml of the homogenate into a sterile tube containing 9ml of distilled water as 10<sup>-1</sup> dilution. From the first test tube another 1ml was transferred into another test tube that contained 9ml of distilled water as 10<sup>-2</sup> dilution. This procedure was repeated up to 10<sup>-4</sup> dilution. Kaaya and Kyamuhangire, (2006).

**Inoculation of Sample**

Samples were inoculated by pour plating method as described by Cheesbrough, (2000). 1ml of 10<sup>-4</sup> dilution was pipette into labeled sterile petri dishes and a 45<sup>0</sup>C molten nutrient agar was poured and mixed. Duplicated plates were incubated for 48 hours at 37<sup>0</sup>C for visible bacteria count. Kaaya and Kyamuhangire, (2006).

**Microbial Count**

The number of microbial colonies of the incubated plates were counted using a colony counter and expressed as colony forming units per gram (CFU/g).

**Sub-Culture**

Developed colonies on the plates were further purified by sub-culturing on fresh sterile agar plates to obtain pure culture. Pure isolates were kept on agar slant and stored in the refrigerator for further test.

**Characteristics and Identification of isolates**

Isolates were identified and characterized base on the culture, morphological, physiological and biochemical tests according to Cheesbrough, (2000).

### **Cultural Characteristics**

The cultural characteristics was carried out based on colonial features such as c shape, size, elevation, texture and color pigmentation.

### **Physiological Characteristics**

The physiological characteristics were carried out based on microscopy by Gram reaction.

### **Gram Staining**

A smear of the colony was prepared on grease free slide. It was air dried and then heat fixed. Two drops of crystal violet was added for 1 minute and then drained off (rinsed) with distilled water. Lugol's iodine was added for 1 minute and was immediately washed with distilled water. It was then decolorized by flooding with Acetone Alcohol for 30 seconds and was equally washed with distilled water. The slide was counter stained with Safranin solution for 1 minute. It was then rinsed with distilled water and dried. Drop of oil immersion was added and observed microscopically under x100 objectives lens. Purple colour indicate gram positive (+ve) while red coloration indicate gram negative (-ve) bacteria.

### **Biochemical Test**

**Method of Cheesbrough (2000). was used**

#### **Catalase Test**

A loopful of the test organisms from a pure culture was place in a test tube containing small amount of hydrogen peroxide. The presence of bubbles indicates a +ve catalase where as its absence indicates -ve catalase.

#### **Coagulase Test**

A suspension of a colony was made with normal saline on a slide and a drop oblood serum was added, rocked for the presence of clumping or agglutination. A positive reaction is seen as clumping of the suspension while in a negative one of the suspension remains uniform (Cheesbrough, 2000).

#### **Sugar Fermentation Test**

This test was carried out with 1ml of peptone water dispensed into test tubes containing inverted Durham tubes and were sterilized at 121<sup>0</sup>C for 15 minutes. This was followed by the addition of 2g of each of the sugar (Lactose, Glucose and Maltose) and 2 drops of phenol red indicator into the medium. After which it was inoculated with the test organism, it was then incubated at 37<sup>0</sup>C for 24 hours with an incubated tube as control. Gas production was indicated by the presence of air bubbles on the inverted Durham tube while Acid formation was confirmed by changes of red colour to orange colour

### Methyl Red Test

A test organism was inoculated in test tube containing 5ml of prepared peptone water and was incubated at 37°C for 48 hours after incubation, 0.5 ml of methyl read was added into the Test tubes and allowed to stand for 15 minutes and the colour change was observed. Positive result gave red colour while negative result gave yellow colour with the indicator solution.

### Motility Test

The presence or absence of flagella as an organelle of movement in the isolates was determined by the test. Discrete colonies of overnight culture (loopful) was placed on sterile microscopic slide containing a drop of peptone water and was covered with a cover slip after a minutes. It was then viewed microscopically with high power objectives. Motile organisms were observed swimming around which indicated a positive reaction, while non-motile organism indicated negative organisms.

### Lacto Phenol Test

The identification was achieved by placing a drop of the lacto phenol cotton blue on a clean slide with the aid of a mounting needle. Subsequently, a small portion of the mycelium from the fungal culture was picked, placed and evenly spread on a slide. A cover slip was gently applied with little pressure to eliminate air bubbles. The preparation was mounted and observed using a (Carl, Zeiss primo star, Germany) light microscope (mag x 1000).

## Experimental Results

**Table I: Microbial Plate Count in (Cfu/ml)**

Coloies	CM	CW	Mm	Mw	Suspected organisms
Colony 1	3.20x10 <sup>4</sup>	2.6x10 <sup>4</sup>	2.2 x10 <sup>4</sup>	1.5 x10 <sup>4</sup>	Staphylococcus sp.
Colony 2	1.5x10 <sup>4</sup>	1.3 x10 <sup>4</sup>	1.2 x10 <sup>4</sup>	1.0 x10 <sup>4</sup>	Bacillus sp.
Colony 3	2.0x10 <sup>4</sup>	1.3 x10 <sup>4</sup>	1.2 x10 <sup>4</sup>	1.1 x10 <sup>4</sup>	Micrococcus sp.
Colony 4	0,3 x10 <sup>4</sup>	0..2x10 <sup>4</sup>	0.7 x10 <sup>4</sup>	0.5 x10 <sup>4</sup>	Clostridium sp.
Colony 5	2.7x10 <sup>4</sup>	2.2 x10 <sup>4</sup>	1.8 x10 <sup>4</sup>	1.4 x10 <sup>4</sup>	Aspergillus sp.
Colony 6	2.5x10 <sup>4</sup>	2.1 x10 <sup>4</sup>	1.5 x10 <sup>4</sup>	1.3 x10 <sup>4</sup>	Penicillium sp.

KEY:

CM =Cassava from Muda lawal market, CW = Cassava from Wunti Market

Mm = Maize from Muda lawal market, Mw = Maize from Wunti market

**Table II: Cultural and Microscopic Characteristics of Isolates**

Col type	Tex	Col	Elev	sha	Size	Hy	Cd	Organisms
Col. 1	Sm	Gy	Rh	Rd	1-4mm			Staphylococcus sp.
Col. 2	W	Gw	Mbn	Rh	2-5mm			Bacillus sp.
Col. 3	Sm	Y-r	F	P	2.0um			Micrococcus sp.

Col. 4	Wy	Bg	F	Bb	1.5-2.5um				Cloridium sp.
Col. 5	Ct	Cr	Gb	Fs	1200um	S	Yr		Aspergillus sp.
Col. 6	W	Gb	Bg	F	1500um	S	Y		Penicillium sp.

**KEY:** Tex = Texture. Col = Colour, Elev = Elevation Mbn = Membranous

W = Wavy, Pk = Pink, Gb = globose, Bg = blue- green, P = Present, BB = Brownish black, Cottony, Sm = Smooth, yg = yellow-green, Greenish WG = White F = Flat, Rd - Round

P = Pherical, Wy =White to yellow, Fs = flash shape,

Yr = Yellow to red. Gb = Green/black,

**Table III: Biochemical Tests of the Isolates**

Col.	Gr	Mot	Cat	Coa	Mr	Glu	Lac	Suc	Suspected Organisms
Col	R	+	+	-	+	AG	A	A	Bacillus sp.
Col. 2	C	+	+	+	+	AG	AG	AG	Staphylococcus sp. Micrococcus sp.
Col. 3	C	-	+	-	+	A	-	-	Cloridium sp.
Col. 4	R	-	+	-	-	AG	-	-	Aspergillus sp.
Col. 5									Penicillium sp.
Col. 6									.

**KEY:** Gr = Gram Reaction, C = Cocci, R = Rod, Mot = Motility, A = Acid S = Septale, Cat = Catalase, AG = Acid & Gas, Cot = Coagulase, NS = Non – septate, Mr = Methyl red, + = Positive, Glu = Glucose - = Negative, Lac = Lactose, Sug = Sucrose

### Discussion

From the experimental result obtained, six (6) microbial genera were isolated identified and confirmed. The result shows Staphylococci, Aspergillus and Micrococcus appeared to be the most prevalent organisms followed by Penicillium, Bacillus and Clostridium, which is in line with the work of (Abba-kareem *et al.*, 2015).), who carried out a research on the microorganisms associated with the skin. And Sabowele *et al.*, 2001), who worked on microorganisms associated with Cassava production. The presence of these organisms may be due to their wide spread in nature and their existence in water, soil, air and vegetation.

The Fungi genera isolated were in line with the work of (Kuku, *et al*, 2016) and Abba-Kareem *et al.*, 2015). Who worked on moisture and micro flora content of Cassava flour stored in plastic containers as well as studies on microbiology of Cassava flour respectively. This is also in agreement with the work of (Kaaya and Kyamuhangire, 2006), who isolated Aspergillus, Fusarium, Penicillium, and Rhizopus in dried and stored maize on their work on effects of storage time and agro ecological zone on mould incidence and Aflotoxin contamination of maize.



## Conclusion

From the experiment carried out, the microorganisms associated with cassava and maize flour were isolated and identified. The species include; staphylococci, Bacillus, Micrococcus, Clostridium, Penicillium, and Aspergillus species. The presence of these microbes is thus an indication of microbial contamination of the cassava and maize flours.

## Recommendations

Most of the organisms isolated might have been introduced into the food samples from soil, air, vegetation and water used during processing. Other sources of contamination could be through cultivating stages, storage in moist environment, handlers of the products and the raw materials itself. The quality of food is determined by the content of indicator organisms, whose presence may indicate that flours are exposed to conditions favorable for the introduction and growth of pathogenic organisms. Therefore, the microbial content of flours is dependent mainly on the microbial quality of the containers, bags and sanitary practice during harvest, production and sales.

Therefore, the following are recommended

The practices of basic sanitary rules of hygiene in terms of processing, preparing and handling should be employed. Handlers are therefore urged to ensure self-cleanliness like washing of hands and cleanliness within the market square.

Also, the use of sterilized processing equipment and water should be given adequate attention, as this will go a long way at alleviating problems associated by educating the producers and sellers and also by routine inspection of equipment, raw materials and products.

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## INVESTIGATING THE OPTIMALITY CRITERIA FOR A PARTIALLY BALANCED LATTICE DESIGN WITH TWO ASSOCIATE CLASSES

**Nenlat R. R,**

Department of Mathematics and Statistics,  
Federal Polytechnic, Bauchi,  
Bauchi State, Nigeria,

**Nwaosu S. C,**

Department of Mathematics/Statistics,  
University of Agriculture, Makurdi,  
Bunue State, Nigeria.

**Abdulkadir A.**

Department of Mathematical Sciences,  
Abubakar Tafawa Balewa University, Bauchi,  
Bauchi State, Nigeria,

**Pam D. D.**

Department of Mathematics and Statistics,  
Kaduna Polytechnic Kaduna,  
Kaduna State, Nigeria

### **Abstract:**

Lattice designs is a class of incomplete block designs most commonly used in agricultural research. There is sufficient flexibility in the design to make its application simpler than most other incomplete block designs. The aim of this study is to investigate the design based optimality criteria of a two associate classes of a Partial Balance Lattice Design. The D, A, and E optimality criteria were studied. These approaches were demonstrated in our study involving nine treatments. We investigated the robustness properties of each of these optimal designs using their relative efficiencies. The results show that D-optimal has the highest values of 27 and 729 respectively for one replicate, and two replicates designs, while A has 9, and 18, E has 3, 3, although the designs. Considering the efficiency of the designs, in maximizing the information matrix, the results show that D, has 3.57 while A has 40 and E have 50. In minimized the dispersion matrix, the results show that D has 96.498 while A has 40 and E have 50. The results above showed that partial lattice design with one and two possess D optimality criteria which maximize the information matrix. It is therefore recommended that

an experimenter that chooses a Lattice design can do with a one or two replicated design without any loss of information.

**Keywords:** Lattice Square design, Associate classes, Optimality criteria, and Efficiency.

### Introduction

Experimental design is usually characterized by size, number of experimental units, the procedure of allocation of treatments to the experimental units and the nature of blocking (Sir R. A. Fisher 1919-30). In some experiments it may not be possible to accommodate all the treatment combination in each block. Therefore incomplete block designs are preferable. If all the treatments are not used in each block of the plan of a design, then it is called an incomplete block design (IBD). Lattice designs are one class of incomplete block design most commonly used in agricultural research. There is sufficient flexibility in the design to make its application simpler than most other incomplete block designs. There are several types of lattice design the two of the most commonly used lattice designs are, the balanced lattices and the partially balanced lattice designs. Both require that the number of treatments must be a perfect square. In balanced lattices, the number of treatment is equal to the square of the number of units per block. The Partially Balanced Lattices design is a subclass of incomplete block design is similar to the balanced lattice design but allows for a more flexible choice of the number of replications. While the partially balanced lattice design requires that the number of treatments must be a perfect square and that the block size is equal to the square root of this treatment number, the number of replication is not prescribed as a function of the number of treatments. In fact, any number of replications can be used in a partially balanced lattice design. They are well-known type of resolvable incomplete block designs.

### Material And Method

The analysis was carried out using Matlab software. In this study we are considering  $m=2$  associate classes, and  $v=9$  treatments with  $r=3$  replicates arranged in  $b=9$  blocks. Considering a  $3 \times 3$  triple lattice design. A relationship satisfying the following three conditions is called a partially balanced association scheme with  $m$ -associate classes. (i) Any two symbols are either first, second, ..., or  $m^{\text{th}}$  associates and the relation of associations is symmetrical, i.e., if the treatment A is the  $i^{\text{th}}$  associate of treatment B, then B is also the  $i^{\text{th}}$  associate of treatment A. (ii) Each treatment A in the set has exactly  $n_i$  treatments in the set which are the  $i^{\text{th}}$  associate and the number  $n_i$  ( $i=1,2,\dots,m$ ) does not depend on the treatment A. (iii) If any two treatments A and B are the  $i^{\text{th}}$  associates, then the number of treatments which are both  $j^{\text{th}}$  associate of A and  $k^{\text{th}}$  associate of B is  $p_{jk}^i$  and is independent of the pair of  $i^{\text{th}}$  associates A and B. The number of  $v, n_1, n_2, \dots, n_m, p_{jk}^i$  ( $i, j, k = 1, 2, \dots, m$ ) are called the parameters of  $m$ -associate partially balanced scheme. Where  $r =$  number of replications,  $v =$  number of treatment in a block  $m =$

associate classes,  $n_1$ = number of treatment in first associates,  $n_2$ = number of treatment in second associates,  $\lambda_1$  = First associate class,  $\lambda_2$  = Second associate class,

### Information and Dispersion Matrix

To use the later described criteria for the selection of the best design, we need to define two other types of matrices. The first is the information matrix  $(X'X)$ . This matrix is the multiplication of the tranpose of the design matrix  $X$  and  $X$  itself. The dispersion matrix  $(X'X)^{-1}$  is the inverse matrix of this calculation (de Aguiar et al. 1995)

### Data Analysis And Result

**Table (1): Layout of the design**

Blocks	Treatments		
1	1	2	3
2	4	5	6
3	7	8	9
4	1	4	7
5	2	5	8
6	3	6	9
7	1	6	8
8	2	4	9
9	3	5	7

**Table (2): Show the 1<sup>st</sup> and 2<sup>nd</sup> associate and associates of all the treatments**

Treatment number	First associates	Second associates
1	2, 3, 4, 6, 7, 8	5, 9
2	1, 3, 4, 5, 8, 9	6, 7
3	1, 2, 5, 6, 7, 9,	4, 8
4	5, 6, 1, 7, 2, 9	3, 4
5	4, 6, 2, 8, 3, 7	1, 9
6	4, 5, 3, 9, 1, 8	2, 7
7	8, 9, 1, 4, 3, 5	2, 6
8	7, 9, 2, 5, 1, 6	3, 4
9	7, 8, 3, 6, 2, 4	1, 5

### RESULT: (1)

From table (3) by inspection of the design we have constructed 2 associate classes with the following properties: number of treatment in first column ( $n_0$ ) = 1, number of treatment in first associate ( $n_1$ ) = 6, number of treatment in the second associate ( $n_2$ ) = 2, first associate( $\lambda_1$ ) =

1, second associate  $\lambda_2 = 0$ , These associate classes assist us in the analysis of data from Lattice design experiment.

### Design with one replication

Figure 1 show the matrix with 3 blocks, 9 treatments

$$X = \begin{bmatrix} 1 & 0 & 0 \\ 1 & 0 & 0 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 1 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & 1 \\ 0 & 0 & 1 \end{bmatrix}$$

The transpose of the matrix  $X'$

$$X' = \begin{bmatrix} 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 \end{bmatrix}$$

The information matrix is given by;

$$(X'X) = \begin{bmatrix} 3 & 0 & 0 \\ 0 & 3 & 0 \\ 0 & 0 & 3 \end{bmatrix}$$

The dispersion matrix is given by

$$(X'X)^{-1} = \begin{bmatrix} 0.3333 & 0 & 0 \\ 0 & 0.3333 & 0 \\ 0 & 0 & 0.3333 \end{bmatrix}$$

From the information matrix and dispersion matrix above,

**D – optimality is**

$$\max|X'X| \equiv \min|X'X|^{-1} = 27 \text{ or } 0.0370 \quad \dots (1)$$

**A – optimality is**

$$\text{Trace}(X'X)^{-1} = \min[\text{trace}(X'X)^{-1}] = 9 \text{ or } 1 \quad \dots (2)$$

**E – optimality is**

$$\max\lambda_{\min}(X'X) \equiv \min\lambda_{\max}(X'X)^{-1} = 3 \text{ or } 0.3333 \quad \dots (3)$$

### Design With Two Replications

Figure 2 show the matrix with 6 blocks, 18 treatments

$$X = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

The transpose of the matrix  $X'$

$$X' = \begin{bmatrix} 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 \end{bmatrix}$$

The information matrix is given by;

$$(X'X) = \begin{bmatrix} 3 & 0 & 0 & 0 & 0 & 0 \\ 0 & 3 & 0 & 0 & 0 & 0 \\ 0 & 0 & 3 & 0 & 0 & 0 \\ 0 & 0 & 0 & 3 & 0 & 0 \\ 0 & 0 & 0 & 0 & 3 & 0 \\ 0 & 0 & 0 & 0 & 0 & 3 \end{bmatrix}$$

The dispersion matrix is given by

$$(X'X)^{-1} = \begin{bmatrix} 0.3333 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0.3333 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0.3333 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0.3333 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0.3333 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0.3333 \end{bmatrix}$$

***D – optimality is***

$$\max|X'X| \equiv \min|X'X|^{-1} = 729 \text{ or } 0.0014 \quad \dots (4)$$

**A – optimality is**

$$\text{Trace}(X'X)^{-1} = \min[\text{trace}(X'X)^{-1}] = 18 \text{ or } 3 \quad \dots (5)$$

**E – optimality is**

$$\max\lambda_{\min}(X'X) \equiv \min\lambda_{\max}(X'X)^{-1} = 3 \text{ or } 0.3333 \quad \dots (6)$$

### DESIGN EFFICIENCY

$$\text{Design efficiency} = \frac{\text{primary component (A)}}{\text{All component s (A+B)}} \times 100\%$$

Maximizing the information matrix

$$\begin{aligned} D - \text{efficiency} &= \frac{729}{729+19683} \times 100 \quad \dots (7) \\ &= 0.0357 \times 100 \\ &= 3.57 \end{aligned}$$

Minimizing the dispersion matrix

$$\begin{aligned} D - \text{efficiency} &= \frac{0.0014}{0.0014+5.0805e-05} \times 100 \quad \dots (8) \\ &= 0.9649 \times 100 \\ &= 96.498 \end{aligned}$$

Maximizing the information matrix

$$\begin{aligned} A - \text{efficiency} &= \frac{18}{18+27} \times 100 \quad \dots (9) \\ &= 0.4 \times 100 \\ &= 40 \end{aligned}$$

Minimizing the dispersion matrix

$$\begin{aligned} A - \text{efficiency} &= \frac{2}{2+3} \times 100 \quad \dots (10) \\ &= 0.4 \times 100 \\ &= 40 \end{aligned}$$

Maximizing the information matrix

$$\begin{aligned} E - \text{efficiency} &= \frac{3}{3+3} \times 100 \quad \dots (11) \\ &= 0.5 \times 100 \\ &= 50 \end{aligned}$$

Minimizing the dispersion matrix

$$\begin{aligned} E - \text{efficiency} &= \frac{0.3333}{0.3333+0.3333} \times 100 \quad \dots (12) \\ &= 0.5 \times 100 \\ &= 50 \end{aligned}$$

### Summary Of Results

**Table (7): Rep 1 Maximizing the information matrix**

Optimality criteria	D – optimality	A – optimality	E – optimality
Optimal	27	9	3
Efficiency	3.57	33.33	50

**Table (8): Rep 1 Minimizing the dispersion matrix**

Optimality criteria	D – optimality	A – optimality	E – optimality
Optimal	0.0370	1	0.3333
Efficiency	96.35	33.33	50

**Table (9): Rep1 and Rep2 Maximizing the information matrix**

Optimality criteria	D – optimality	A – optimality	E – optimality
Optimal	729	18	3
Efficiency	3.57	40	50

**Table (10): Minimizing the dispersion matrix**

Optimality criteria	D – optimality	A – optimality	E – optimality
Optimal	0.0014	2	0.3333
Efficiency	96.498	40	50

### Discussion Of Result

In this research work, we have carefully constructed 2 associate classes of a Partially Balanced Lattices design of 9 treatments with three replications. In this manner, two treatments lying in the same row or in the same column of the association schemes are first associates meaning they occur together, while two treatments not lying in the same row or in the same column are second associates they do not occur together. We have demonstrated how good a design is maximized or minimized with respect to information matrix in one replicate and two replicated of Partial Lattices, Based on the analysis D-criteria has the highest value follow by A-criteria, then E-criteria. While in minimized the dispersion matrix, the result shows that D-criteria have the lowest value followed by E-criteria then A-criteria. Considering the efficiency of the design, the result of D, A and E efficiency which maximized the information matrix shows that D-criteria has a value 3.57, A criteria has the value 40 and E-criteria have the value of 50, while in minimized dispersion matrix the results shows that D-criteria has the value 96.498 while A criteria have 40 and E-criteria have 50.

### Conclusion/Recommendation

In conclusion since in experimental design, a good criterion for one design may not be the best in another design. We have shown that the Partial Lattice possesses D optimality criteria which advices an experimenter to employ any of the designs. Considering the nature of our research and the result of the experiment which informs the experimenter to predict the result in advance, D-optimal is the best suited for Partially and Balanced Lattice design.

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## ENVIRONMENTAL SANITATION PRACTICES ON MALARIA CONTROL AND PREVENTION IN ABI LOCAL GOVERNMENT AREA, CROSS RIVER STATE, NIGERIA

**Onu Nkechi Emmanuela**

*Department of Home and Rural Economics  
Federal Polytechnic Oke*

### ABSTRACT

This study was conducted to determine the environmental sanitation practices on malaria prevention and control in Abi Local Government Area, Cross River State, Nigeria. A descriptive cross-sectional study design in Abi Local Government Area, Cross River State, Nigeria from June to August, 2016 conducted. A pre-tested structured questionnaire was used to generate data from 450 adult respondents who were selected using multi-stage sampling technique. An observational checklist was used to assess the sanitary condition of residential dwellings and facilities. Data generated was entered into excel spread sheet and exported to Statistical Package for Social Sciences (SPSS version 20.0) software for analysis. Results were presented in frequencies, tables and charts. Chi-square was used to test for association between variables at 0.05  $\alpha$  level. It was revealed that 283 (62.9%) respondents exhibited poor environmental sanitation practices while 167 (37.1%) had good environmental sanitation practices. It also was observed that age ( $p=0.023$ ), gender ( $p=0.000$ ), educational status ( $p=0.000$ ) and income ( $p=0.000$ ) were found to be statistically significantly associated with environmental sanitation practices. Hence, malaria intervention programmes should be redesigned or remodeled to include the core components of environmental sanitation to prevent mosquito breeding and mitigate malaria transmission in rural areas.

**Keywords:** Environmental sanitation practices; malaria control; malaria prevention; mosquito.

### INTRODUCTION

Malaria still remains a significant public health problem especially in low and middle income countries. According to the World Health Organisation (WHO) [1], malaria transmission in Nigeria is abysmally high with over 76% of the population reporting more than 1 case per 1,000 populations annually. There was a less than 50% decrease in projected incidence of malaria from 2000–2015. Nigeria and the Democratic Republic of Congo account for more than 35% of the global total of estimated malaria deaths [2]. Malaria is principally caused by protozoa (*Plasmodium species*) and is transmitted through the bite of an infected female *Anopheles* mosquito [3]. Within the tropics and sub-tropics, human malaria is seen to be the

most wide spread vector-borne disease [4]. Available statistics have documented that malaria is highly endemic in Nigeria with over 90% of the populace at risk of infection. It is the prime cause of 60% outpatient consultation for all age groups and at least half of the Nigerian populace are exposed to at least one bout of malaria attack every year [5-7].

An integrative approach has been recommended spraying) [9]. Other malaria control strategies recommended by WHO for the control of malaria include; ITNs use, IRS and prompt management of malaria cases with Artemisinin-based Combination Therapies (ACTs) [10].

From a triad perspective which includes the agent, host and environment, researchers and scholars have encouraged the source reduction, elimination and eradication of mosquitoes breeding sites by concentrating on the environment. These tend to be essential because, the proliferation of mosquitoes continually perpetuate the transmission of malaria. So, it can be postulated that if the sources of mosquitoes breeding sites is eradicated or eliminated, malaria would be drastically reduced. This implies that good environmental sanitation practices could help mitigate malaria transmission, promote healthiness and improve quality of life of the populace.

Cross River State is situated in an area of stable malaria transmission throughout the year. This is because its surroundings are covered by mangrove vegetation and rainforest. Abi Local Government Area is a rural area which is to mitigate the spread of malaria parasites. characterized by squatter settlements or villages One of such strategy or approach is the that lack modern facilities, good drainage and Integrated Vector Management (IVM) through a waste disposal systems, tarred road and water combination of biological and chemical methods. supply. The area is also characterized by It is aimed at improving ecological soundness overcrowding and poor sanitation resulting from and sustainability for the control of vector- high level of refuse generation, indiscriminate borne diseases, improve efficacy and cost effectiveness [8]. Components of IVM include the use of preventive (e.g. use of mosquito repellents, long lasting insecticide-treated nets (LLINs) and wearing of protective clothing) and chemical control methods (e.g. environmental and biological control measures, outdoor spraying, larviciding and indoor residual dumping of refuse, open defecation, bushy surroundings, blocked gutters, potholes creating stagnant pools of water for mosquito breeding and odour nuisance. Also, most inhabitants of Abi local Government Area are farmers; hence every available land space is converted into farmlands. All of these factors proliferates the breeding of female anopheles mosquitoes. Hence, considering the significant of the environment on the control and prevention of malaria, this study was aimed at assessing environmental sanitation practices on malaria prevention and control in Abi Local Government Area, Cross River State, Nigeria.

## **METHODOLOGY**

The study was carried out in Abi Local Government Area of Cross River State, Nigeria. It is situated in the Central Senatorial District of Cross River State and has boundary with Yakurr Local Government Area to the South, Biase Local Government Area to the West, Obubra Local Government Area to the East, and Ikwo and Onitcha Local Government Areas of Ebonyi

State in the North. The area has 10 political wards with a population of 218, 734 persons covering a landmass of approximately 334.43 square kilometres [11]. Most inhabitants of the areas are mainly commercial farmers, petty traders and civil servants. A descriptive cross-sectional study design was used for the study. Multi-stage sampling technique was used to select 450 respondents who were available and expressed enthusiasm to participate in the study. Firstly, five council wards were used for the study. Simple random sampling technique (take-a-pick lottery method) was used to select five (5) wards out of the ten council wards in Abi Local

Government Area (LGA). Numbers were assigned to each ward, folded in pieces of papers, put in a container and mixed thoroughly. Then, the research assistants were asked to pick a piece of the folded paper each. Names of wards written on the paper picked were considered for the study. Secondly, out of the selected five (5) wards, simple random sampling technique (take-a-pick lottery method) was also used to select five (5) villages from each ward (i.e.  $5 \times 5 = 25$  villages). Thirdly, the primary health center (PHC) house-enumeration list for Abi L.G.A. was used as the sample frame and systematic random sampling technique was utilized to select eighteen (18) households in each selected village. The sample interval was obtained by dividing the total number of households in each village by the sample size (households to be sampled) depending on the total number of households in each village. Lastly, in each of the randomly selected households, an adult, either male or female was selected by simple random sampling to participate in the study. The total number of respondents recruited for the study was 450. A total of 450 copies of the questionnaire were administered to 450 households in 25 villages in the selected 5 wards of the study area. A pretested structured questionnaire developed by the researcher was used to collect quantitative data from eligible respondents (18 years and above). The rationale for considering individuals who were 18 years and above is based on the fact that data needed to draw inference and generalization should constitute reliable data which these category of individuals can provide. Also, the target population for this study were adults which are usually from 18 years and above by Nigerian standard. An observational checklist designed by Federal Ministry of Environment [12] was also used to assess residential houses and their surroundings sampled for the study. Items assessed with the checklist were basically type of house, household size, window/door screening, outside surroundings and waste disposal methods. Data generated was entered into excel spread sheet and exported to Statistical Package for Social Sciences (SPSS version 20.0) software for analysis. Results were presented in frequencies, tables and charts. Chi-square was used to test for association between variables at 0.05  $\alpha$  level. Ethical approval was obtained from the Cross River State Health Research Ethics Committee (CRS-HREC) to carry out the study. Respondents gave their informed consent verbally before participating in the study. No names were required during the process of data collection to maintain anonymity and information obtained were kept confidential throughout the period of research.

## RESULTS

### Socio-demographic Characteristics of the Respondents

The results obtained in this study shows that 120 (26.7%), 110 (24.4%) and 101 (22.4%) of the respondents were between the ages 28-37, 38-47 and 18-27 years of age respectively. Male respondents were 243 (54.0%) while 207 (46.0%) were female respondents. Most respondents 237 (52.7%) were married, 159 (35.3%) were farmers, 415 (92.2%) were Christians, 167 (37.1%) had attained secondary level of education, 353 (78.4%) earned a monthly income of less than N20,000, 182 (40.4%) live in mud houses with zinc roof and 181 (40.2%) have a household size of between 4-6 persons (Table 1).

**Table 1. Socio-demographic characteristics of the respondents (n=450)**

Variables	Number of respondents	Percentage
<b>Age (in years)</b>		
18-27	101	22.4
28-37	120	26.7
38-47	110	24.4
48-57	86	19.1
58 and above	33	7.3
<b>Sex</b>		
Male	243	54.0
Female	207	46.0
<b>Marital status</b>		
Married	237	52.7
Single	73	16.2
Divorced	33	7.3
Widowed/widower	67	14.9
Co-habiting	40	8.9
<b>Household size</b>		
1-3	180	40.0
4-6	181	40.2
7-9	76	16.9
10 and above	13	2.9
<b>Occupation</b>		
Farmer	159	35.3
Trader	90	20.0
Civil servant	103	22.9
Fulltime housewife	17	3.8
Artisan	10	2.2

Student	51	11.3
Unemployed	20	4.4
<b>Religion</b>		
Christianity	415	92.2
Islam	0	0.0
Traditional religion	35	7.8
<b>Educational status</b>		
No formal education	103	22.9
Primary	111	24.7
Secondary	167	37.1
Tertiary	69	15.3
<b>Monthly income</b>		
Less than N20,000	353	78.4
N20,000-N50,000	61	13.6
Above N50,000	36	8.0
<b>House type</b>		
Mud house with bamboo roof	85	18.9
Mud house with Zinc roof	182	40.4
Block house with Zinc roof/asbestos roofing sheets	177	39.3
Uncompleted building	6	1.3
Wooden made house	0	0.0

### **Environmental Sanitation Practices for Malaria Control and Prevention**

Most respondents 306 (68.0%) admitted that there were bushes and grasses in their premises, out of which 128 (41.8%) respondents cleared their surrounding of bushes and grasses monthly, 100 (32.7%) cleared weekly and 45 (14.7%) cleared their surroundings whenever they like or expect visitors. Out of 450 respondents, 188 (41.8%) claimed that they had drainage system in their houses; out of which 96 (51.1%) clean the drainage on weekly basis, 50 (26.6%) clean on daily basis while 26 (13.8%) clean their drainage every six months. On methods of solid waste storage, 172 (38.2%) of the respondents claimed that they store their solid wastes in close plastic containers, 116 (25.8%) stored in open containers while 87 (19.3%) of respondents practice open dumping behind their houses (Table 2).

The methods of waste disposal adopted by the respondents were predominantly open dumping 276 (61.3%) and burning 116 (25.8%). A reasonable proportion of the respondents 319 (70.9%) claimed that they dispose their household generated solid waste on daily basis, 46 (10.2%) once a week while 31 (6.9%) disposed their waste only when the waste bin is filled. Similarly, majority of the respondents 174 (38.7%) disposed their wastewater by pouring in

the drain, 111 (24.7%) by pouring anywhere while 84 (18.7%) by throwing on the road. On method of household water storage, 292 (64.9%) of the respondents claimed to store their water in covered containers to avoid contamination while 106 (23.6%) stored in open containers (Table 3).

The types of toilet facilities used by majority of the respondents was pit latrine with cover 149 (33.1%) while 137 (30.4%) used pit latrine without cover. A larger proportion of the respondents 145 (36.7%) claimed that they cleaned their toilets on daily basis, 101 (25.6%) said they cleaned once a week while 89 (22.5%) claimed that they cleaned their toilets only when it is dirty. On methods employed by respondents in preventing mosquito from entering the house, more than half of the respondents 248 (52.1%) admitted that they close their doors and windows especially at night, 117 (24.6%) screened doors and windows with nets while 69 (14.5%) used insecticide spray. On methods of preventing mosquito bites inside the house, most respondents 359 (75.7%) claimed using bed nets or ITNs, 41 (8.6%) said they covered their bodies with clothes while 32 (6.7%) used insecticide spray. Majority of the respondents 299 (66.4%) admitted that they have a small farmland of crops in their area of residence (Table 4).

Averagely, a greater proportion of the respondents 283 (62.9%) recorded poor environmental sanitation practices while 167 (37.1%) recorded good environmental sanitation practices (Fig. 1).

**Table 2. Environmental sanitation practices for malaria control and prevention (Bush clearing and cleaning of drainage system)**

<b>Variables</b>	<b>Number of respondents</b>	<b>Percentage</b>
<b>Presence of bushes in the surroundings (n=450)</b>		
Present	306	68.0
Absent	144	32.0
<b>Frequency of cleaning the surroundings of bushes and grasses (n=306)</b>		
Weekly	100	32.7
Monthly	128	41.8
Every 2-3 months	23	7.5
Every six months	10	3.3
Whenever I like/expect visitors	45	14.7
<b>Availability of drainage system he house (n=450) around t</b>		
Available	188	41.8
Not available	262	58.2
<b>Frequency of cleaning the drainage system (n=188)</b>		

Daily	50	26.6
Weekly	96	51.1
Monthly	13	6.9
Every 2-3 months	0	0.0
Every six months	26	13.8
Not at all	3	1.6
<b>Method of solid waste storage (n=450)</b>		
Open container	116	25.8
Polythene bag	75	16.7
Closed plastic container	172	38.2
Open dumping behind the houses	87	19.3

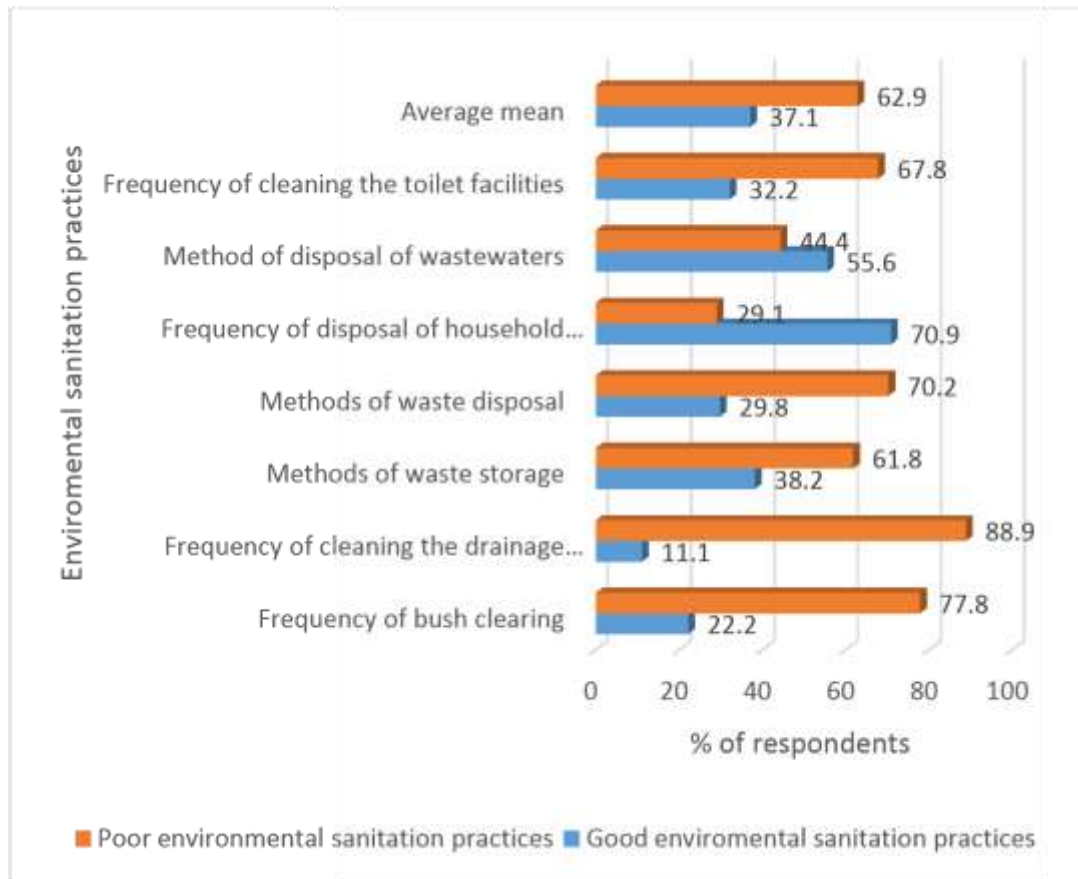
*Inah et al.; AJMAH, 6(2): 1-12, 2017; Article no.AJMAH.34870*

**Table 3. Environmental sanitation practices for malaria control and prevention (Waste management and water storage)**

Variables	Number of respondents	Percentage
<b>Methods of waste disposal (n=450)</b>		
Burning		25.8
Open refuse dumpsite		61.3
Dump waste in drains/gutters	116	8.9
Burying	276	4.0
<b>Frequency of disposal of household generated solid waste (n=450)</b>	40	70.9
Daily	18	10.2
Once a week	319	6.7
2-4 times a week	46	6.9
Only when it fills the waste bin	30	3.6
Only when the waste emits offensive odour	31	1.8
1-3 times a month	16	38.7
<b>Method of disposal of wastewater (n=450)</b>	8	18.7
Pour in the drain	174	24.7
Throw on the road	84	16.9
Pouring anywhere	111	1.1
In an open pit	76	23.6
Stored in the house	5	7.8
<b>Method of household water storage (n=450)</b>	106	3.8
Open water container	35	64.9
Open surface water tanks	17	
Underground cover containers	292	



## Covered water containers



**Fig. 1. Environmental sanitation practices among respondents**

**Table 4. Environmental sanitation practices for malaria control and prevention (sanitary facilities and indoor malaria control)**

Variables	Number of respondents	Percentage
<b>Type of toilet facility currently in use (n=450)</b>		
Pit latrine without cover	137	30.4
Pit latrine with cover	149	33.1
Water system closet without cover	20	4.4
Water system closet with cover	89	19.8
Bush	51	11.3
In polythene bags	4	0.9
<b>Frequency of cleaning the toilet facility (n=395)</b>		

Daily	145	36.7
Once a week	101	25.6
2-4 times a week	43	10.9
Only when it is dirty	89	22.5
1-3 times a month	17	4.3
<b>Methods of preventing mosquitoes from entering the house (n=476)</b>		
Closing door and windows regularly	248	52.1
Screening doors and windows with nets	117	24.6
Use of insecticide spray	69	14.5
Using insect mosquito coil	7	1.5
None at all	35	7.4
<b>Method of preventing mosquito bites inside the house (n=474)*</b>		
Using bed nets	359	75.7
Using insecticide spray	32	6.7
Rubbing repellent cream before going to bed	16 daily	3.4
Covering body with clothes	41	8.6
None at all	26	5.5
<b>Presence of small farmland of crops in area of residence (n=450)</b>		
Present	299	66.4
Absent	151	33.6

*\*Multiple responses*

### **Test of Relationship between Sociodemographic Characteristics of Respondents and Environmental**

#### **Sanitation Practices using Chi-square**

##### **Analysis**

From the table, it was observed that age ( $\chi^2 = 11.90$ ;  $P = 0.023$ ), gender ( $\chi^2 = 20.27$ ;  $P = 0.000$ ), educational status ( $\chi^2 = 25.45$ ;  $P = 0.000$ ) and income level ( $\chi^2 = 69.13$ ;  $P = 0.000$ ) were statistically significantly associated with environmental sanitation practice among respondents (Table 5).

### **DISCUSSION OF FINDINGS**

More than half of the respondents admitted that there were bushes and overgrown weeds/grasses in their surroundings; out of which 128 (41.8%) clean their surrounding monthly, 100 (32.7%) clean weekly and 45 (14.7%) only clean the surrounding whenever they choose or expect visitors. This result clearly indicates poor environmental sanitation practice despite the fact that the respondents reported that they clear their surrounding bushes to prevent malaria

(Table 3). The low frequency in bush clearing exhibited by the respondents in this study predisposes them to the risk of contracting malaria. This fact is supported by a Cameroonian study in which malaria prevalence was higher among school children who had bushes around their homes [13]. This is a clear indication that bushes around residential areas poses substantial health risk to humans. Even though it is a common fact that rural people reside in areas surrounded by bushes and undeveloped plots, it is also consequential that they should be aware of the danger of not clearing their surrounding bushes at least on weekly basis. This approach would increase the awareness level as well as suppress the spread of malaria.

**Table 5. Test of relationship between socio-demographic characteristics of respondents and environmental sanitation practices using chi-square analysis**

Variables	Number of respondents (Percentage)			Chi-square (P-value)
	Good environmental sanitation practice (n = 167)	Poor environmental sanitation practice (n = 283)	Total (n = 450)	
<b>Age (in years)</b>				11.90 (0.023)*
18-27	43 (9.6)	58 (12.9)	101 (22.4)	
28-37	51 (11.3)	69 (15.3)	120 (26.7)	
38-47	36 (8.0)	74 (16.4)	110 (24.4)	
48-57	21 (4.7)	65 (14.4)	86 (19.1)	
58 and above	16 (3.6)	17 (3.8)	33 (7.3)	
<b>Gender</b>				20.27 (0.000)*
Male	67 (14.9)	176 (39.1)	243 (54.0)	
Female	100 (22.2)	107 (23.8)	207 (46.0)	
<b>Education</b>				25.45 (0.000)*
No formal education	26 (21.3)	77 (17.1)	103 (22.9)	
Primary	38 (8.4)	73 (16.2)	111 (24.7)	
Secondary	45 (10.0)	122 (27.1)	167 (37.1)	
Tertiary	58 (12.9)	11 (2.4)	69 (15.3)	
<b>Monthly income</b>				69.13 (0.000)*
<N20,000	96 (21.3)	257 (57.1)	353 (78.4)	
N20,000-N50,000	46 (10.2)	15 (3.3)	61 (13.6)	

>N50,000	25 (5.6)	11 (2.4)	36 (8.0)
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While 188 (41.8%) respondents claimed that they had drainage system around their houses, (Table 5), it was discovered from observation that only 136 (30.2%) had drainage system around their homes; out of which 41 (30.1%) drains were in sanitary condition. The poor environmental sanitation practice observed in this study may be linked to the fact that the drains were probably used as refuse dumpsite for residents in the area. It is common practice that during heavy rainfall, people dump their refuse in the drains and gutters so that run-off water or storm will carry the waste away. During this process, some waste materials are flushed away as expected while others may remain as nuisance, causing offensive odour and providing breeding sites for the female *Anopheles* mosquitoes. Hence, the poor sanitary condition of most drainage systems observed in most homes presents significant level of health risks to the people residing in such environments as exposure to malaria is inevitable. Thus, rural dwellers need to be properly informed of the need to clean their drains on daily basis.

Out of the 450 respondents, only 172 (38.2%) respondents reported that they store wastes in plastic containers with cover. The remaining 278 (61.8%) respondents store wastes in open containers, polythene bags while 87 (19.3%) practice open dumping behind their houses. It was also observed that half of the households surveyed 229 (50.9%) had waste storage facility; out of which only 77 (33.6%) used sanitary waste storage facilities. As reported in the current study, only 38.2% practice the proper method of waste storage while 61.8% practice the improper methods. The ultimate aim of proper waste storage is to prevent the emission of obnoxious odour, flies/rodent infestation and maintain environmental hygiene. According to Pat-Mbano and Ezirim [14], where proper waste storage is not practiced, individuals resident in such households are at risk of malaria infection. The health risk becomes higher for households without any waste storage facilities. This is because absence of waste storage facilities would lead to littering of wastes around the surroundings which is hazardous to human health. It is therefore pertinent to emphasize proper storage of household solid wastes (i.e. storage of waste in a closed plastic container) with the aim of maintaining environmental hygiene and healthiness.

A reasonable proportion of the respondents 276 (61.3%) practiced open refuse dumping as the method of waste disposal, 116 (25.8%) practiced burning, 40 (8.9%) dumped their waste in drains/gutters while 18 (4.0%) buried their waste.

This result is comparable to that of Warunasinghe and Yapa [15], whereby the respondents practiced burning, burying, composting and incineration as methods of waste disposal. In most rural areas, open dumping of solid wastes is the most widely practiced method of waste disposal probably because of its cost-effectiveness and convenience. It is also common practice that households dispose wastes in open pits and cover with earth once it is filled. Nevertheless, open waste dumping has its negative impact on health as it encourages

flies/rodent infestation, breeding of mosquitoes and emit offensive odour all of which are hazards to human health. Open dumping also destroys the aesthetic beauty of the environment. Thus, public enlightenment should be directed towards acceptable methods of waste disposal such as burning, burying, incineration, composting, etc.

Two-third of the respondents 319 (70.9%) claimed that they dispose their wastes on daily basis while 46 (10.2%) dispose wastes once a week. The daily disposal of wastes by the respondents in this study may be linked to their knowledge level and personal experience of the consequences of prolonged wastes storage before disposal. If such waste consist things like empty cans, discarded plastics, etc., it can facilitate mosquito breeding. Hence, there is need to intensify awareness to abolish such practice. While 200 (44.4%) of the respondents practice indiscriminate disposal of wastewater such as pouring anywhere, throwing on the road and storing in the house, 250 (55.6%) respondents on the other hand dispose wastewater by pouring in the drains or in an open pit. This result clearly suggests that most respondents knew the implication of indiscriminate disposal of wastewater especially water from the kitchen. Lack of drainage systems around homes may encourage the indiscriminate disposal of wastewater in the surrounding. For example, in households where bathroom facilities are constructed without a good drainage system, the wastewater accumulates causing breeding sites for mosquitoes. In such practical instance, malaria control becomes very difficult.

Most respondents 292 (64.9%) practice the acceptable method of storing their water in covered water containers to avoid contamination whereas 106 (23.6%) store water in open water containers and 35 (7.8%) in surface water tanks. This observation is supported by a similar study carried out in Akwa Ibom State, Nigeria where 81.2% respondents reported that they store water in close containers [16]. Lack of appropriate storage facilities with cover could predispose to water-borne diseases. A greater proportion of the respondents 286 (63.5%) had pit latrine; out of which 145 (36.7%) clean once a week. This finding is contrary to the findings by Ekong [16], in which 52.8% of the subjects used flush toilets and washed them on daily basis. This result concurs with what was observed, where 283 (62.9%) households used pit latrine; out of which 140 (37.6%) households maintained their toilets in sanitary condition. This is a clear indication that most rural households still patronize the pit latrine probably because of its cost-effectiveness and less complexity in maintenance than the water system closet. Routine and daily cleaning of toilet facilities should be highly emphasized to maintain hygiene standards as well as protect the health of household members from infectious diseases that may arise from unsanitary facilities.

On methods used by the respondents to prevent mosquito from entering the house, majority of respondents 248 (52.1%) claimed to close their doors and windows regularly, 117 (24.6%) said they screened their doors and windows with nets, 69 (14.5%) used insecticide spray. Three-quarter of respondents 359 (75.7%) claimed they used bed nets for preventing mosquito bites inside the house. This finding contradicts that of Bamidele, Ntaji, Oladele, and Bamimore

[17], in which the use of ITNs was rated low, but agrees with that of Olayemi et al. [18], in which high usage of bed nets was reported. This result clearly indicates that respondents acknowledge the high endemicity of malaria infection and adopt multidimensional approaches to its effective control. Existing literature has clearly highlighted that no one single strategy is capable of combating malaria effectively. Currently, integrated vector management (IVM) is the recommended strategy to combat malaria. The high usage of bed nets may be attributed to the fact that it is widely advertised, readily available and cost-effective. This evaluates the efficacy of malaria intervention programmes especially as it concerns the distribution of ITNs to rural households. Two-third of the respondents 299 (66.4%) acknowledged that they have a small farmland of crops near their residential areas. While agricultural productivity propels food availability, food security, economic benefits and maintenance of good health via intake of nutritious food products, its benefits are not without trade-offs. Some agricultural practices such as the use of irrigation for crop cultivation, ponds for fish farming and storage of water in tanks for livestock provides suitable breeding sites for the female *Anopheles* mosquito to thrive, proliferate and infect their hosts [19]. Residents near these farmlands are susceptible to high malaria transmission. It can be inferred that farming activities should be done far from residential areas if healthiness is to be maintained.

From the results, it was observed that age was significantly associated with environmental sanitation practice ( $P < 0.05$ ). Younger ages were found to engage in good and standard environmental sanitation practices than their older counterparts. This is strongly associated to the fact that, in most homes, the younger adults and teenagers take responsibility of bush clearing, disposal of household solid wastes, wastewaters and cleaning of sanitary facilities. Secondly, the younger respondents may be more aware of the implications of good environmental sanitation practices than their older counterparts even though in some cases the older adults can be an impetus to proper environmental sanitation practices. In a typical African family setting, while parents are saddled with the responsibility of providing basic household needs, their offspring on the other hand are in charge of the chores in the house which clearly explains the disparity in environmental sanitation practices among age groups. Females were found to be more engaged in good environmental sanitation practices than their males counterparts ( $P < 0.05$ ). This may be attributed to the fact that females are seen to be home builders, home managers and organizers. They usually ensure the environment is kept tidy and clean. The males on the other hand, engage in day-to-day activities with the aim of providing for their families. As a result, maintaining good environmental sanitation may probably be of less concern. Educational status was also found to be associated with environmental sanitation practice ( $P < 0.05$ ). This means that the higher the educational status, the higher the standard of environmental sanitation practice and vice versa. Adequate access to health information and high awareness level on the implication of proper environmental

sanitation practice may largely account for good environmental sanitation practices among respondents with higher educational status.

Income level was also observed to be significantly associated with environmental sanitation practice ( $P < 0.05$ ). This means that income greatly influence the standard of environmental sanitation practice to a reasonable extent. Arguably, the desire to maintain clean and safe environment is highly dependent on the availability of materials and equipment such as rakes, hoes, cutlasses, durable waste bins, disinfectants and detergents. However, it was observed that lower income earners were found to be more engaged in good environmental sanitation practices than the higher income earners. Aside the fact that they constitute more than two-third of the respondents in the current study, they may largely constitute the unemployed or self-employed categories of persons which enables them create the time to maintain their surroundings. The higher income earners may be government or private employees or large-scale business owners who may only attend to their environment about 2-4 times a month probably because of their busy schedules.

## CONCLUSION AND RECOMMENDATIONS

Poor environmental sanitation practice has been strongly linked to high malaria transmission, morbidity and mortality rates especially in low and middle income countries. In Nigeria, malaria remains a major public health problem with higher endemicity in rural and semi-urban settings. Findings in the current study showed that most respondents recorded poor environmental sanitation practices. Hence, the government at all levels in conjunction with the local communities should provide basic sanitation facilities such as good channeling of drainage systems for proper disposal of wastewater and waste collection services for proper disposal of household generated solid wastes, etc. This is critical to the prevention and control of mosquitoes and malaria transmission. Agricultural activities such as the use of bamboo in the construction of yam barns and the planting of water-bearing crops that encourage the breeding of mosquitoes should be restricted to places outside residential areas. This would also minimize consent verbally before participating in the study.

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## **SIMULATION AND IMPLEMENTATION OF A LOW-COST CARBON MONOXIDE DETECTOR**

**Romanus I.O<sup>1</sup>,**

Department of Applied Physics,  
Federal Polytechnic Mubi,  
Adamawa State.

**Sunday Ayigun<sup>2</sup> &**

Department of Applied Physics,  
Federal Polytechnic Mubi,  
Adamawa State.

**Maria Dingari<sup>3</sup>**

<sup>3</sup>Department of Science Laboratory Technology,  
Federal Polytechnic Mubi,  
Adamawa State.

### **Abstract**

In this research, simulation and implementation of a low-cost Carbon monoxide detector was carried out to provide an efficient, straight forward and robust solution to monitor the air quality continuously and in real-time. It is a portable system that integrates single sensor MQ9 sensor as single unit and can be place anywhere. The result for simulation are 00ppm at 00seconds, 128ppm at 1.8secs, 100ppm at 2.00secs and 50ppm at 2.80secs and in testing the implemented detector, the obtained result in room was 20ppm at 0.00secs, 120ppm at 5secs and 60ppm at 30secs while in outdoor environment at 0.00secs, CO level was 10ppm at 5secs the CO level was 300ppm and at 30secs the ppm level was 40 respectively. The system uses 9V as it DC power supply. The research recommends that the device be modified using GSM module.

**Key words: Sensor, Carbon monoxide, Module, Gas, Pollution and detector.**

### **Introduction**

In recent years, with the development of industry, the problems of air pollution and global warming are becoming increasingly serious, and the gas monitoring system has obtained a sufficient market for development. Gas sensors are essential in the field of Carbon monoxide detection, for purposes such as gas monitoring, high-temperature fire detection, smoking in ghetto, and air quality detection (Gutmacher D *et.,al* 2012) . MQs gas sensor not only

overcome the shortcomings of gas sensors based on catalytic or electrochemical principles, i.e., prone to poisoning, aging, and a short life, but also have high detection accuracy, a large range, high reliability, a long service life and other recognized advantages, which makes this project hotspot and development direction in the future (Betty C.A *et.,al* 2014).

For any workplace, society and homes, a clean and safe environment is all we need. And, factors like CO (Carbon monoxide from cigarette), combustible materials and ethanol gases make an unhealthy impact at the workplace, society and homes. And, that's why you have seen that many organizations make the other rooms for smoking because it is highly unacceptable to do these activities in cooperate environment.

Carbon monoxide (CO) is a colorless, tasteless, and toxic gas to humans. It is usually the result of imperfect combustion, which creates the CO that is a great threat to human health. CO is a serious threat because it can lead to intoxication, which is one of the main causes of uncertain morbidity and mortality (mostly combustion related inhalation injury) (Tomchenko, A *et.,al* 2003). Because of that, it is necessary to determine the best material and technology for sensing this toxic gas. Therefore, researchers investigated many materials using several methods and techniques to detect this gas and to commercialize them in the form of CO sensors. Because carbon monoxide is created in residential and household environments, It is very important to develop mini or micro sensing devices that are cost effective and efficient in these environments. Metal oxide semiconductor (MOS) and electrochemical based sensor of Gas has received a lot of attention because it can be used in the form of micro and macro detector Therefore the concept of this project is to simulate and implement CO Carbon monoxide detector, using electrochemical sensor (MQ-3 sensor) module and microcontroller system.

Several studies have shown that CO sensors are promising in detecting fires (Gutmacher, U *et.,al* 2012). Cestari, Worrell and Milke conducted a study where they compared data from CO sensors in combination with other measurements and technologies, such as temperature rise rate, ionization and photoelectric Carbon monoxide alarms. One of the key findings from the study was that CO sensors detect Carbon monoxide earlier than photoelectric detectors, and that they provide a higher level of nuisance immunity.

Besides looking at how detectors are made by other manufacturers it is also possible to seek out certain standards and specifications which must be followed when designing a detector or sensor. There are standards written by approval companies that manufacturers go to help ensure the safety of their product. These standards can include design requirements for eachCarbon monoxide detectors, heat detectors, and carbon monoxide detectors if the appropriate sets of standards are inquired.

The most used standard for Carbon monoxide detectors is called *Carbon monoxide Detectors for Fire Alarm Signaling Systems (UL 268)* written by Underwriters Laboratories Inc. (UL). This standard goes into great detail about how Carbon monoxide detectors will be tested, which in turn provides information on how detectors can be made and specifications should be followed when designing the detectors. The standard also explains different tests which a

Carbon monoxide detector should be able to pass in order to become a device listed for use. One requirement to meet in this standard is that a detector “shall not alarm prior to an obscuration level of 0.5 percent per foot (1.65 percent/m), or less”. This standard also has many approval tests that a detector must pass in order for it to be accepted by UL.

There is also standard for heat detectors. This is called *Heat Detectors for Fire Protective Signaling Systems (ANSI/UL 521)* and is approved by the American National Standards Institute (ANSI) and Underwriters Laboratories. This standard states that a heat detector with a temperature range of 134 °F to 174 °F is of an ordinary temperature range which is often used for residential applications. The standard says that if the ceiling temperature is not projected to rise above 100 °F then a heat detector within the range of 135 °F to 165 °F should be installed. Another standard which deals with carbon monoxide is called *Standard for Single and Multiple Station Carbon Monoxide Alarms (ANSI/UL 2034)* and is also approved by ANSI and UL.

Safety is the primary concern in any residential or commercial premises. Carbon monoxide and fire are the key element in safety considerations. This project study to simulate and implement an arduino microcontroller Carbon monoxide detector system. Gas detector are very sensitive. However, the most interesting factor is that the gas sensor is easily affected by environmental factors, such as temperature and humidity, so it should have the advantages of better anti-interference ability and a stable and reliable system. The cost of simulating and implementing this detector is relatively low since the components used are relatively cheap and are easily available in the market. The single microcontroller can be used to interface several sensors with alarms located in different locations as long as more pins are freed for multiple inputs multiple outputs.

The aim of this project is to simulate and implement a low-cost Carbon monoxide sensor for environmental monitoring, based around a single-board microcontroller that offer an alternative to commercial gas sensing equipment while still providing accurate measurement. The Following objectives will also be addressed

- i. To simulate Carbon monoxide detector
- ii. To implement a Carbon monoxide Detector using single board microcontroller.

## MATERIALS AND METHODS

The following materials were used during the simulation and implementation of the carbon monoxide detector:

Table 1. Components Required

Components Name	Quantity
Arduino Nano with USB cable	1
MQ-3 Gas Sensor	1
LCD Display with I2C interface - 16 x 2	1
Active Buzzer Module	1
Slide Switch	1
9V Battery with Battery connector	1

PCB Zero board	1
Connecting wires	As required in the circuit diagram
Case	1

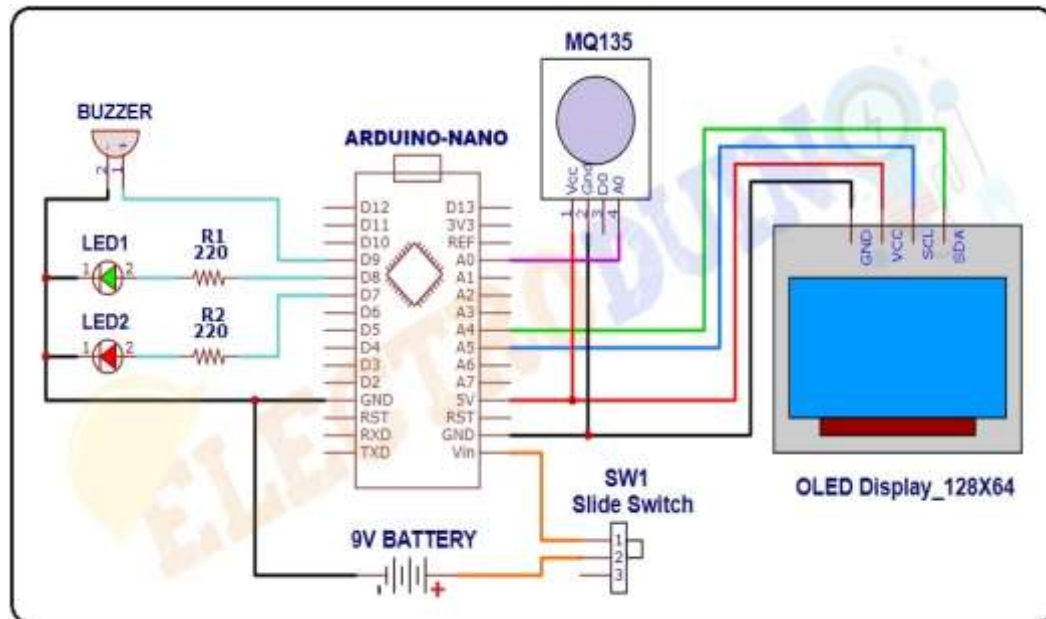
### Tools Required

Tools Name	Quantity
Soldering Iron	1
Soldering wire	1
Soldering flux	1
Soldering stand	1
Multimeter	1
Desoldering pump	1
Wirecutter	1
Standard Screwdriver (Flat heat screw driver)	1

### Software

- Arduino IDE

### METHOD



**Figure.1** Circuit diagram of the carbon monoxide detector

The experiment was conducted to simulate the detector on several rooms, offices and outdoor to monitor and control the concentration of the Carbon monoxide on each of those locations. The area mentioned where simulated.

### Step by Step procedure

1. First mount the sensor to a breadboard. Note that MQ-3 is a heater-driven sensor. For accurate measurement, the sensor needs to be fully warmed up. The code below has a 20s warm-up, but increase the warm-up time to 2 hours for maximum accuracy.
2. Do wiring.
3. Open Arduino IDE.
4. Plug your Arduino Nano board into your PC and select the correct board and com port
5. Verify and upload sketch for analog output or sketch for digital output to your Arduino Nano.
6. Open up Arduino IDE Serial monitor
7. The code was upload to the selected Arduino board
8. The Arduino board was unplugged and the detector was tested



**Figure. 2 The Carbon monoxide detector**

### SIMULATION PROCESS

The programming language used for the coding was C++. The basic structure of the Arduino programming language runs in three parts. The first part includes importing required libraries,

declaring variables and functions. The second part is setup. The setup function runs only once and is used to perform initialization steps, such as setting pin mode as input or output, initializing serial communication, etc. The third part is loop function, this function is the core of programming and the codes in the loop will be executed continuously. The basic structure of the software running on the Arduino board is shown as flowing:

1. The first step is initialization and setup. This process includes declaration of any required variables, setting up and initializing all the pins. For example, declaring using float to define humidity value, setting pin mode, initializing serial communication, and setting baud rate at 9600
2. The loop function follows next and includes the actions of sensors that to be executed by the controller continuously. In the loop, data collection proceeds in the following sequence: CO<sub>2</sub>. This is an infinite loop and will end when the device shuts down.
3. The measurement results are displayed on the LCD screen and sent to the serial port.
4. I set a 30 seconds cycle for the microcontroller to take all the measurements. If the time has not passed the 30 seconds cycle, there will be a delay. During the delay, only the time is refreshed (at the rate of once per second) on the LCD screen and the serial port. The simulation process was conducted by filling a building room and the opened space with Carbon monoxide and other gases.

After there is enough flow of the Carbon monoxide inside the room and the opened space, turn off the Carbon monoxide gas. Turn on the sensor, the data will be conducted by a computation unit. The threshold values was set to 9000.

## **IMPLEMENTATION**

After the simulation the setup was implemented as Carbon monoxide detector system by interfacing the required materials on the vero board. The have the sensitivity to detect Carbon monoxide and other flammable gas level in both indoor and outdoor environment.

## **RESULT AND DISCUSSION**

The MQ-3 gas sensor module has four pins (standard male headers) as shown above. The air quality information is readable via the AO pin. Since AO is a varying voltage, this pin is connected to one analog input of a microcontroller. The DO pin is an open-collector digital output (but with a pull-up resistor onboard) that becomes low when the detection level exceeds a predefined level. The detection threshold can be tailored through the small trim pot soldered on the bottom of the module. Following is the generic schematic diagram of the MQ-3 module (forged by me). Initial preparation of the module shouldn't present any undue difficulties if you strictly follows the procedure lined here. Well, first of all power up the module alone with a regulated 5VDC power supply. The heater of the MQ-3 sensor requires 5V and have  $33\Omega \pm 5\%$  resistance, so your power supply must render a minimum 200mA of current for the

sensor part. Remember that at first the MQ-3 gas sensor have to be kept on continuously for its preheating time (over 2 hour) before you can actually play with it. Thereafter, introduce the MQ-3 sensor to the gas you want to detect and slowly adjust the trim pot until DO gets low. I tested my module with isopropyl alcohol, cigar lighter gas, perfumed body spray, and the breath of mine.

Now every time your sensor gets introduced to that gas at predefined concentration, DO will go low (0V) else will remain high (5V). Note that the green LED (OUT\_LED) should also light up when gas is observed. Also note that when the sensor is powered up for gas detection, it needs around 60-120 seconds to settle, because the heater will need that much time to heat the sensor up. Remember, the MQ-3 gas sensor is suitable for detecting (or measuring) of NH<sub>3</sub>, NO<sub>x</sub>, alcohol, Benzene, smoke, CO<sub>2</sub>, etc.

As might be expected you can take the AO output to achieve the same thing rather in a slightly different way. Try to read the AO output (0-5V) through a microcontroller so that you'll get an output voltage directly proportional to the concentration of the gas to which the sensor is keyed to detect. This lets you experiment more with the analog output values and develop your project accordingly. Give it a good try!

This is a very bare code to read values from the MQ-3 module with its AO connected to A0 of an Arduino nano. The values read from the sensor is proportional to the air quality measured by the sensor, and it's displayed on the serial monitor. Remember to use a separate 5VDC power supply for the MQ-3 module (as mentioned earlier) but firmly join their ground rails (GND) together so that they can work with a common ground connection As the device is powered, the Arduino board loads the required libraries, flashes some initial messages on the LCD screen and start sensing data from the MQ-3 sensor. The sensor is calibrated by preheating for 2hours so that its analog output voltage is proportional to the concentration of polluting gases in PPM. The analog voltage sensed at the pin A0 of the Arduino is converted to a digital value by using the in-built ADC channel of the Arduino. The Arduino board has 10-bit ADC channels, so the digitized value ranges from 0 to 1023. The CO<sub>2</sub> sensor module requires a pre-heat time before taking measurements. Because of this, the device was powered on for about 2 hours before taking the first reading.

When the detector is placed in a smoky environment the buzzer is activated and indicated "CARBON MONOXIDE DETECTED". This was as expected since the quantity of Carbon monoxide had surpassed the environment. The device was placed outdoor and monitored temperature and humidity. The results were read from the LCD screen in ppm .Before taking the measurement, the device was given time to adjust to the outdoor temperature because of the large temperature difference between the room temperature and outside temperature. When the ppm value is <400 the environment is clean and if the ppm level exceed 40, there is presences of Carbon monoxide in the environment.

## CONCLUSION AND RECOMMENDATION

### Conclusion

Human safety is a very crucial aspect in both domestic and industrial setting, hence use of CO sensors is inevitable in addition to other more sophisticated security systems. From the discussion of the work above, it was observed that it detects CO and other flammable gases and its detection rate depends on the range at which you place the controller, it uses low power and the battery used for the device has a long-life cycle, it is very small and not heavy. For efficient and good detection level it is advisable that the device should be mounted to the ceiling above the ground and in direction of the window where there is most likely to be the direction of the wind to facilitate the contact of the sensor with the smoke containing CO so as to be able to detect fast enough and issue an audible alert to the occupant of the premises. This project is done to help the society secure good air quality and the device can be used for security purposes in detecting smoke where it is prohibited.

### RECOMMENDATIONS

The following suggestions are for future research:

1. Increasing the range of detection and by making the device use both DC (Direct Current) and AC (Alternating Current) power supply and also make the battery rechargeable.
2. The function of the system can be enhanced by adding a wireless network function.

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**CHARCOAL STOVE (KOLLYSON-YOYO) INNOVATION WITH THERMAL PERFORMANCE, SAFETY AND DURABILITY FOR WOMEN IN NORTH-CENTRAL NIGERIA**

**Sikiru Gbenga K.,**

Department of Pest Management Technology,  
Federal College of Forestry, Jos,  
Plateau State, Nigeria

**Olorundare Olufunke O.,**

Department of Pest Management Technology,  
Federal College of Forestry, Jos,  
Plateau State, Nigeria

**Olori Oke Olusolape.,**

Department of Pest Management Technology,  
Federal College of Forestry, Jos,  
Plateau State, Nigeria

**Ayorinde James,**

Department of Pest Management Technology,  
Federal College of Forestry, Jos,  
Plateau State, Nigeria

**Oladejo Afolabi O.**

Department of Pest Management Technology,  
Federal College of Forestry, Jos,  
Plateau State, Nigeria

**John Omokoje**

Department of Pest Management Technology,  
Federal College of Forestry, Jos,  
Plateau State, Nigeria

**Abstract**

The cooking stoves used by households are not always efficient and pose serious environmental and health problems. Improving the energy efficiency of cookstoves reduces biomass consumption and thus the anthropogenic pressure on forests. This work aims to

identify the best charcoal cooking stove(s) in terms of energy performance, safety and sustainability. The approach combines the combined study of the energy performance, safety and durability of charcoal cooking cookers. A representative sample of five types of charcoal stoves commonly used in Nigeria is tested according to the requirements of the ISO 19867 standard. These are the square cooking stove, the circular cooking stove, the clay cooking stove, the Nansu cooking and Kollyson-Yoyo stove. The results show two stoves with the best performance: The Nansu stove with a total energy efficiency of 21.43% and an output of 0.9 kW and the Kollyson-Yoyo Charcoal stove with a total energy efficiency of 24.12% and an output of 0.71 kW. These two stoves are made of clay and double metal walled coupled with a blower of 12 volt power bank respectively. They both offer the best safety with an overall average rating of 61.5 and 70.5 for. The Kollyson-Yoyo stove has better durability than the clay stove. This study thus contributes to the preservation of the environment and health through the recommendation of efficient, safe and durable charcoal cookers to be promoted.

**Keywords:** Charcoal stove, Energy performance, Safety, Health risks, Thermal performance

## INTRODUCTION

Around two-thirds of the population of developing countries, as at 2000, is still primarily dependent on bio-fuels for domestic use (Boy *et al.*, 2000). In Nigeria, seventy-two percent of the population depends on traditional fuel wood for cooking (ICEED 2013). There are 2.8 billion people or 38% of the world's population and nearly 50% of the population in developing countries who live without access to modern sources of cooking energy to cook food according to International Energy Agency (2017) WEO-2017 special report. In Africa, the number of people without access to modern sources of cooking energy exceeded 900 million in 2018. This situation forces people to rely mainly on traditional solid fuels (firewood and charcoal), International Energy Agency (2019). The cooking stoves used by households are not always efficient and pose serious environmental and health problems. Indeed, traditional three-stone cookstoves are mostly used in rural areas. Traditional cooking stoves are most commonly used by low-income households. This type of traditional cooking stove is generally identified as a very inexpensive or free device, which may include a simple open fire, built on the ground with three stones to support a pot, or a basic ceramic, clay or metal stove. It is characterized by very low efficiency, unlike improved cookstoves, which have better performance, International Energy Agency (2017) WEO-2017 special report. Traditional cooking stoves in Africa have average energy efficiency scores ranging from 18% to 21% for wood-burning stoves and 21% to 24% for charcoal stoves. Meanwhile, these scores are much higher for improved cookstoves. Several works are therefore being carried out to implement improved cookstove technologies to improve household health and economy. Many cookstove models have been implemented in many countries around the world (Akolgoet *al.*, 2018).

These different programs have had mixed but generally unsatisfactory results. Energy is at the heart of all human development. To this end, Sustainable Development Goal 7 (SD Goal 7) to ensure access for all to reliable, sustainable and modern energy services at an affordable cost is defined by the United Nations. However, millions of people around the world live in energy poverty, marked by lack of access to modern energy sources and lack of access to clean cooking energy, Internationalenergyagency(2017)WEO-2017specialreport. About 40% of households worldwide cook on open stoves or inefficient biomass cooking stoves.

A World Bank study conducted in 2015 indicates that 81% of households in Sub-Saharan Africa use solid fuels for cooking energy needs (Jagger et al., 2018). Recently, the special report Africa Energy Outlook 2019 published by the International Energy Agency (IEA), shows that about 850 million people in Sub-Saharan Africa still use wood energy as their main source of energy.

In Benin, according to the 2017 report of the Energy Information System of the Ministry of Energy, wood energy (firewood and charcoal) accounts for nearly 50% of the national energy balance, followed by hydrocarbons (about 47%) and electricity accounts for about 3%. A recent study indicates that out of a sample of 640 households surveyed in Benin, 76.48 percent depend on fuelwood and 18.18 percent on charcoal, Internationalenergyagency(2019). Charcoal is mainly used in urban and peri-urban areas, while fuelwood is used in rural areas. The dependency of populations on solid fuels increases anthropogenic pressure on vegetation cover. This is exacerbated by inefficient charcoal burning techniques and the use of very inefficient wood or charcoal cooking stoves. The GHG emissions are no longer captured because trees are cut down in an uncontrolled manner. Emissions generated by the combustion of biomass also contribute to the GHG emissions responsible for global warming. Several studies are being conducted to improve the energy efficiency of cooking stoves by looking at the technology of cooking stoves or the geometry of charcoal or the emissions generated by the combustion of biomass. In this sense, Zhao et al. (2020) have shown that reducing the size of coal has improved thermal efficiency and reduced pollutant emissions (Akolgoetal.,2018). The same source recalls that residential use of coal has been recognized as a major source of air pollutants (Zhao et al.,2020). including carbon monoxide (CO), nitric oxide (NO), hydrogen sulfide (H<sub>2</sub>S), sulfur oxides (SOX), methane (CH<sub>4</sub>), black carbon (BC), primary particulate matter (PM), volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), and greenhouse gases. Exposure to pollutant emissions and indoor pollution causes several negative health effects in households (Akolgoetal.,2018).Households are susceptible to respiratory, cardiopulmonary, and other health problems, which are responsible for an estimated 1.1 million premature deaths in China, for example (Cohen et al., 2017). In addition to the adverse health and environmental effects, the economic losses are not negligible (Akolgoetal.,2018).

In Nigeria, the carbonisation technique is that of the traditional millstone with a low mass yield (generally less than 15%) (Hello International 2014). It thus takes on average 6 kg of wood to produce 1kg of charcoal. Energy management is one of the surest ways to achieve Sustainable Development Objective 7 (SDO7). It is therefore important to identify the equipment with the best aptitudes from an energy, environmental and safety point of view. Thus, this study focuses on assessing the energy performance, safety and durability of charcoal cooking stoves commonly used by households in the North-central, Nigeria. Indeed, previous studies carried out in Nigeria have focused on determining the technical performance of cooking stoves used in Benin by the boiling water technique (Anjorin et al., 2014). This work is devoted to the study of the influence of the type of cooking stove on performance, as well as the savings that can be achieved with the different cooking stoves.

### **STATEMENT OF THE PROBLEM**

The cooking stoves used by households are not always efficient and pose serious environmental and health problems. The square cooking stove, the circular cooking stove, the clay cooking stove, the rim cooking stove and the Nansu cooking stove, all have one problem or the other (Okafor et al., 2019), (Evrard et al., 2021). There are currently more than 160 operating cookstove implementation programs in the world (Raman et al., 2013). A few thousand of the cookstove implementation program distribute stoves in specific areas. This is due to high cost of alternative stoves, cookstove malfunction, and the lack of understanding as well as the importance of gender roles and discussing the adoption of alternative cookstove technology. In failing to include women in the household decision-making process, as they are predominantly responsible for childcare and meal preparation, it can lead to a decrease in adoption of improved cookstoves ([https://en.wikipedia.org/wiki/Improved\\_cookstove](https://en.wikipedia.org/wiki/Improved_cookstove)).

### **JUSTIFICATION**

The concept of user-centred design has arguably given rise to one of the most fundamental changes in the field of design over the past few decades (<https://www.interaction-design.org>). Design has since shifted focus from giving form to objects and information to enabling user experiences, and from physical and cognitive human factors to the emotional, social, and cultural contexts in which products and communications take place. (Boztepe, 2007: 57). The design process used for this project was loosely based on the process of user-centred design by van Buurman (1997) as discussed in Kahmann and Henze (1999: 114 in Green and Jordan, 1999) but adapted by the research group for the specific needs of the project. As seen above, there is a lot of work being done to improve the energy efficiency of cookstoves and reduce solid fuel consumption, but the safety and durability of cookstoves has long been overlooked (Johnson and Bryden, 2015).

**AIMS:**

This project aims to produce the best charcoal cooking stove(s) in terms of energy performance, safety and sustainability.

**Objectives:**

- Assessing the energy performance, safety and durability of charcoal cooking stoves commonly used by women in north-central Nigeria.
- Determining the technical performance of cooking stoves used in north-central, Nigeria by the boiling water technique
- Study the influence of the type of cooking stove on performance, as well as the savings that can be achieved with the different cooking stoves.

**MATERIALS AND METHOD*****Materials***

A representative sample of four types of charcoal cooking stoves being used in Panyam, Mangu, Jos-south and Jos-North were compared with Kollyson-Yoyo stove. The five models of cooking stoves are described in the following paragraphs. Each stove model represents a family of similar charcoal cooking stove models.

**(1) The charcoal/Wood circular cooking stove**

For this traditional charcoal cooking stove, very often, the sheet metal used in the construction of this type of stoves are the carcasses of abandoned cars or scrap metal. The coal chamber is circular with holes distributed over the bottom. The stove is covered with a thin coat of paint for aesthetics.

The following Figure 1 describes this type of cooker.



***Figure 1: The charcoal/Wood circular cooking stove***

(2) Square charcoal cooking stove

Usually manufactured by welders from metals (usually iron), it is widespread and mainly used in households and in food service locations. This type of cooking stove (see Figure 2) is widely available throughout the country.



**Figure 2: Square charcoal cooking stove**

(3) Charcoal cooking stove made of baked clay

In keeping with rural uses and practices, this stove is made from a local material available in the environment: fired clay (see Figure 3). It is used because of its resistance to weather conditions such as heat, wind, rain, insulation capacity etc. (see Figure 3). This stove allows a good part of the energy to be contained in the material due to the thermal properties of clay.



**Figure 3: Charcoal cooking stove made of baked clay**

(4) Nansu charcoal cooking stove

Made from metal (iron or aluminum) and clay, the Nansu stove, shown in Figure 4, is a clay stove with a metal lining. The upper part consists of a ceramic core for the fuel, two handles used to lift the stove and three triangular metal rod supports on which the pot rests. The lower part of the stove rests on a pedestal and has a door at the front of the stove to control air flow and remove ashes.



**Figure 4. Nansu charcoal cooking stove.**

**(5)Kollyson-Yoyo Charcoal Stove: Design Solutions**

We began design and development work on the stoves based on the scientific principles of the Maputo Ceramic Charcoal Stove and informed by the experience of the stove users particularly the women in Panyam, Mangu Local Government, Jos-south and Jos-North, Plateau State(Bradnum *et al.*, 2013). The intention of this phase of the project was to develop solutions from concept sketches into physical test models, test the scientific validity of the new design through basic efficiency tests and also test the user reaction to the designs proposed(Boztepe, 2007). This phase resulted in several minor improvements to the current stoves including: the addition of a removable ash tray and the addition of a cover plate. In addition to this, several new stoves were developed: the Prism Design, Double Walled, Based on Scientific Principle andthe Pot Skirt. What follows is a brief collection of the more interesting designs and some of the results obtained. The Yoyo charcoal stove was manufactured and developed based on the combination of users desire, energy safety, efficiency, durability and longevity (Boztepe, 2007).



**Figure 5: Kollyson-Yoyo Charcoal Stove**

**YOYO Charcoal Stove Uniqueness:**

***Double metal walled filled with fiber coupled with rechargeable battery and a blower of 12volt power bank***

- **Forced air stoves** have a fan powered either by a battery, an external source of electricity, or a thermoelectric generator. This fan blows high velocity, low volume jets of air into the



combustion chamber, which when optimized results in more complete combustion of the fuel (Global Alliance for Clean Cookstoves, <http://cleancookstoves.org/technology-and-fuels/stoves/>)

### **Methods Methods**

- The water boiling test (WBT), stove performance test protocol version 1.5 (Bailiset *al.*, 2004) was used in this study to measure performance during operation of the stoves. This method has three components: a test at high power that is conducted with cold and hot start conditions and a test at low power that begins immediately after the hot start phase. In this study, the high power test was conducted with the cold start phase to determine the thermal efficiency, fire power, specific fuel consumption and the burn rate of the various stoves. The water boiling test procedure is described below
  - i. The pots are weighed empty and dry, then the weights are recorded
  - ii. The pots are filled with water to 2/3 of their capacity, their new weights are taken and recorded
  - iii. A quantity of wood not more than twice the estimated needed amount Taken, weighted, and its weight recorded.
  - iv. A thermometer was placed in each pot and the water temperature may be measured at the center, about 1 cm from the bottom.

The water temperature was recorded.

- v. A record of the time at which water in the first pot comes to full boil was taken
- vi. At this point, the following rapidly done:
  - All wood from the stove was removed and any charcoal knocked off. The Weight the wood, together with the unused wood from the previously weighted supply was taken.
  - The Weight of all charcoal was separately taken.
  - A Record the water temperature from each pot was taken.
  - Each pot, with its water was weighted.
  - The charcoal, burning wood and pots were returned to the stove to begin the “low power “phase of the test. i. The charcoal and all remaining wood was recovered and weighted separately, the weights are recorded ii. The weight of each pot with its remaining water was taken and recorded

The stoves were tested in the out-door environment to match the cooking method mostly used by the people in Mubi. The test was conducted in Yelwa ward, Mubi metropolis of Adamawa State. Each stove was loaded with the required quantity of fuelwood or charcoal, and sprinkled with 10ml of kerosene to aid ignition. A Pot without lid was filled with 2kg of water and placed on the charged stove and was observed till boiling. At boiling, the pot was removed from the stove and the fire was immediately quenched. The measurements taken before, during and after the experiment include: the calorific value of fuels, the moisture content of fuels, the

mass of the pot, the initial mass of fuel, the mass of fuel remaining, the mass of water in the pot at the beginning and end of the test phase, temperature of water at the beginning and end phase and the time taken to boil the water. Each experiment was repeated four times and average results recorded.

The water boiling test (WBT) method can be used to assess the thermal efficiency (H), the fire power (P), the specific fuel consumption (SC) and the burn rate (F) of stoves. Several formulae relating to cookstove performance have been developed. For this study the methods based on the approach by (Johnson 2015) and (Gallagher *et al.*, 2016). would be used.

1. Thermal efficiency (H) is the ratio of the work done by heating and evaporating water to the energy consumed by burning wood (Johnson 2015). Mathematically,

$$H = \frac{4.186W_w(T_f - T_i) + 2260W_v}{F_d \times \text{LHV}}$$

Here,  $W_w$  is the mass of water in the pot in Kg, 4.186J/g°C the specific heat of water,  $(T_f - T_i)$  the change in water temperature in °C,  $(W_v)$  is the amount of water evaporated from the pot, while 2260J/g is the latent heat of evaporation of water. The dry wood equivalent consumed during each phase of the test is  $(f_d)$  in Kg and the LHV, lower heating value (also called net heating value) of the fuel.

2. Fire Power (P) is the ratio of the wood energy consumed by the stove per unit time (W) during each phase of the test. Mathematically,

$$P = \frac{f_d \times \text{LHV}}{60(t_f - t_i)}$$

Where  $(t_f - t_i)$  is the duration of the specific test phase.

3. Specific fuel consumption (SC) is the ratio of the amount of fuelwood consumed to the amount of water remaining at the end of the trial, can be defined for any number of cooking tasks, and should be considered “the fuelwood required to produce a unit output” whether the output is a boiled water, cooked beans, or loaves of bread (Johnson 2015). Mathematically

$$SC = \frac{f_d}{W_{wf}}$$

Where,  $W_{wf}$  is the mass of water boiled in Kg. In this case specific fuel consumption refers to a measure of the amount of wood required to produce 2kg of boiling water.

4. Burn rate (F) is the measure of fuel consumption to bring water to boil. It is the ratio of fuel consumed to duration of the test (Gallagher *et al.*, 2016). Mathematically,

$$F = \frac{1}{t} \times \frac{100(W_i - W_f)}{100 + M}$$

where,  $t$  is the total time taken for burning fuel,  $W_i$  is the initial mass of the fuel before burning in Kg,  $W_f$  is the mass of fuel after burning in Kg and  $M$  is the moisture content.

$$\text{Moisture Content} = \frac{\text{mass of moisture in wood sample}}{\text{mass of oven - dry wood sample}}$$

## RESULTS AND DISCUSSION DISCUSSIONS

The moisture content was measured to be 9.6% for the fuelwood. The charcoal which is the byproduct of the combustion of wood has a moisture content of 5.2%. The calorific value of fuelwood was determined as 18400KJ/kg and for charcoal was 27600KJ/kg. Results of the five stoves tested are summarized for easier comparison in Table 1; the time to boil, thermal efficiencies and specific fuel consumptions for the four stoves tested are also presented as bar graphs in Figs 5, 6 and 7 respectively.

**Table1: Water Boiling Rate (WBT) Results for the various stoves tested**

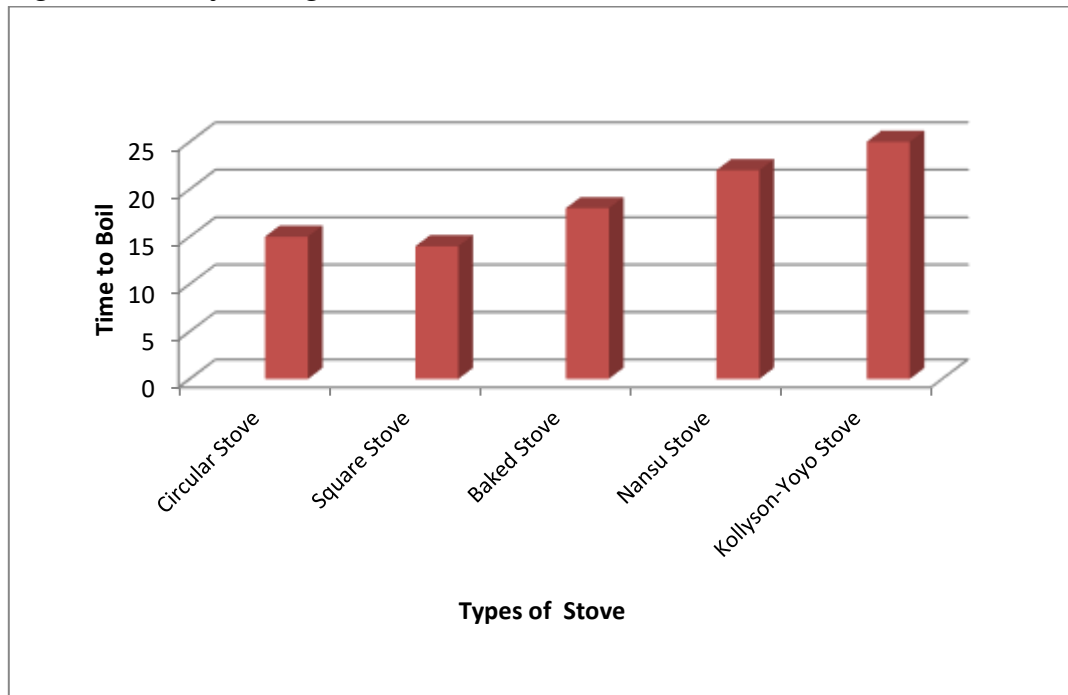
Parameters	Circular Charcoal stove	Square charcoal cooking stove	Baked Charcoal stove	Nansu Charcoal stove	Kollyson-Yoyo charcoalstove
Mass of Pot (kg)	0.42	0.42	0.42	0.42	0.42
Mass of stove(kg)	0.37	0.88	1.43	1.74	2.88
Initial fuelMass(kg)	3.15	2.70	1.10	0.90	0.61
Final Fuel Mass(kg)	2.76	2.42	0.96	0.82	0.69
Initial Temp °C of water	26.2	26.2	26.2	26.2	26.2
Final Temp °C of water (kg)	100	100	100	100	100
Initial Mass of Water (kg)	3.0	3.0	3.0	3.0	3.0
Final Mass of Water (kg)	2.92	2.90	2.91	2.93	2.9
Boiling During(kg)	17.5	15.8	14.1	13.4	12.2
Fire Power (W)	0.52	0.50	0.45	0.4	0.31
Specific Fuel Consumed	0.33	0.30	0.23	0.18	0.08

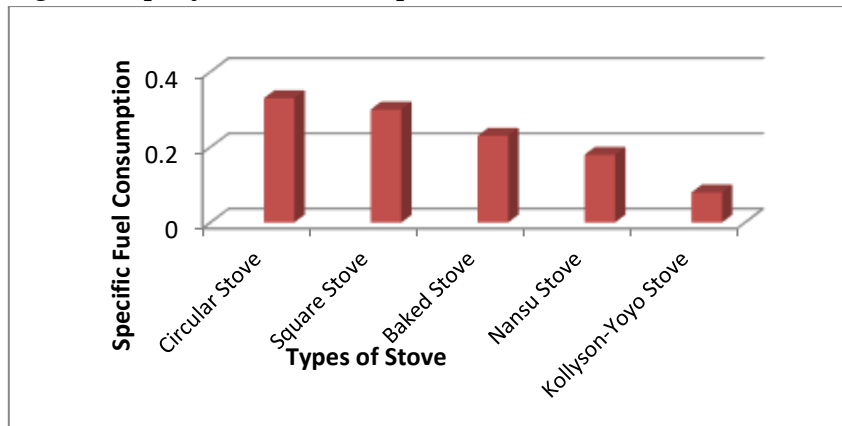
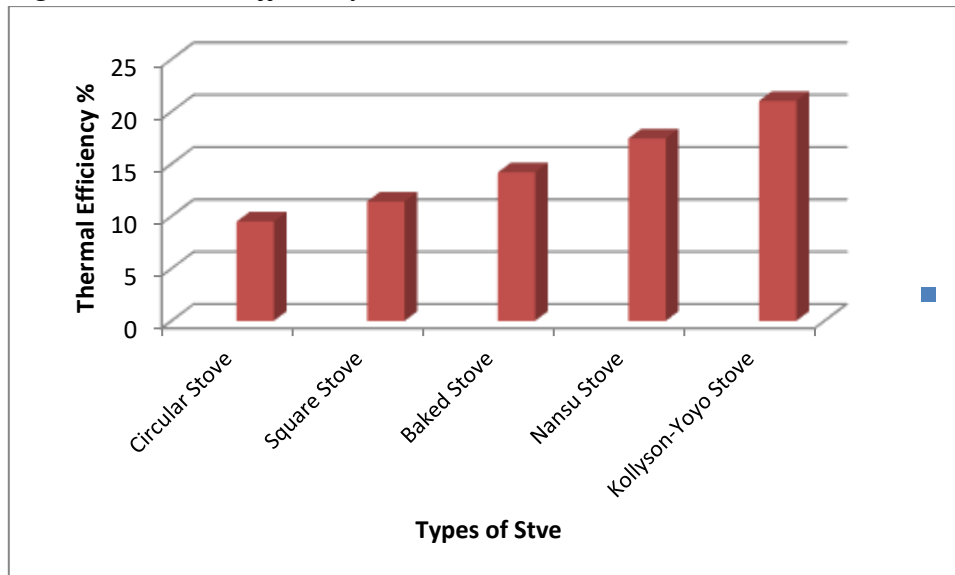
<b>Burn Rate(kg/min)</b>					
<b>Thermal Efficiency(%)</b>	<b>0.0283</b>	<b>0.028</b>	<b>0.008</b>	<b>0.007</b>	<b>0.006</b>
	<b>9.50</b>	<b>11.41</b>	<b>14.20</b>	<b>21.43</b>	<b>24.12</b>

**Table 2: Cost of Stove**

Type of Stove	Type of Fuel	Cost In (Naira)
<b>Circular Charcoal stove</b>	Wood	500
Square charcoal cooking stove	Charcoal	1000
Baked Charcoal stove	Charcoal	800
Nansu Charcoal stove	Charcoal	7000
Kollyson-Yoyo charcoalstove	Charcoal	10000

**Figure 6: Time of Boiling**



**Figure 7: Specific Fuel Consumption****Figure 8: Thermal Efficiency**

Through the present study, we have managed to show that among the five types of charcoal cooking stoves commonly used in North-central Nigeria, only two present interesting energy performances and safety. These are the Nansu and Yoyo stoves respectively. However, the study revealed that only the Kollyson-Yoyo cooking stove has excellent durability with a lifespan of between 3 and 5 years. The improved stove technology should include the use of double walled vacuum as this study proves that the presence of double walled frame improves the energy performance of the stoves(Boztepe2007), the reduction of pressure on the forests, the improvement of the household economy and the reduction of the drudgery of collecting

wood for women and children(Zhao et al., 2020). It is desirable that the authorities in charge of energy and environment issues popularize the improved stoves as much as possible to subsidize their purchase.

## CONCLUSION

The present study shows that among the five types of charcoal cooking stoves commonly used in Panyam, Mangu, Jos-south and Jos-North, only two presented interesting energy performances and safety. These are the Nansu and Kollyson-Yoyo stoves respectively.

However, the study revealed that only the Kollyson-Yoyo cooking stove has excellent durability with a lifespan of between 3 and 5 years. The improved stove technology should include the use of double walled frame, as this study proves that the presence of fiber in-between the walls improves the energy performance of the stoves. Switching to the Kollyson-Yoyo cooking stove is beneficial in several ways. The reduction of pressure on the forests, the improvement of the household economy and the reduction of the drudgery of collecting wood for women and children. It is desirable that the authorities in charge of energy and environment issues popularize the improved stoves as much as possible to subsidize their purchase.

## RECOMMENDATION

This study could not evaluate wood burning cook stoves and could not measure emissions from cookstoves. The next stages of research should address not only these aspects but also the implementation of new improved stove technologies.

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**MEDIATING EFFECT OF ORGANIZATIONAL CULTURE ON THE  
RELATIONSHIP BETWEEN SERVICE QUALITY, CUSTOMER SATISFACTION  
AND CUSTOMER LOYALTY IN TELECOMMUNICATION INDUSTRY**

**Ladokun, I. O \***,

\*Department of Marketing,  
The Polytechnic, Ibadan, Nigeria

**Oyeniya, K.O \*\***,

\*\*Department of Business Administration and Management,  
Osun State Polytechnic, Iree, Nigeria

**Ogunrinade, Ranti \*\***,

\*\*Department of Business Administration and Management,  
Osun State Polytechnic, Iree, Nigeria

**Adeyemi, M. A \*\***

\*\*Department of Business Administration and Management,  
Osun State Polytechnic, Iree, Nigeria

**Abstract**

Today's highly competitive environment, technological advancements, increasing customer demands and an increasingly dynamic economic environment pose the world's greatest challenges to the telecommunications sector. Therefore, this study examines the mediating role of organizational culture between service quality, customer satisfaction, and customer loyalty, with particular reference to the MTN, Nigeria. The survey was distributed to 470 of the MTN Nigeria employees. Data analysis was performed with the structural equation modeling using STATA version 15. The results reveal that service quality was significantly correlated with customer satisfaction and customer loyalty. The study also confirms that service quality is highly related to organizational culture. It also shows that corporate culture has a significant impact on customer loyalty. It was also shown that organizational culture partially mediates between service quality, customer satisfaction, and customer loyalty. It was concluded that organizational culture and service quality are important factors in customer satisfaction and loyalty. Therefore, the study recommends that the Nigerian telecom industry management needs to continue to introduce a culture of service quality across the different

services offered. This will go a long way to achieve a leading position in the global Telecommunication space by 2030

**Keywords:** Service quality, Customer satisfaction, loyalty, Organizational culture, MTN

## **Introduction**

Nigeria's telecommunications industry is one of the fastest-growing telecommunications markets in sub-Saharan Africa. Apparently, the sector has grown from 400,000 active lines in 2001 to over 301.5 million functional lines in May 2022 (NCC, 2022). These pioneering achievements in the telecommunications industry contributed significantly to the growth of the national economy. This has made Nigeria an investment haven for foreign telecom operators. The NCC's regulatory acumen has enabled the first group of licensed service providers to become complacent monopolies in expanding the quality of service, the telecommunications infrastructure that reliably protects consumer interests. Industry competitiveness, driven by competitive business and sound regulatory policies, has pushed the price of phone lines across the market from N30,000 per SIM card in 2000 to free of charge in 2020. The cost of GSM lines has made mobile phone service for the wealthy affordable to the marginalized in society. The emergence of deregulation in Nigeria's telecommunications sector has brought competition to the industry (Sajuyigbe, 2017).

Today's highly competitive environment, strong regulatory committee guidelines, technological advancements, growing customer demands and an increasingly dynamic economic environment are the world's major challenges facing the telecommunications sector (Sajuyigbe, 2017). To survive in this global competition, an organizational culture must be developed towards service quality and support continuous customer satisfaction and retention (Saghier & Nathan, 2013). According to Quyet, Vinh, and Chang (2015), listening to customers' needs and producing and providing quality products and services will undoubtedly help companies stay competitive and grow stronger. Attention to customer needs is critical for modern businesses.

Today, many organizations around the world employ a variety of strategies to satisfy, retain, and grow customer numbers, increase loyalty, increase sales, profits, and market share, and then survive (Saghier & Nathan, 2013; Ragavan & Mageh, 2013). One of these strategies is quality of service. According to Supriyanto, Bambang, and Burhanuddin (2021), service quality is the customer's perception of a firm's overall service performance in a long-term context. Sajuyigbe (2017) argues that the success of service providers depends heavily on their ability to deliver customer-oriented services. This indicates that quality of service is the ability of a service provider to balance expected and perceived service to generate customer charges. In addition to service quality, organizational culture was related to service quality, customer

satisfaction and loyalty (Oyeobu, et al., 2014; Osman & Sentosa, 2014). Kissack and Callahan (2009) argue that many scholars have noted that culture would remain linked with customer satisfaction and loyalty only if the culture is able to adapt to changes in environmental conditions. In the same vein, Anas (2009) notes that organizational culture has been an important theme in management and business research for the past few decades due to its effect and potential impact on organizationally and individually desired outcomes such as commitment, loyalty, and satisfaction. In today's business environment, organizational culture is used as a powerful tool that portrays many facets of a workplace as well as to quantify the way a business functions (Gray, Densten & Sarros, 2003; Okeke, et al., 2015). Research has confirmed that organizational culture is not only able to change, guide and display but also give significant contributions by influencing the thought, feeling, interaction, and performance in the organization (Ab. & Ali, 2000).

Similar to the telecom industry, the service sector has a responsibility to provide the best possible service to its customers in order to achieve a sustainable competitive advantage. Service quality is difficult for service providers to measure because it is critical to their business. The difficulty in measuring service quality stems from its intangibility, variability, and difficulty in isolating it (Saghier and Nathan, 2013). In this vision, services should have an independent framework for describing and measuring quality. Among the major frameworks, the service quality model developed by (Parasuraman et al., 1988) is the most popular and widely used in the service industry to measure service quality. In addition, while research on the issues of service quality and customer satisfaction has dominated the service literature, there is a growing interest in the telecommunications environment to examine the mediator of organizational culture in its relationship to service quality, customer satisfaction, and customer loyalty. No new research has been done. This study therefore aims to fill existing gaps in the literature by examining the mediating role of organizational culture in the relationship between service quality, customer satisfaction, and customer loyalty in the Nigerian telecommunications industry.

### **Theoretical Framework**

Studies on service quality and customer satisfaction confirm several theories. The theory underlying this study is the SERVQUAL model, developed by Parasuraman, Berry, Leonard, and Zeithaml (1988), which defines service as the discrepancy between customer expectations of service delivery and customer perceptions of that service. The SERVQUAL model consisted of ten dimensions of service quality: Concrete, Responsiveness, Communication, Reliability, Safety, Competence, Courtesy, Customer Understanding, and Accessibility. (Parasuraman et al., 1985). According to Ohiorienoya (2013), companies that practice a culture of service quality can deliver services reliably and accurately. In a similar study, Ezekiel and Dairus (2012) argue that organizations culturally attuned to service quality have a capable workforce

that inspires trust and confidence in quality assurance. Research has confirmed that organizational culture is not only able to change, guide and display but also give significant contributions by influencing the thought, feeling, interaction, and performance in the organization towards tangibles, reliability, responsiveness, communication, credibility, security, competence, courtesy, understanding the customer, and access (Oyeobu et al., 2014; Osman & Sentosa, 2014 ). This theory suggests that when the quality of service is the watchword, businesses are better able to respond to customer's expectations and are willing to help accordingly.

### **Service Quality**

Quality of service has generated considerable interest and debate in the research literature, as there is no general consensus not only on its definition but also on its measurement. Note that this theme has several definitions. For example, Ofosu-Boateng and Acquaye (2020) view service quality as a measure of how an organization performs its services relative to customer expectations. According to Parasuraman et al. (1988), quality of service is an overall assessment of a particular service company, the result of comparing that company's performance to customers' general expectations of the performance of companies in that industry. Similarly, Nitecki and Herson (2000) define service quality as meeting or exceeding customer expectations, or the difference between customer perception and service expectations. Previous studies have linked service quality to customer satisfaction and loyalty. For example, a study conducted by Liu and Khalifa (2003) established a positive correlation between service quality, customer satisfaction, and customer loyalty. Ofosu-Boateng and Acquaye (2020) also argue that service quality is highly related to customer satisfaction and customer loyalty. In a similar study, Hennayake (2017) agreed with previous studies that service quality is a predictor of customer satisfaction and customer loyalty. Brophy et al. (2015) argue that service quality, customer satisfaction, and customer loyalty must be viewed as essential in the service economy, as consumer needs/desires and expectations regarding shopping experiences are constantly evolving. According to Johanson & Ström (2002), customer satisfaction is the result of customers comparing perceived quality with actual service performance, and customer loyalty is the extent to which customers are committed to a company's products and services, and how strong the customer's propensity to choose a brand over its competition. Customer loyalty is positively correlated with customer satisfaction because satisfied customers always prefer brands that meet their needs (Ofosu-Boateng & Acquaye, 2020). Loyal customers only buy a company's products and services and are less willing to change their preferences than their competitors (Ofosu-Boateng & Acquaye, 2020). A study by Shanka (2012) found a positive correlation between service department service quality, customer satisfaction, and customer loyalty. This means that service quality has a lot to do with customer satisfaction and customer loyalty.

### **Organizational Culture as a mediator**

There is no universally accepted definition of organizational culture. Organizational culture was defined differently. For example, Schein (1990) defines organizational culture as “a pattern of fundamental assumptions that certain groups have invented, discovered, and developed as they learned to deal with problems of external adaptation and internal integration that have worked well. Therefore, being considered valid and valid teaches new members how to properly perceive, think and feel these issues. According to Dwirantwi (2012), culture is built into an entire organization over time as values, practices are developed and passed on to new employees. This idea was also endorsed by Suppiah and Sandhu (2012), stating that organizational culture generalized as a "set theory" of key values, beliefs, and understandings shared by the, offering a better (or best) way of thinking, feeling, and thinking. Responses that help managers make decisions and arrange organizational activities.

Numerous studies have confirmed the impact of organizational culture on service quality, customer satisfaction and loyalty. For example, Alshemmari (2020) argues that organizational culture has a lot to do with service quality. Similarly, Nongo and Ikyanon (2012) assert that organizational culture is essential to building an effective workforce and achieving customer satisfaction and loyalty within an organization. A study by Gantsho and Sukdeo (2018) confirms that company culture is directly related to service quality, customer satisfaction and loyalty. Similarly, Schein (2010) reiterates that culture as a variable can improve organizational effectiveness through service quality. Wilkins (2010) also argues that organizational culture is a predictor of service quality and customer satisfaction and loyalty. This suggests that if the telecommunications sector is to remain competitive, it must have strong organizational cultural service qualities that can satisfy, attract and retain customers.

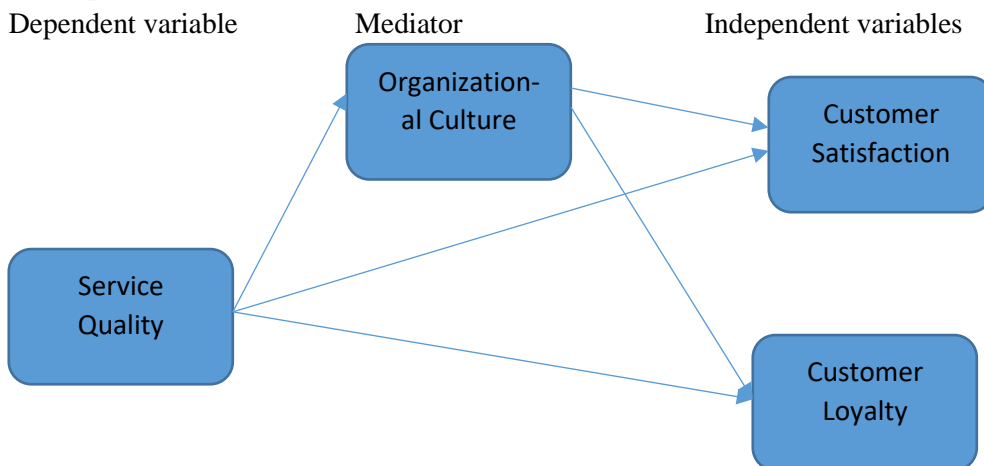
### **Overview of Nigerian Telecommunications Sector**

The telecommunications industry is a strategic and important sector of the Nigerian economy. This has security implications. It is also a source of employment and livelihood for millions of Nigerians. The development of telecommunications in Nigeria can be traced back to 1851 when the British Post established a post office in Nigeria (Sajuyigbe, 2017). This was followed by the establishment of telecommunications in 1885, which the colonists used for effective administration and communication with the London Home Office. Local telecommunications using this system was also introduced in 1885 by the colonial government under the Department of Public Works ( Sajuyigbe, 2017). The first direct telegraph service between Lagos and London finally started in September 1886. By 1950, Nigeria had 98 switches in her 15,063 telephone sets. The replacement was of the magnetic and central battery type. In the same year, General Electric Corporation installed his 600-line automatic switchboard at Port Harcourt, followed by 1953 at Lagos where he installed his 500-line automatic switchboard. In 1963, Ikeja's satellite exchange began with 400 lines, Ebut Metta with 500 lines, and Apapa

with 600 lines. After Nigeria's independence, the sector underwent several stages of development. Potential demand and worldwide acceptance of Global Service Mobile technology has opened the door for GSM operator licenses (Sajuyigbe, 2017).

The first GSM operators, namely MTN, ECONET and NITEL, were licensed in early 2001 and in August 2001 Econet (now Airtel Bharti) and MTN started commercial service. He currently has eight major telecom companies in Nigeria. So MTN, Globacom, Airtel and Etisalat offer Global Systems Mobile Communication (GSM), while another four - Visafone, Zoom and Multilinks - Starcom's Code Division Multiple Access (CDMA). These companies provide voice, data, and video services. According to the Nigerian Telecommunications Commission (2011), the number of fixed and wireless fixed lines available in December 2011 was 95,886,714 compared to 400,000 lines 15 years ago. According to Nigeria His Pilot (2012), NCC Executive Vice Chairman, Eugene Juwah said while speaking at the forum: To realize Nigeria's ambition to become a truly dominant development economy (Sajuyigbe, 2017). The importance of communication is clear, whether developed or not. In fact, the interrelationship between a country's economic development and effective telecommunications services is so closely intertwined that it is difficult to say which comes first. Communication is applicable to nearly every human endeavour, from agriculture and food security to manufacturing, energy and physical infrastructure sectors, and to governance, e-commerce, and public and social service delivery remains visible in perpetuity because it affects. The number of active subscribers in the mobile network is approximately 301.5 million connections (NCC, 2022).

### Conceptual Model



**Figure 1: Conceptual Model**

Based on the literature review and conceptual model, the following hypotheses are proposed:

H1: there is a significant association between service quality and customer satisfaction

H2: there is a significant association between service quality and organizational culture

H3: there is a significant association between service quality and customer loyalty

H4: Organizational culture has a significant association with customer satisfaction

H5: Organizational culture mediates has a significant association with customer loyalty

H6: Organizational culture mediates between service quality and customer satisfaction

H7: Organizational culture mediates between service quality and customer loyalty

### **Methodology**

The survey was distributed to 470 staff members of MTN Nigeria. The survey was personally conducted on randomly selected employees with the help of one assistant researcher to ensure prompt attention and response from respondents. This self-administered questionnaire method allows researchers to ask respondents follow-up questions and collect more information. The choice of this company is based on the fact that it has the largest coverage in Nigeria and is believed to have corporate culture service quality policies that make them aware to satisfy and retain customers.

The data shows that 65.4 percent of the respondents were male while 34.6 percent of the respondents were female. This trend implies that males constituted the larger proportion of the telecommunication industry in MTN. This distribution may be due to the fact that culturally, males often have access to education more than females in most Third World Countries. A look at the age analysis reveals that 42.3 percent of the respondents are between 41-50 years, 38.0 percent were between 31- 40 years, 16.5 percent were between 51 – above years and only 3.0 percent are within 30 years. The mean age of most of the respondents is 42 years which implies that most of the staffers are still very young, energetic, and active. This development connotes that they can still contribute meaningfully to the development of the telecommunication industry in Nigeria.

The result also indicates that 63.5 percent of the respondents are married, 34.2 percent are single, 1.5 percent are divorced and another 0.8 percent are widowed respectively. The result, therefore, shows that most of the staff in the telecommunication industry are married which implies that there will be a great sense of responsibility among those who are married as marriage seems to correlate with being responsible. Result also shows that 30.3 percent of the respondents have a Master's as their highest educational qualification, and 41.1 percent have HND/B.Sc degree, 23 percent have NCE/ND, while 5.4 percent have the professional certificate as their highest educational qualification. The result also indicates that 30 percent are junior staff, 26.9 percent are intermediate and 43 percent are senior staff. The result of the finding implies that most of them attained a minimum status of senior staff. It was also revealed that 23 percent of respondents have been in the industry between 1 – 5 years, 37.7 percent have been in the industry for 6 – 10 years and 39.2 percent have been in the industry for more than 10 years. This implies that most of the staff have experience.



### Measurement of Scale

To test the hypotheses and assess the parameters of this research, STATA version 15 was employed. For mediation analysis, the Structure Equation Modelling was used. The scales measuring variables of the study are:

**Service Quality Scale:** The scale that was developed by Supriyanto et al., (2021). It is a Likert-type scale anchored on the 5-point rating scale. Its response format ranges from “strongly agree” (5) to “strongly disagree” (1). The ICQ consists of four items of service reliability scale with a reliability alpha coefficient of .81; a three-item of service responsiveness scale with an alpha reliability coefficient of .79; a four-item of service provider empathy scale with an alpha of .76 and a three-item of service assurance with an alpha of .82., in the current study, composite reliability alpha coefficient for the ICQ was obtained as .88

**Organizational Culture Scale:** The scale was developed and validated by Suppiah and Sandhu (2012). The response format was in Likert form with indicants ranging from strongly agree (5) to strongly disagree (1). It consisted of 5 items, for example, Employees’ use of required skills and knowledge to answer customers’ questions, having a convenient period and terms for activation, recharge, and account suspension, free call times, having operating hours convenient to all customers, and apologizing for incontinence caused to customers. The author reported Cronbach’s reliability alpha of .91.

**Customer Satisfaction Scale:** The scale was derived from the work of Ofosu-Boateng and Acquaye (2020) and has a total of 5 items. Includes sample items; The products/services offered by my network are satisfactory, my network has satisfactory coverage, your network is truthful (keeping to promise) to customers, and your network gives prompt customer service and attends to customers’ needs/ problems. It is a Likert-type scale anchored on a 5-point rating scale with a degree of response ranging from strongly agree (5) to strongly disagree (1). The author reported a KMO value of 0.774, a principal component value eigenvalue of 1.879, and a variance% of 80.27%. This indicates that the exploratory factor analysis confirmed the consistency of the construct.

**Customer Loyalty Scale:** This construct was created and validated by Hennayake (2017) and has a total of 4 items. Includes sample items; you do not have the intention of switching to other networks and the quality of my network services meet my expectation. It is a Likert-type scale anchored on a 5-point rating scale with a degree of response ranging from strongly agree (5) to strongly disagree (1). The author reported a KMO value of 0.744, a principal component value eigenvalue of 1.765, and a variance% of 71.89%. This indicates that the exploratory factor analysis confirmed the consistency of the construct.

### Results and Discussion

**Table 1: Structure Equation modeling without mediation (Direct Model)**

Path	beta-value	Std. Err.	t-value	P-value	Hypothesis	Remark
CS <- SQ	.3295932	.0678751	4.86	***	H1	Supported
OC <- SQ	.4837035	.0660652	7.32	***	H2	Supported
CL <- SQ	.4835612	.0675563	7.16	***	H3	Confirmed

CL <- OC	.2917963	.0725649	4.02	***	H4	Confirmed
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Table 1 depicts the direct relationship between service quality, organizational culture, customer satisfaction, and customer loyalty. The beta-value of 0.329 and t-value of 4.8 indicates that service quality has a direct link to customer satisfaction. A p-value of 0.000 further reveals that service quality has a significant effect on customer satisfaction. This implies that service quality is a major predictor of customer satisfaction. The study is consistent with the previous studies that service quality is sine-qua-none to customer satisfaction (Ofosu-Boateng & Acquaye 2020; Hennayake, 2017)

Thus, H1 is supported.

The result also reveals that service quality is directly associated with organizational culture with a beta-value of 0.483 and t-value of 7.32, while a p-value of 0.000 confirms the association to be significant. This indicates that an organization embraces a quality culture, and intends to retain its customers. This finding is in line with Osho's (2006) assertion that organizational culture is essential to building an effective workforce and achieving customer satisfaction and loyalty within an organization. A study by Gantsho and Sukdeo (2018) also attests that company culture is directly related to service quality, customer satisfaction, and loyalty. Therefore, H2 is supported.

The beta-value of 0.483 and t-value of 7.16 reveal that service quality has a direct relationship with customer loyalty, while the p-value confirms the relationship to be significant. This connotes that service quality is a strong predictor of customer loyalty. The study is in agreement with the study of Shankar (2012) that a positive correlation exists between service quality and customer loyalty. Thus, H3 is confirmed.

Evidence also shows that organizational culture has a significant influence on customer loyalty with a beta-value of 0.29, t-value of 4.02, and p-value of 0.000. This implies that organizational culture is a major determinant of customer loyalty. Hence, H4 is confirmed.

The implication of this finding is that the telecommunication sector in Nigeria is embracing strong organizational cultural service qualities that can attract, satisfy, and retain subscribers, so as to achieve a vision of taking a leading position in the global Telecommunication space by 2030.

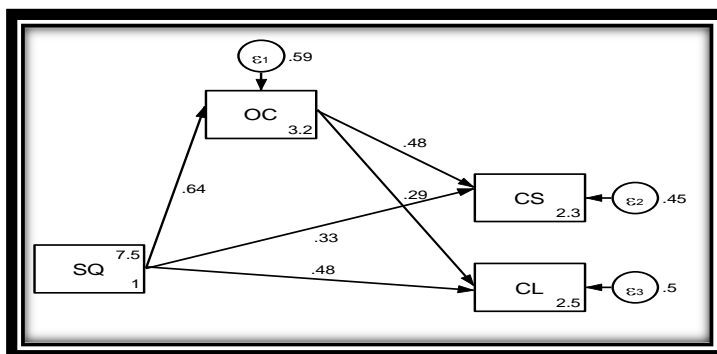


Figure 2: Structural Equation Modeling

**Table 2: Structural Equation Modeling with mediation (Indirect Model)**

Path	beta-value	Std. Err.	t-value	P-value	Hypothesis	Remark
CS <- OC <- SQ	.2783069	.0483781	5.75	***	H5	Partially Supported
CL <-OC <- SQ	.1666306	.0450957	3.70	***	H6	Partially Supported

Table 2 reveals the mediating role of organizational culture between service quality, customer satisfaction, and customer loyalty. The beta value of 0.278 and p-value of 0.000 indicate that organizational culture partially mediates between service quality, and customer satisfaction, while the beta-value of 0.166 and p-value of 0.000 also evident that organizational culture partially mediates between service quality and customer loyalty (see Figure 2). This result is in line with the guidelines proposed by Zhao et al., (2010), and Baron and Kenny (2003) that partial mediating occurs when the independent variable and mediator are predictors of the dependent variable. Thus, H5 and H6 are partially supported.

The implication of this finding is that the telecommunication sector demonstrates a service quality culture such as understanding customers' needs, using required skills and knowledge to answer customers' questions, giving prompt customer service and attending to customers' needs/ problems, keeping to promises to customers, and apologizing for incontinence caused to customers, customer satisfaction and loyalty. This is true because organizational culture quality policies attract subscribers and retain them (Sajuyigbe, 2017). Therefore, the sector can still become stronger and remain competitive and achieve a leading position in the global Telecommunication space by 2030 when the service quality culture is implemented.

### Conclusion

Today's highly competitive environment, technological advancements, increasing customer demands and an increasingly dynamic economic environment pose the world's greatest challenges to the telecommunications sector. Therefore, this study examines the intermediaries in organizational culture between service quality, customer satisfaction, and customer loyalty, with particular reference to the MTN, Nigeria. The survey was distributed to 470 of the MTN Nigeria employees. Data analysis was performed with structural equation modeling using STATA version 15. The study found that service quality was significantly correlated with customer satisfaction and customer loyalty. The study also confirms that service quality is highly related to organizational culture. It also shows that corporate culture has a significant impact on customer loyalty. It was also shown that organizational culture partially mediates between service quality, customer satisfaction, and customer loyalty. It was concluded that organizational culture and service quality are important factors in customer satisfaction and loyalty.

## Recommendations

The following recommendations are derived from the findings of this study.

- i. Nigerian telecom industry management needs to continue to introduce a culture of service quality across the different services offered.
- ii. Nigerian telecom industry management should foster a culture that does not encourage subscribers to switch to other networks.
- iii. Nigerian telecom industry management needs to improve network services as the level of security and reliability that customers receive from their service providers determines their level of confidence in the services provided.
- iv. Nigerian telecom industry management should have a culture of offering a range of value-added services such as music, internet access, SMS and MMS, far superior to other networks.

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## **INFLUENCE OF CORONA VIRUS (COVID-19) PANDEMIC ON THE EDUCATION OF CHILDREN LIVING WITH SPECIAL NEEDS IN NIGERIA**

**Mwapishak, Mikitda Sani**

Otana Edu-Health Services Nigeria,  
Jos Branch, Jos,  
Plateau State

**Mbai Matlong Sylvia**

Department of Special Education and Rehabilitation Sciences Faculty of Education,  
University of Jos,  
Plateau State.

### **Abstract:**

This paper focused on factors that influenced the level of inclusion in education for children with special needs before and during the Corona Virus Pandemic (COVID-19) and determined the influence of pandemic-related circumstances (e.g social distancing, online learning) on the well-being and daily activities of children living with special needs and their parents. The writers portray that during the pandemic period, home isolation, lack of socialization, changes in daily routines and lack of services negatively affected the emotional states of children living with special needs, contributing to parental overload and stress. Multiple factors influenced low inclusion and benefits for children with special needs in distance/online education during the pandemic. Thus, to improve education quality, inclusion and opportunities for children living with special needs, we recommend adapting curricula and teaching programmes according to children's individual needs, providing equal treatment to all children, encouraging teachers' professional advancement, providing services within schools, involving and supporting parents in their children's education.

**Keywords:** COVID-19, Children with special needs, online learning and Inclusion.

### **Introduction**

Over the past two decades, coronaviruses (CoVs) have been associated with significant disease outbreaks in East Asia and the Middle East. The severe acute respiratory syndrome (SARS) and the Middle East respiratory syndromes (MERS) began to emerge in 2002 and 2012, respectively. At present, a novel coronavirus, the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), causing the Coronavirus Disease 2019 (COVID-19) has emerged in late 2019 which has posed a global health threat with its ongoing pandemic in many countries and territories. Health workers worldwide are currently making efforts to

control further disease outbreaks caused by the novel CoV (originally named 2019-nCoV) that was first identified in Wuhan City, Hubei Province, China, on December 12th, 2019. On February 11th, 2020, the World Health Organization (WHO) announced the official designation for this current CoV-associated disease to be “COVID-19”, caused by the SARS CoV-2. The primary cluster of patients was found to be connected with the Huanan South China Sea food Market in Wuhan. CoVs belong to the family Coronaviridae (sub-family Coronavirinae), the members of which infect a broad range of hosts, producing symptoms and diseases ranging from a common cold to severe and ultimately fatal illnesses such as SARS, MERS and as of present COVID-19 (Sutton Trust, 2020).

The COVID-19 that emerged in China spread rapidly throughout the country and subsequently to other countries including Nigeria. Due to the severity of this outbreak and the potential of spreading on international scale, the WHO declared a “global health emergency” on January 31st, 2020. Subsequently, on March 11th, 2020, a pandemic situation was declared in Nigeria. At present, we are not in a position to effectively treat COVID-19. Although most countries including Nigeria are currently making swift efforts to prevent further spreading of this potentially deadly virus by implementing preventive and control strategies (WHO, 2020). Although distance online learning has been implemented worldwide due to the spread of the COVID-19 pandemic (United Nations Educational, Scientific and Cultural Organisation, 2020). The demand to adapt this format to learners’ individual needs and foster an inclusive and supportive online educational system are among world organizations’ main requirements (e.g European Disability Forum, 2020; United Nations Children’s Education Fund (UNICEF, 2020). Lockdowns, physical distancing and shifts in learning formats as well as other economic and contextual factors related to the pandemic can have disproportionate effects on vulnerable groups including children with special needs and their families (WHO and World Bank 2011, UNICEF 2020). In addition to the challenges caused by the COVID-19 period, children living with special needs and their families are experiencing particular obstacles in comparison with other families. Such challenges can negatively influence their well-being and opportunities for online learning. Although children are less likely than adults to exhibit COVID-19 symptoms, children living with special needs are considered to have more healthcare needs (UN, 2020). Since COVID-19 infection may aggravate existing health conditions, especially those related to respiratory function, immune system function, heart disease, or diabetes (Halfon, 2012). Moreover, aside from the risk of infection, limited resources and support due to lockdown conditions may intensify parental concerns (European Disability Forum 2020). Thus, in addition to the perpetual challenges pertaining to inclusiveness adequate access to distance (online) learning during the COVID-19 period is considered another challenge for children living with special needs and their parents (UNICEF, 2020). Corona virus has brought great setback in the educational system of children

living with special needs but it is hope that in the end, this paper will proffer better ways of educating children living with special needs even in the epoch of COVID-19 and after.

### **COVID-19 and Family Well-Being**

The changes brought about by the COVID-19 pandemic have reportedly influenced adult citizen's well-being and mood states, as well as their children's behaviour. In children conducted by Wang (2020) and Zhang and Ma (2020) in various countries during the pandemic period, participants have expressed increase in moderate to severe levels of psychological stress as well as fear and apprehension due to the pandemic's spread. The effects of COVID-19 have also been felt in Nigeria. According to studies conducted during earlier stages of the current pandemic, Nigerians have reported high increase in stress levels, changes in children's moods and behaviours, and aggravated parenting practices (Hyseni & Duraku, 2020). Furthermore, parents of children with autism spectrum disorder have reported physical fatigue, anger and fear due to changes in their children's behaviour and concern regarding their children's health (Hyseni & Duraku, 2020).

Distance (online) learning during the pandemic in addition to those related to the pandemic, several factors correlating specifically with distance (online) learning have been reported for various groups involved in the educational system worldwide, especially in countries where distance (online) learning had not been previously implemented. The main related concerns of parents include lack of experience in supporting their children living with special needs in distance (online) learning, lack of access to technology and economic constraints (UNESCO, 2020). In fact, UNESCO (2020) further confirm that teachers' concerns include lack of knowledge and skills to implement (online) learning and restricted access to technology to children living with special needs. Likewise, teachers and parents have reported numerous factors that impact the successful implementation of and support for distance (online) learning. As factors that influence this process, teachers report the lack of previous experience with distance (online) learning and insufficient knowledge for utilizing technology during teaching, while parents report feeling overloaded by the need to support their children's learning process (Hyseni and Duraku 2020).

Influencing factors for well-being and education of children living with special needs before the COVID-19 pandemic Global estimates for the total number of children 0–14 years old who live with a disability vary from 93 million to 150 million (WHO and World Bank, 2011). According to Organization for Economic Co-operation and Development (2020), almost one in five children may develop a special needs during their schooling (Global Education Monitoring Report Team 2015). Although the right to education and inclusive education are regulated and assured by legal provisions, in practice, various universal challenges are associated with the active involvement of children living with special needs in educational institutions.



According to a report by WHO and World Bank (2011) list several factors that hinder successful educational involvement of children living with special needs at various stages. At the governmental and policy-making level, the report emphasizes poor coordination of services and the lack of policies plans and resources. At the school level, this report list inadequacies in curricula and pedagogy lack of teacher training and support physical barriers, negative attitudes, bullying and violence in schools as factors that negatively influence inclusiveness of children living with special needs.

### **Challenges of Staying at Home and Benefits for Children with Special Needs and their Parents**

Circumstances surrounding the wild spread of COVID-19 associated with home isolation and social distancing, have affected the lives of children living with special needs and their parents. Wang (2020) opined that among the main difficulties are changes in daily routines, including prohibition of regular activities lack of socialization and changes in learning formats (online) which is not all that do participate, including lack of good services, which was also emphasized as having affected their emotional state of mind. Thus, the additional responsibilities they have in caring for their children during the pandemic have been reported to make parents feel overwhelmed. Furthermore, Zhang and Ma (2020) were quick to note that parents are often afraid their children will regress during this period, which has affected their emotional states. Lack of services and isolation at home have also affected parental stress and parental practices and led to the deterioration of marital relationships, which have also been observed to negatively impact children living with special needs (Borup, 2020).

Nevertheless, nothing in life come all through with disadvantage alone. There are also several advantages to staying home with their parents. Smith (2020) confirmed that during this period, children living with special needs have had good opportunities to create new routines activities improve on their health status become more involved in joint activities with their families and receive more attention and commitment from their families. It also give insight to parents about the strength/weakness and the potential and the capability of their children living with special needs. Furthermore, Harper (2020) stated that staying at home increased parental commitment and support for their children living with special needs and this period was considered an appropriate time for parents to help their children living with special needs acquire new skills in other areas of life.

### **Influencing Factors for Inclusiveness in Online Learning**

The literature on technology integration in educational systems, as well as that on inclusiveness, reveals both challenges and opportunities related to inclusiveness in distance online learning. Significant factors for effective distance online learning include technological

readiness and access to online learning consistency between online materials and curricula, the willingness of teachers and parents to support learning, monitoring and evaluation (UNESCO, 2020). Notably, while inclusive educational policies and practices emphasize that environments should be accessible for children living with special needs, there is evidence that teachers usually report having difficulties understanding what the least restrictive environment would be like in relation to online learning (Burdette, 2013). In fact, in many cases, online learning is not part of teachers' formal training (COLSD 2016) and they lack the necessary resources to successfully implement online learning to children living with special needs (Pugach 2015 and Young, 2018).

Dela and Varre (2014) also reported different perspectives regarding children engagement levels and the benefits of online learning and traditional learning. The scholars showed that online learning compared to traditional learning environments, children living with special needs often demonstrated less willingness to complete homework in online environments, mainly due to low motivation for learning, technological problems, distance in time and space from teachers, and lack of parental support. Other scholars like Deshler (2014), Rice and Carter (2016) reported that children identified that disability is a predictive factor for low grades in online learning.

### **Parental Challenges in Supporting Children with Special Needs in Online School Activities**

Increased parental involvement is required in online learning, especially for children living with special needs (Smith, 2020). This is mostly due to the shift in roles which appoints the parents as the primary persons supporting their children's education activities. However, while parental involvement has been shown to have many benefits for children's education, several potential challenges can hinder effective parental engagement in distance online learning. First, some parents seem to lack understanding of their added role as a teacher, their responsibilities and the level of engagement required from them (Borup, 2020 and Smith 2020). In the words of Cluver, 2020 and Harper 2020) opined that level of engagement of parents may be more challenging in large families and those with low incomes. They further disclosed that in practice, this role entails a greater time commitment and a considerable level of expertise to support children especially children living with special needs. Adding the role of "teacher" to parenting may also influence family dynamics, leading to frustration for parents, children and eventual conflict as the case may be.

Borup (2020) Studies have reported different findings regarding parental motivation for involvement in their children's education. One study reported that when parents have difficulties handling their children, they may be less motivated to help them. Grolnick (2015) buttress that when children struggle to complete their homework due to learning difficulties, parents are more committed to support them while Hoover (2015) has suggested that income

level and the value parents place on education are factors that could influence parental support for their children's learning.

Along with parental motivation, parental involvement is also influenced to a degree by school-related factors. Teachers' attitudes, skills, knowledge and willingness to cooperate along with their encouragement of parents to be involved, especially regarding individualized educational plans, are among school-related factors believed to influence parental involvement in their children's education. In fact, parental perception regarding school support also has a role in their involvement (Hoover, 2015).

### **Opportunities for the Advancement of Online Learning and academic Achievement of children with Special Needs**

In the context of distance online learning, educational systems increasingly supporting "individualized" or "child-centered" learning methods to address children's diversity aiming to stimulate learning. Personalized online learning is consistent with the principles of inclusive educational system as it takes into account individual children needs supports the implementation of individualized education plans and measures progress. It also stimulates children independent learning, motivation to learn and the use of self-regulation skills (Boekaerts and Corno 2015). Parental involvement in distance online learning is considered important for the academic achievement of children living with special needs. Rice and Carter (2016) and Smith (2020) identified four factors of parental involvement in child learning that foster online learning management. These factors include parental encouragement, parental modelling, parental reinforcement and parental instructions. Mwapishak, Golar and Sunday (2014) also concur that several parental engagement activities that can support their children living with special needs in the online learning process such as identifying children's needs, finding appropriate strategies and materials for learning, planning and structuring lessons, providing instructions, adjusting activities to fit children's needs, teaching and supporting problem-solving, monitoring and reporting progress and offering technological support. Smith (2020) Furthermore added that through technology, parent-teacher communication is more efficient and frequent, compared with a traditional school environment.

In addition to the aforementioned, another significant factor that contributes to inclusiveness by enhancing children living with special needs benefits from online learning is emotional support from the school, for parents, children and teachers especially under circumstances in which each of these parties face many other concerns related to the COVID-19 pandemic (Hyseni and Duraku 2020).

### **School Closure and Education Disruption**

The COVID-19 pandemic has caused the largest disruption of educational activities in history, having already had a near universal impact on learners especially the once living with special

needs and teachers around the world from pre-primary to secondary schools, colleges of education institutions, universities, adult learning and skills development establishments. By mid-April 2020, 94 per cent of learners worldwide were affected by the pandemic, representing 1.58 billion children and youth, from pre-primary to higher education in 200 countries. The ability to respond to school closures changes dramatically with level of development: for instance, during the second quarter 2020, 86 per cent of children in primary education have been effectively out of school in countries with low human development compared with just 20 per cent in countries with very high human development (Center on Online Learning and children with Disabilities, 2016).

The lockdowns in response to COVID-19 have interrupted conventional schooling with nationwide school closures in most and partner countries, the majority lasting at least 10 weeks. While the educational community have made concerted efforts to maintain learning continuity during this period, children and students have had to rely more on their own resources to continue learning remotely through the Internet, television or radio. Teachers also had to adapt to new pedagogical concepts and modes of delivery of teaching, for which they may not have been trained. In particular, learners in the most marginalised groups, who don't have access to digital learning resources or lack the resilience and engagement to learn on their own, are at risk of falling behind. Hanushek and Woessman (2020) have used historical growth regressions to estimate the long-run economic impact of this loss of the equivalent to one-third of a year of schooling for the current student cohort.

Looking at this scenario in Nigeria, the COVID-19 pandemic has also had a severe impact on pre-primary, secondary schools education as well as universities closed their premises and shut all borders in response to lockdown measures. Although some educational institutions were quick to replace face-to-face teaching with online learning, these closures affected learning and examinations as well as the safety and legal status of the children in the country. Thus, only little or no effort was made on online learning for children living with special needs. Perhaps most importantly, the pandemic raises questions about the value offered by schools in education which includes networking and social opportunities as well as educational content. To remain relevant, schools will need to reinvent their learning environments so that digitalisation expands and complements student-teacher and other relationships. In fact, reopening schools will bring unquestionable benefits to children/students and the wider economy. In addition, reopening schools will bring economic benefits to families by enabling some parents to return to work and also earn income which was not forthcoming. Those benefits, however, must be carefully weighed against the health risks and the requirement to mitigate the toll of the pandemic. The need for such trade-offs calls for sustained and effective coordination between education and public health authorities at different levels of government, enhanced by local, state and national participation.

### **Conclusion**

The shock of the COVID-19 pandemic on education has been unprecedented. It has set the clock back on the attainment of local, state, national and international education goals and disproportionately affected the poorer and most vulnerable. The education community has

proved resilient, laying a groundwork for the rebound. There remains a risk of a downward spiral in a negative feedback loop of learning loss and exclusion. Yet every negative spiral of aggravating socio-economic circumstances suggests its reverse image of a positive spiral one which would lead to the future of education we want. One of inclusive change in education delivery of unleashing the potential of individuals living with special needs and of collective fulfilment in all areas of life is through education investment.

There is unlimited drive and untapped resources we can count on for the restoration, not only of education's essential services but of its fundamental aspirations. It is the responsibility of governments and the international community to stay true to principles and conduct reforms so that not only will the children with or without disabilities and youth regain their promised future but all education stakeholders find their role in making it happen.

### **Recommendation**

Based on the above discussed, the following recommendations were made:

- Adequate funding should be provided for proper and effective implementation of online education programmes in all Nigerian schools. The federal, state and local governments should put their hands together in providing enough funds for combating COVID-19 pandemic.
- Adequate planning must be proactive and realistic to the Nigerian educational system and adaptation of curriculum and teaching programmes to meet the yarning needs of children living with special needs. This could be done through the provision of enough online teaching and learning materials.
- In the epoch of the pandemic, there is need for equal treatment of all children with or without special needs in our society. That could be done through online teaching and learning as it is only done in some few schools.
- Parents of children living with special needs should be encouraged to contribute towards the education of children living with special needs. This could be done through intensive campaign to such parents having the belief that it is not possible to educate children living with special needs.
- Teachers at all levels of education should be exposed to the nature, demands and guidelines of COVID-19 in the process of providing good services to persons with special needs in all schools. This could be done through organising seminars, workshops and conferences for all teachers in each state and also advertisement through media on radio, television, flyers and posters.

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**STUDY OF OPTICAL PROPERTIES OF HYDROXYAPATITE/TITANIUM  
DIOXIDE FOCUS: IN BANDGAP ENERGY DETERMINATION USING THREE  
DIFFERENT MODELS.**

**T. Yunana,**

Department of Physics,  
Kaduna state College of Education, Gidan Waya  
Kaduna State, Nigeria.

**H. Ali**

Department of Physics,  
Nigerian Defence Academy, Kaduna,  
Kaduna State, Nigeria.

**M. Onimisi**

Department of Physics,  
Nigerian Defence Academy, Kaduna,  
Kaduna State, Nigeria.

**Abstract**

In the recent past, improvement of optical and band gap energy properties of photocatalytic materials via the amalgamation of synthetic titanium dioxide with natural mineral modifier became a new strategy to achieve novel photovoltaic optical devices. Inspired by this idea, we prepared a natural minerals called hydroxyapatite ( $\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$ ) with  $\text{TiO}_2$  stoichiometrically by standard sol – gel method and characterized. The role of varying percentage weight of HAp on optical and bandgap energy proposed was fully examined. UV –visible spectroscopy was used to measure the absorbance data, were optical constants such as absorption coefficient, extension coefficient, refractive index, transmittance and absorbance were evaluated. From the optical analysis it was found that, the absorption response in UV-region is at 200nm – 400nm with an absorption edge around (650 – 950) nm was achieved, and its transmittance is at (400 – 800) nm in the visible region. The value of absorption coefficient ( $\alpha$ ) and extension coefficient (k) of HAP/ $\text{TiO}_2$  increased with increasing the wt% of HA. likewise, the band gap energy decreases as the percentage weight of HAP increases in all the three models, Notwithstanding, the optical band gap in DASF (derivation of absorption spectrum fitting) method was obtained by taking the whole derivative of the spectrum instead of extrapolating certain range as in Tauc and ASF (absorption spectrum fitting) method. As a result, this makes DASF method exceptional, more efficient and accurate model for band gap energy determination.



**Keywords:** Hydroxyapatite, titanium dioxide, optical band gap, spectrum fitting, nanoparticles.

### Introduction

nanocrystal line titanium dioxide ( $\text{TiO}_2$ ) thin films have been investigated extensively in recent years because of their potential use as a low cost material in photovoltaics gas sensors photocatalytic [1-3], smart windows, antireflection coatings, optical filters [4- 6] and as dye-sensitized solar cells [7]. However, literature reported that a wide range of semiconductor photo catalysts such as  $\text{TiO}_2$ , ZnS,  $\text{Fe}_2\text{O}_3$ , CdS, GaP and ZnO had proven their efficacy by degrading the various organic pollutants in the presence of light by monitoring its band gap energy. [8] Among them, titanium dioxide ( $\text{TiO}_2$ ) has gained an interest in photocatalytic wastewater treatment owing to its thermal stability, and its higher chemical resistivity and robust mechanical properties. [9-13]. It was found that,  $\text{TiO}_2$  can exist in amorphous form and also in three crystalline forms – anatase (a) rutile (r) and brookite (b). These phases are well distinguishable in terms of their physical properties. anatase and rutile phases are tetragonal in nature. Optical band gap is higher for anatase compared to that of rutile (3.2 vs 3.0 eV). anatase phase is known to exhibit better photocatalytic activity and is preferred over rutile for photodecomposition of environmental pollutants [14 -16]. Rutile phase exhibits better optical activity than anatase and is used for antireflective and dielectric applications [17,18]. High dielectric constant of the material enables the use of  $\text{TiO}_2$  thin films in micro-electronic devices [19]. The variation in properties, exhibited by amorphous, anatase and rutile thin films, have generated much interest in the study of their growth mechanisms and towards the energy band gap determination, Since the optical properties of  $\text{TiO}_2$  films also show interesting variations influenced by oxygen defects, impurities and crystalline size. However, utilization of  $\text{TiO}_2$  was constrained due to its low adsorption performance for pollutants [20,21] and high recombination of photo generated electron-hole pairs as a result of suggested energy band gap. [22,23]. Moreover, literature suggested that composite introducing of  $\text{TiO}_2$  with other materials, such as hydroxyapatite (HAP), zeolite, silica, activated carbon, had evidenced to enhance the sample active adsorption sites, improved band gap energy which may results in rapid mass transfer of mobility carrier from the valence band to the conduction band and ultimately increase the rate of catalytic reactions. [24,25]. Notwithstanding, hydroxyapatite (HAP),  $\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$  is having outstanding mechanical stability, good biocompatibility, non-toxicity and less expensive. [26] It consists hydroxyl ions ( $\text{OH}^-$ ) in its hexagonal structure and these  $\text{OH}^-$  ions may as well increase electrical conductivity as well as charge carrier capacity in the presence of required band gap energy. [27,28] Besides,  $\text{PO}_4$  groups in the HAP surface generates  $\text{O}_2$  Accept radicals during the photocatalytic process and these generated  $\text{O}_2$  radicals may act as an electron receiver to attained the separation of electron-hole pairs.[29,30] Thus, it is expected that synthesis of HA/ $\text{TiO}_2$  composite might enhance the optical properties,

adsorption capability and also minimize the recombination of generated electron-hole pair during the photo catalysis process through appropriate and required band gap energy. Therefore, despite all the aforementioned extensive investigation on the properties of HA/TiO<sub>2</sub> there are no reports on the study of optical properties of hydroxyapatite doped titanium dioxide: focus in band gap energy determination using three different models to the best of our knowledge. Hence, the present study is intended to analyzed the nature of optical constant of HA/TiO<sub>2</sub> at different percentage weight of hydroxyapatite (0wt%, 30wt%, 40wt%, 50wt%, 60wt%, 70wt% and 80wt%), thereby focusing on band gap energy determination using three different models. The models are Tauc, ASF (atomic spectrum fitting), DASF (Derivation of atomic spectrum fitting) in order to ascertain the exact, correct and precise method of band gap energy determination that could be able to excite a greater number of mobility carrier applicable for optoelectronic application. It was found that, the absolute magnitude of the optical gap as determined by the linear extrapolation in Tauc's and ASF procedures, is quite sensitive to the range over which the extrapolation is taken, according to [31], while DASF avoids this problem since the complete spectrum is fitted. Notwithstanding, the optical band gap in DASF method is obtained by taking the whole derivative of the spectrum instead of extrapolating certain range as in Tauc and ASF method. As a result, this makes DASF method exceptional, more efficient and accurate model for band gap determination.

## **Experimental Procedure**

### **Materials**

1.7244g per 20ml of TiO<sub>2</sub> solution, 4.311mg of HA per 2ml solution, glass slides of dimensions all of purity 99.9%, and glass slide plate of 2.5mm x 2.5mm Titanium (IV) isopropoxide [C<sub>12</sub>H<sub>28</sub>O<sub>4</sub>Ti] (TTIP). serum plain micro point diagnostics vacuum tube. propanol, acetic acid and orthophosphoric acid [H<sub>3</sub>PO<sub>4</sub>]. Hence, calcium to phosphate ratio (ca/pa) was found to be 1.65 – 67.

### **Preparation of HAP/TiO<sub>2</sub> Composite Thin Film and Characterization.**

Titanium (IV) isopropoxide [C<sub>12</sub>H<sub>28</sub>O<sub>4</sub>Ti] (TTIP) of purity 99.99% was used as a source material for Titanium [Ti]. Propanol and double distilled water (dH<sub>2</sub>O) were used as solvents and acetic acid was used as a stabilizing agent. The propanol, acetic acid and orthophosphoric acid [H<sub>3</sub>PO<sub>4</sub>] were obtained from solaronic. Microscopic glass slides of dimensions 2.5 mm × 2.5 mm were used as substrates. The substrates were washed with soap solution for 5 min and subsequently kept in a hot chromic acid at 50°C for 20 min. Finally, the substrates were cleaned ultrasonically and washed with distilled water. A prepared solution of HA/TiO<sub>2</sub> Nano composite were obtained by stoichiometric analysis of 1.7244g per 20ml of TiO<sub>2</sub> solution which contained 2930g is mixed together with proportion of 4.311mg of HAP per 2ml solution. By varying stoichiometrically the Wt% of HA (0, 30, 40, 50, 60, 70, and 80) wt%

with a corresponding 20ml volume of TiO<sub>2</sub>. To obtain the corresponding mass in grams of the HAP, we make use of the relationship

$$\frac{x}{4.311+x} = wt\% \quad 1.0$$

$$\text{Similarly for volume of TiO}_2 \text{ we used } 20 \times \frac{x}{2930} \quad 2.0$$

After that, 20ml of TiO<sub>2</sub> propanol mixture suspension was added drop by drop in different percentage weight of HA mixture, and then, stirred vigorously for 2 h. Subsequently, the reaction mixture was ultra-sonicated (60W Bath sonicator, PCI Analytics) for another 4hr. Next, the reaction mixture was autoclaved for 8h at 190<sup>OC</sup> and then, centrifuged at 6000 RPM for 20 min to collect the formed HA/TiO<sub>2</sub> composites. The TiO<sub>2</sub> film was deposited on the slide glass to fabricate a 4nm thick film, then the HA was coated to obtain a 4nm thickness. The total film thickness was 8nm. The film was annealed in air at 350<sup>OC</sup> for 4 h in an electric furnace. The optical characterization was carried out using Thermo scientific Evaluation 300 UV- vis absorption spectrophotometer. (300UV; Jasco corp., japan) were used.

### Theories and Models for HA/TiO<sub>2</sub> Evaluation

From the absorption data, the optical constant such as absorption coefficient, extension coefficient and refractive index of the materials following the below relationship.

Recall that, the absorbance (A), is the ratio of intensity of light absorbed I<sub>A</sub> by the sample to the incident intensity of light I<sub>0</sub>.

$$A = I_A/I_0 \quad 3.0$$

Transmittance T is given by

$$T = \exp(-2.303A) \quad 4.0$$

Reflectance R is calculated as

$$R = 1 - (A + T) \quad 5.0$$

The reflectance data was used to calculate the refractive index (n) of the thin film using equation

$$R = \frac{(n-1)^2}{(n+1)^2} \quad 6.0$$

$$n = \frac{1+\sqrt{R}}{1-\sqrt{R}} \quad 7.0$$

The extension coefficient (k) was calculated using the following equation

$$\bar{n} = n + ik \quad 8.0$$

Where n is the real part named as refractive index and k is the imaginary part named as extinction coefficient. Extinction coefficient provides information about the absorption of light in material medium due to inelastic scattering. It is known that extinction coefficient and absorption coefficient can be related by the following formula

$$k(\lambda) = \frac{\alpha(\lambda)\lambda}{4\pi} \quad 9.0$$

Where  $k(\lambda)$  is the extinction coefficient. The wavelength dependence of extinction coefficient of the thin films.

### Models (Tauc, ASF and DASF)

Similarly, based on the absorption values, three different models (Tauc's, ASF, and DASF) were used to estimate the band gap energy of the synthesized HA/TiO<sub>2</sub>. The popular method known as Taucs plot required both the data of absorbance and sample thickness at the UV-spectroscopy.

However, ASF and DASF models requires only the absorbance values HA/TiO<sub>2</sub> for band gap determination, hence the following theoretical approaches were used. In Taucs models the following relationship were used according to Davis and Mot to estimate the direct band gap energy of HA/TiO<sub>2</sub>

$$\alpha(\nu)h\nu = B(h\nu - E_{HA/TiO_2}^{TAUC})^m \quad 10.0$$

By re-arranging equation 15 to obtained

$$\alpha(h\nu)^{1/m} = B(h\nu - E_{HA/TiO_2}^{Tauc})^m \quad 11.0$$

HA/TiO<sub>2</sub> Tauc , B and  $h\nu$  are the HATiO<sub>2</sub> energy independent constant and incident photon energy, respectively. The exponent m can take the values 1/2, 2, 3/2, and 3, which respectively signify the direct allowed, indirect allowed, direct forbidden, and indirect forbidden optical transitions. The absorption coefficient  $\alpha(\nu)$  according to the Beer– Lambert law takes the form

$$\alpha(\nu) = \frac{2.303 \times A}{t} \quad 12.0$$

where t and A are the thickness and absorbance of the glass sample, respectively. Transforming Tauc's relation in terms of the wavenumber and wavelength ( $\lambda$ ), the optical absorption coefficient ( $\alpha(\lambda)$ ) can be obtained through the ASF relation according to [12.0].

$$\alpha(\lambda) = B(hc)^{m-1} \lambda \left( \frac{1}{\lambda} - \frac{1}{\lambda_g} \right)^m \quad 13.0$$

where  $\alpha(\lambda)$  is the absorption coefficient defined by the Beer–Lambert's law as:

$$\alpha(\lambda) = (2.303/z) A, \quad 14.0$$

Considering z and A as film thickness and film absorbance, respectively, also, m is the index which can have different values 1/2, 3/2, 2, 3 [32]  $\lambda_g$ , h, and c are wavelength corresponding to the optical gap

$$(E_{gap}^{ASF} = \frac{hc}{\lambda_g} = 1239.83/\lambda_g), \quad 15.0$$

Planck's constant and the velocity of the light, correspondingly. Using the Beer–Lambert's law, Eq.18 can be re-write as:

$$A(\lambda) = D\lambda \left( \frac{1}{\lambda} - \frac{1}{\lambda_g} \right)^m \quad 16.0$$

$$\text{where } D = [B(hc)^{m-1} z/2.303]. \quad 17.0$$

In ASF and Tauc's methods, one can determine  $m$  by examining the different  $m$  values and choosing the best fitted  $m$  value; so, using the optimized value of  $m$ , the optical gap can be obtained in ASF methods using equation 15.0

In this proposed method (DASF), Eq. 21 can be written as:

$$\ln A \frac{(\lambda)}{\lambda} = \ln(D) + m \ln \left( \frac{1}{\lambda} - \frac{1}{\lambda_g} \right) \quad 18$$

and then:

$$\frac{d \left[ \ln \left( \frac{A}{\lambda} \right) \right]}{d \left( \frac{1}{\lambda} \right)} = \frac{m}{\frac{1}{\lambda} - \frac{1}{\lambda_g}} \quad 19$$

Plot of  $d \left[ \ln \left( \frac{A}{\lambda} \right) \right]$  Against  $\frac{1}{\lambda}$  can be made to locate the expected discontinuity at  $\frac{1}{\lambda} = \frac{1}{\lambda_g}$  yields

$$\frac{E_{HA}^{DASF}}{TiO_2} = \frac{hc}{\lambda_g} = 1239.83/\lambda_g \quad 20$$

The value of  $m$  (indicating the nature of optical carrier transition) were determined from the slope of the linear part of plot as can be seen in equation 21, and the value of  $m$  can be determine using equation 22

$$\ln[A(\lambda^{-1}) \text{ versus } \ln(\lambda^{-1} - \lambda_g^{-1})] \quad 21$$

$$\text{The slope was achieved by } m = \frac{\Delta \ln A(\lambda^{-1})}{\Delta \ln(\lambda^{-1} - \lambda_g^{-1})} \quad 22$$

Which gives the exact values of  $m^{DASF}$  for various material

## Results and Discussion.

### Optical characterization.

It was reported that, the absorption spectrum of semiconductor directly determines the electronic structure of the material by exciting electrons from the valence band to the conduction band using ultraviolet and visible radiation. Hence, Fig.2.0 depict the optical absorption spectra of HA/TiO<sub>2</sub> composite thin films with a percentage weight (wt%) of 0, 30, 40, 50, 60, 70, 80, recorded in the spectrum of wavelength ranging from 400 nm - 1200 nm. It was observed clearly, that the strong response in the UV region is shown at 200 nm–400 nm, with an absorption edge around 650nm–950 nm. The reason for the absorption edges of HA/TiO<sub>2</sub> at 650 nm is due to the charge transfer from the valence band to the conduction band of the Ti<sup>4+</sup> cations, as a result of enhancement of HA/TiO<sub>2</sub> films compactness (shrinkage of the bond length). This is in agreement with research done by [32]. Here it is clearly showed that, the absorption band corresponding to the HA/TiO<sub>2</sub> Nano composites gets blue shifted, the shift of the absorption band towards shorter wavelength indicates decrease in particle size, while the absorption edges get red shifted indicating an increase in the particles size of HAP that are active in TiO<sub>2</sub> layer, which is also consistent with the result of [32]. Figure3.0 is the optical transmittance of HA/TiO<sub>2</sub> at different weight percentage, which was obtained using

equation 5.0. It was observed that, at 0wt% the transmittance is at maximum greater than 95% in the visible light region (400 – 800) nm due to 0wt% of HAP particles on  $\text{TiO}_2$ , negligible wt% of HAP particles which in turns leads to small particles size, and this create more avenue for high transmittance capacitance at 0wt% of  $\text{HA/TiO}_2$  film. Conversely, spectra transmittance sharply decreased at the UV region as the wt% of HAP increased, hence an obvious absorption edge was observed at 680 nm, this could be as a result of increased in percentage weight of HAP on  $\text{TiO}_2$  which in turn gives larger particle size that will trap the UV- light thereby reduce the degree of transmittance in  $\text{HA/TiO}_2$  this is in accordance with the result of [33]. After subsequent percentage weight of HA on  $\text{TiO}_2$  and moderate heat treatment, the transmittance of the  $\text{HA/TiO}_2$  film decreased by around 8% in the visible light region. This is because the crystal grain grows by heat energy. In addition, it was reported by [33] that the grain size of  $\text{TiO}_2$  film increased with annealing temperature from an atomic force microscopy observation, and the transmittance of the film decreased.

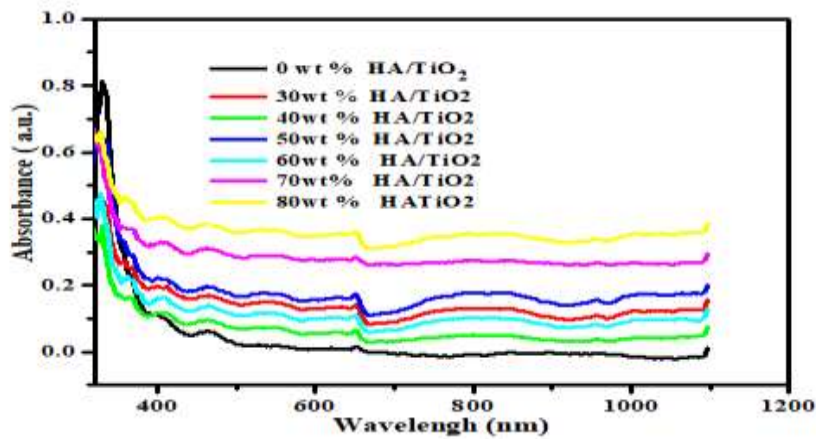


Figure 3.0 optical absorbance of  $\text{HA/TiO}_2$  at different percentage weight.

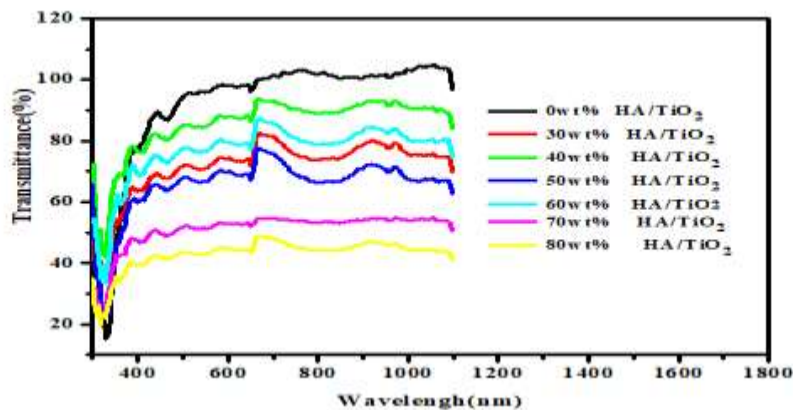


Figure 3.1 optical transmittance of  $\text{HA/TiO}_2$  at different percentage weight.

### Optical Constant of HA/TiO<sub>2</sub>

#### Absorption coefficient, Extension coefficient and Refractive index.

Figure 3.2 illustrate the variation of absorption Coefficient with Wavelength at different wt% of HA, at a wavelnght ranging from 300nm – 1200nm, and it was evaluated using equation 9.0 From figure 3.2 it was observeded that as the wt% of HA increases in TiO<sub>2</sub> the absorption also increases except at 0wt% and 40wt% which shows an abnormality with a greater absorption coefficient value, this could be as a result of absence or little percentage of hydroxyapatite nanoparticles which could disperse homogeneously in the matrix with sufficient TiO<sub>2</sub> proportion and greatly reduce the agglomeration effect of the hydroxyapatite nano particles; hence promoting the absorption coefficient with little or no HA nanoparticles, which is in line with the result of [34]. Figure 3.3 displayed the extension coefficient (k), of HA/TiO<sub>2</sub> at different wt% of HA, it was evaluated using equation 9.0 from absorbance data. It is clearly shown that, the extension coefficient is high at 0wt% and low at 40wt% of HA, and it was found increasing with increased in wt% of HA up (80wt %). The small wt% of HA indicates that, the composite samples are still transparent to electromagnetic radiation, thereby increase the extension coefficient, this is in accordance with the other researcher such as [36]. The variation in the refractive index (n) and extension (k) values HA/TiO<sub>2</sub> with the wavelength reveals that some interaction takes place between photon and electrons of the films. Furthermore, increase in values of extension coefficient (k) at high wavelength for wt% of HA, indicates scattering of more photon with added quantity of HA, this agreed with the result of [37]. The values of absorption coefficient ( $\alpha$ ) and extension coefficient (k) of HA/TiO<sub>2</sub> at a particular wavelength of 300nm are observed in figure 3.2 & figure 3.3. These values show an increasing trend on increasing the wt% of HA. This is in accordance with work of [37,38]. Figure 3.4 depict the dispersion in refractive index (n) for different doped HA/TiO<sub>2</sub> at invested range of wavelength from 300nm – 1200nm, which were evaluated from the absorbance values using equation 7.0. Figure 3.4 indicate that, the refractive index (n), increases with increasing %wt of HA thin films up 0.325 in HA/TiO<sub>2</sub> and the increase in the dispersion of thin films occurs at 0wt% HA/TiO<sub>2</sub>. However, highest refractive index occurs at owt% and the lowest occurs at 40wt% HAP with a high wavelength value respectively. The increase and decrease in refractive index (n) with increasing wt% of HA/TiO<sub>2</sub>, indicates that the refractive index (n) is tunable upon addition of different wt% of HA on a substrate, this is in accordance with the work of [39]. From the below figure 3.4.0 it could be noticed that, the refractive index decreases abruptly as the wavelength increases and gets saturated beyond the wavelength of 1000 nm. The high wavelength region of refractive index (n) represents the materials bulk properties. The sudden increased of refractive index (n) for TiO<sub>2</sub> volume and wt% of HA may be attributed to the percolation threshold phenomenon; this is in agreement with [39].

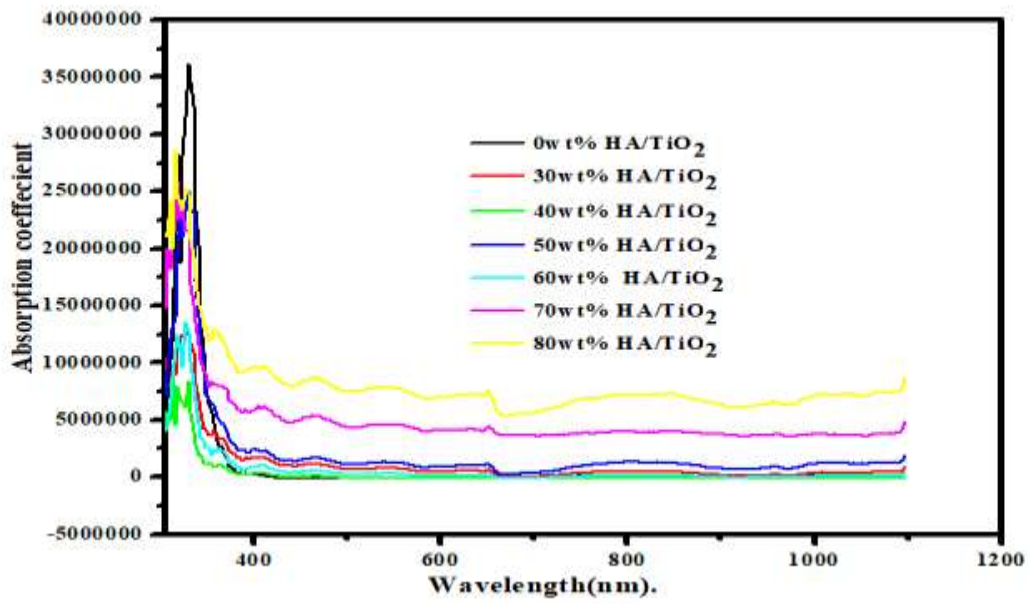


Figure 3.2 Variation of Absorption Coefficient of HA/TiO<sub>2</sub> with Wavelength at different wt% of HA.

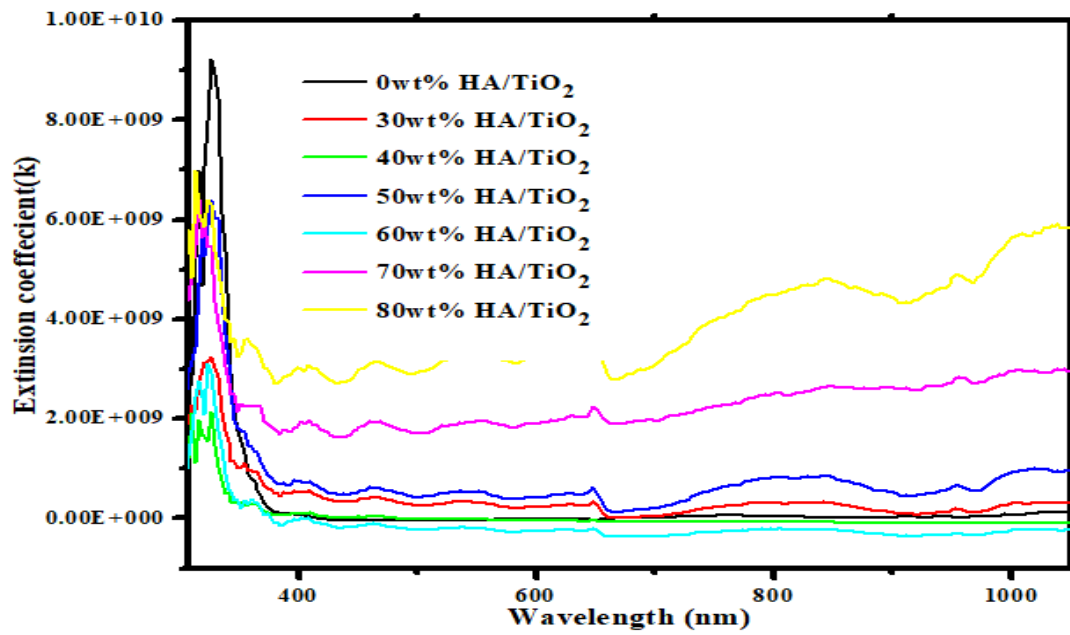
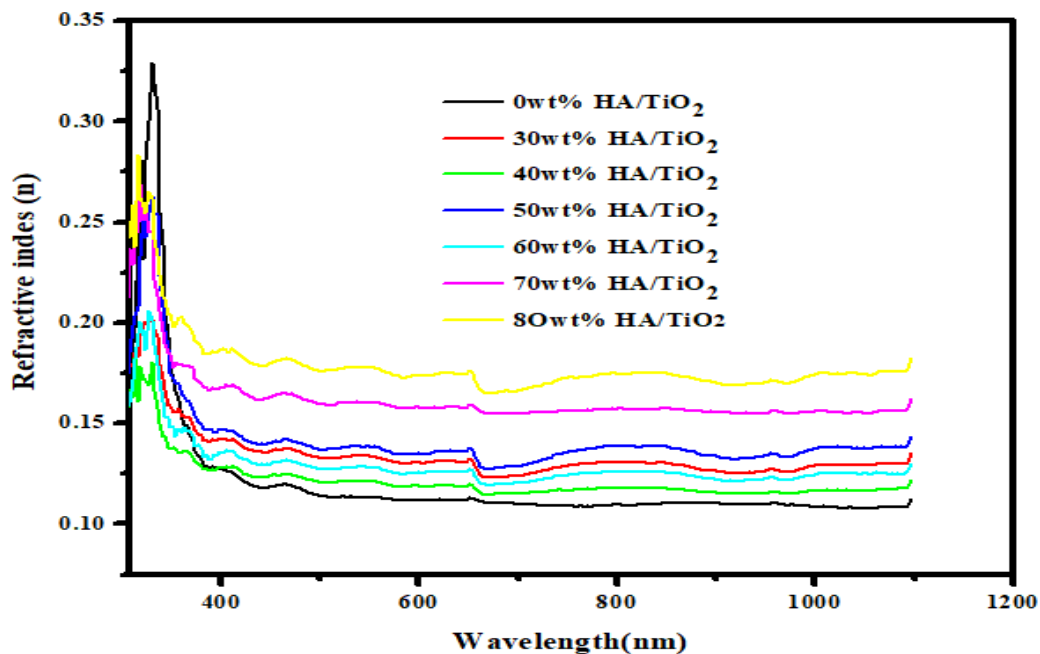


Figure 3.3 Variation of Extension coefficient (k) of HA/TiO<sub>2</sub> with wavelength at different wt% of HA.





**Figure 3.4.0** Variation of Refractive index( $n$ ) with Photon Energy of HA/TiO<sub>2</sub> at different wt% of HA

### Optical Band Gap Energy Using Three Different Models (Tauc, ASF and DASF)

#### Tauc Model

Figure 3.5 displayed the Tauc method for band gap determination of HA/TiO<sub>2</sub> at different percentage weight of hydroxyapatite (wt%). The band gap energy is obtained by extrapolating the linear portion of a curve and intersecting it with the horizontal axis, thereby estimating an appropriate value for each percentage weight of HA using equation 16, and the value of estimated band gap energy is shown in table 1.0. The analysis proved that, at 0wt% and 30wt% HA/TiO<sub>2</sub> the band gap energy has an estimated value of 3.61eV and 3.57eV. In addition, at 40wt%, 50wt% and 60wt% the observed value of band gap energy at each point is 3.51eV, 3.38eV, and 3.56eV respectively. From the above analysis, it is clearly shown that, the band gap of a material decreases as the percentage weight of hydroxyapatite increases within a range of (3.61 – 3.25) eV, except at 60wt% which has an increase in the band gap value of about 3.56eV. The lower value of  $E_g$  is attributed to the creation of allowed energy states in the band gap [44,45] as a result of increase in particles size at the time of film preparation, while the higher value of  $E_g$  is accounted to the very small grain size of the film leading to an increase in the grain boundary, hence increase in the band gap energy. This is in agreement with the research conducted by [44,45].

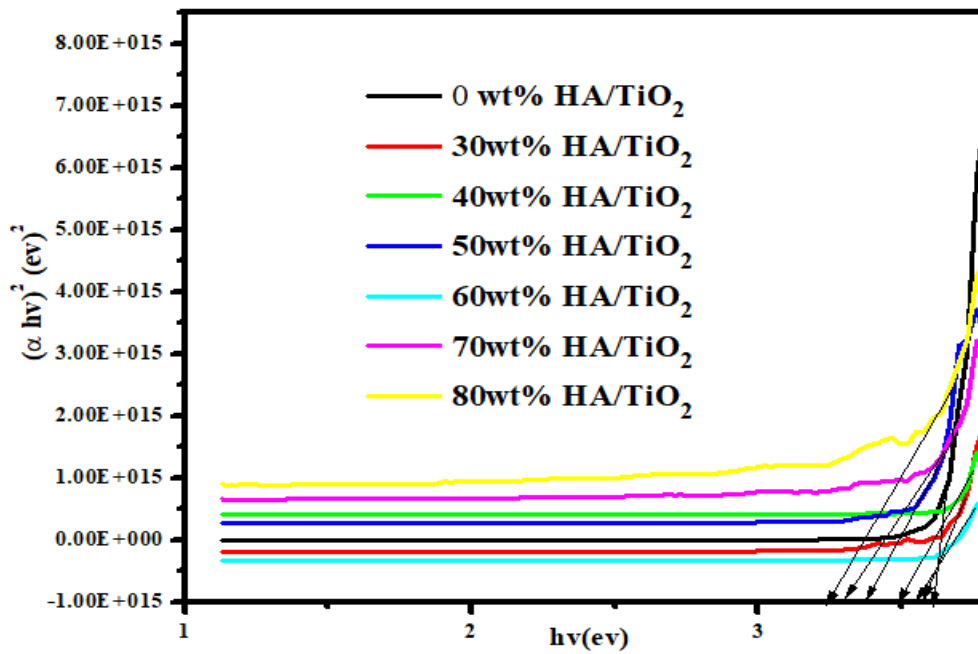


Figure 3.5 Variation of  $(\alpha hv)^2$  (ev)<sup>2</sup> against hv(ev) optical bandgap of HA/TiO<sub>2</sub> at different HA wt% using Tauc mode

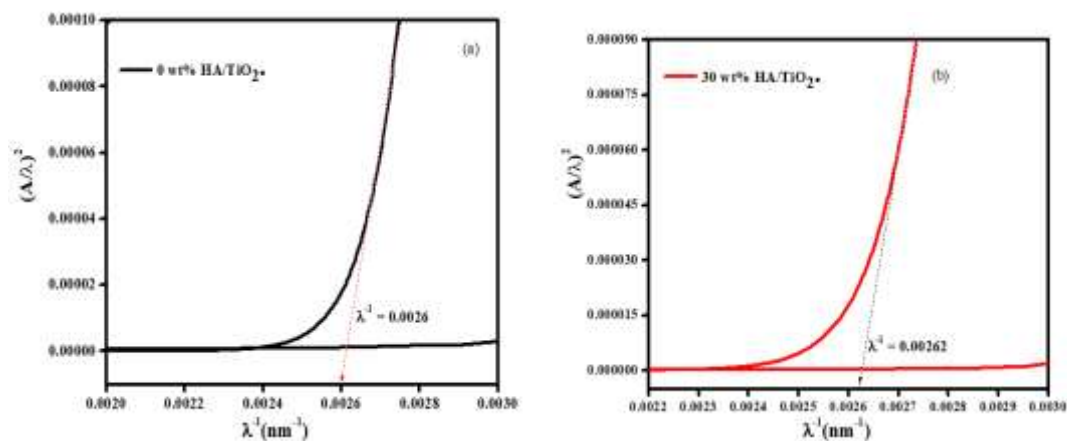
Table 1.0 Optical bandgap values for three different models and their type of transition.

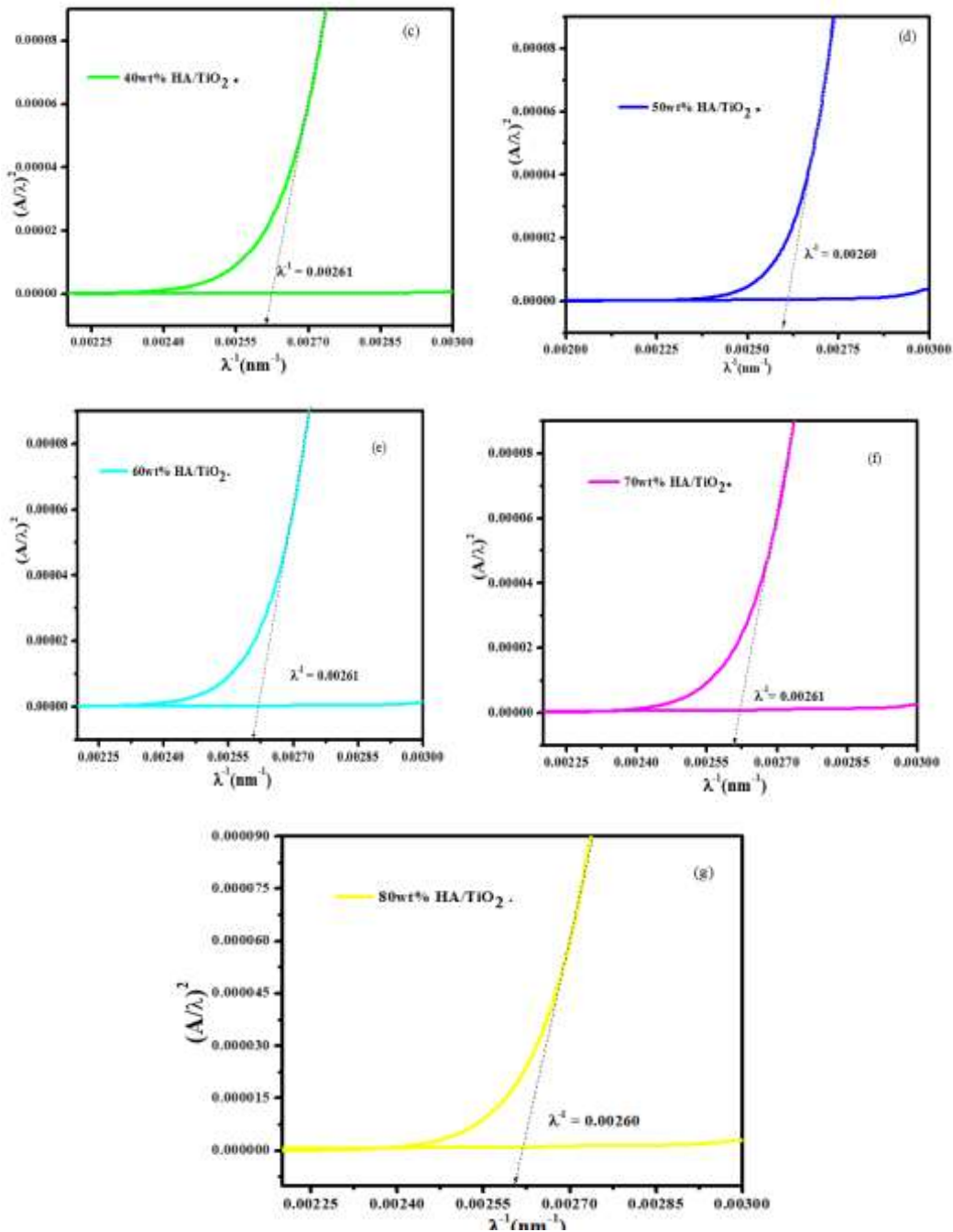
Sample wt%	0 HA/TiO <sub>2</sub>	30 HA/TiO <sub>2</sub>	40 HA/TiO <sub>2</sub>	50 HA/TiO <sub>2</sub>	60 HA/TiO <sub>2</sub>	70 HA/TiO <sub>2</sub>	80 HA/TiO <sub>2</sub>
Tauc model $E_{Direct}^{Tauc}$ $E_g$ (ev)	3.61	3.57	3.51	3.38	3.58	3.25	3.22
ASF model $E_{Direct}^{ASF}$ $E_g$ (ev)	3.22	3.25	3.24	3.22	3.24	3.24	3.22
$m^{ASF}$ $\pm 0.01$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$

<b>DASF model</b>	3.11	3.09	3.09	3.09	3.11	3.11	3.09
<b><math>E_{Direct}^{DSF}</math></b>							
<b><math>E_g</math>(ev)</b>							
<b><math>m^{DASF}</math></b>	1.24	1.26	1.25	1.27	1.27	1.27	1.27
<b><math>\pm 0.01</math></b>							

### ASF (Atomic Spectrum Fitting) Model

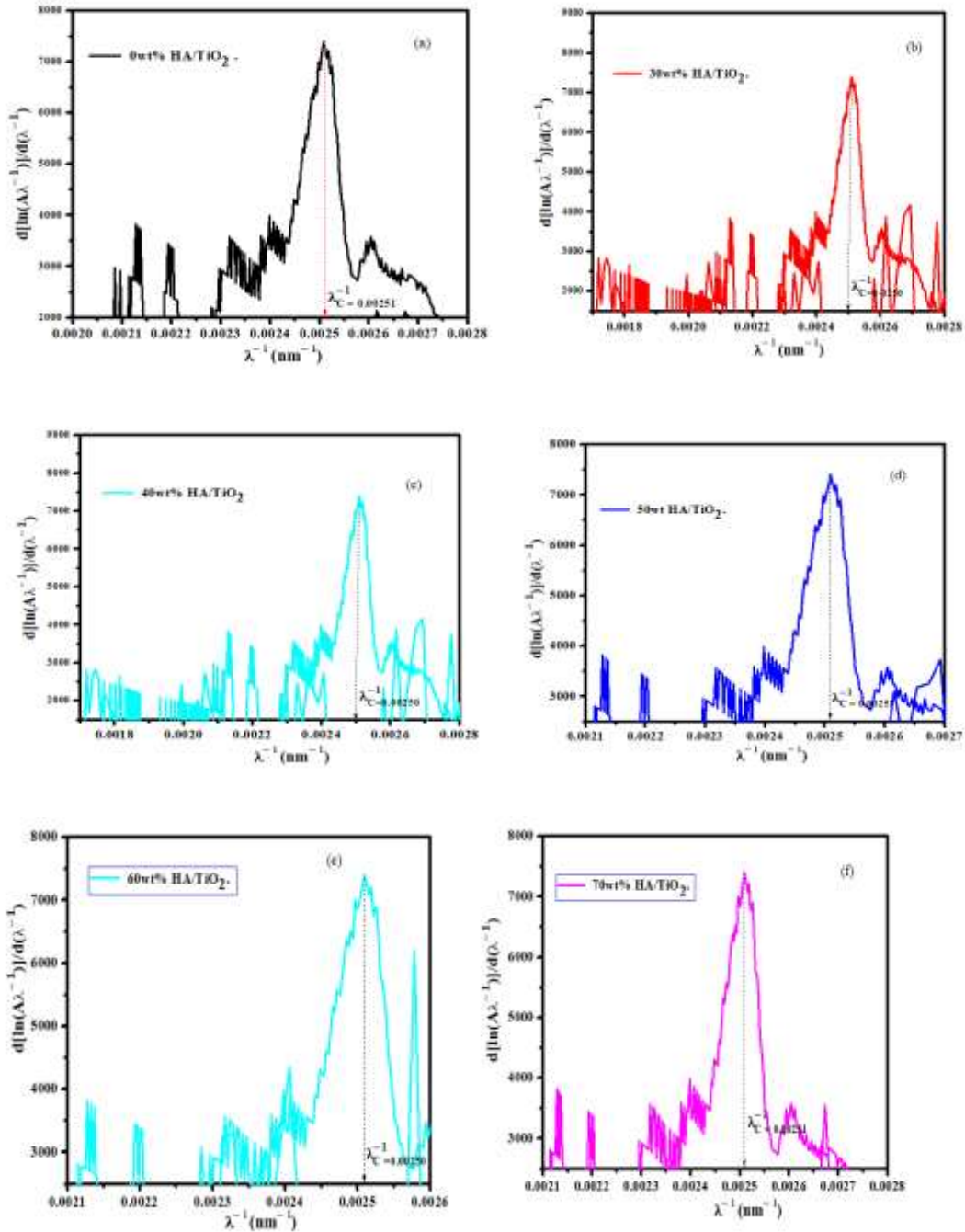
Figure 3.6 depicted an ASF method for band gap determination at different wt% of HA on TiO<sub>2</sub>. To estimate the value of the band gap energy using these model, a plot of  $(A/\lambda)^2$  versus  $\lambda^{-1}$  (nm<sup>-1</sup>) were established using equation 13.0, assuming that the transition is a direct one and a linear fit was made. The band gap energy  $E_g$  was obtained from the intercept with the  $\lambda^{-1}$  (nm<sup>-1</sup>) axis, by substituting the value of  $\lambda^{-1}$  (nm<sup>-1</sup>) in each case in equation 15.0 yield the exact value of band gap energy at each wt% of HA/TiO<sub>2</sub>. Hence from the above analysis, its observed that in figure 3.6 (a & b) with 0wt% and 30wt% of HAP has a band gap energy value of 3.22eV and 3.25eV. Thereafter, as the percentage weight of HA increases to 40wt%, 50wt% and 60wt% as displayed in figure 3.6 (c, d & e) the estimated value of band gap energy was observed to be 3.24eV, 3.22eV, and 3.24eV respectively. In general, the band gap energy value is at the range of (3.22 – 3.24) eV at (0 – 40) wt% HA shown in figure 3.6 (a, b, and c), similarly (d, e, f and g) the band gap energy ranging from (3.22 – 3.22) eV. This shows clearly that, there is slight increase in the band gap energy and then it became constant as the percentage weight of hydroxyapatite increases. The increase in wt% of HA lead to an increase in the film thickness. However, slight increase in the optical band gap is attributed to the improvement in the crystallinity of the films when they become thicker, because the crystallinity of the film also increases due to the increase in crystallite size which account for the decrease in the band gap. This is in line with the research done by [45].

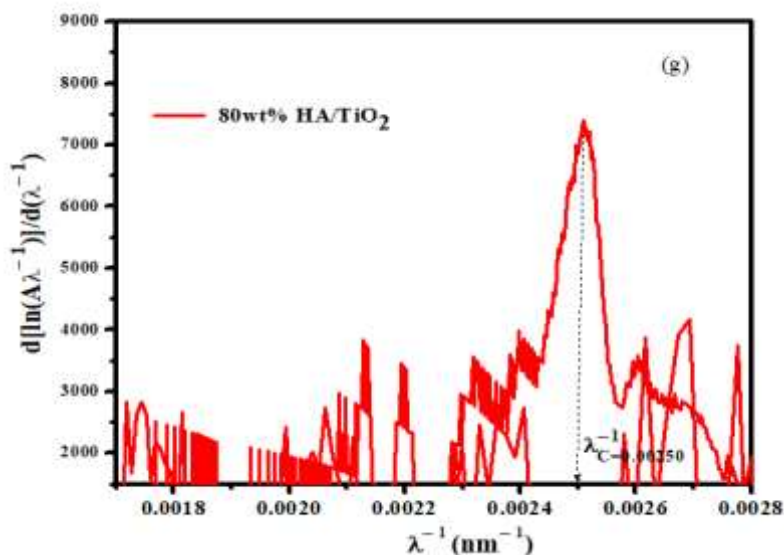




**Figure 3.6** Variation of  $(A/\lambda)^2$  versus  $\lambda^{-1}$  (nm<sup>-1</sup>) Bandgap energy of HA/TiO<sub>2</sub> at different HA wt% (a) 0HAwt% (b) 30wt% (c) 40wt% (d) 50wt% (e) 60wt% (f) 70wt% (g) 80wt%. Using ASF models.

### 3.1.5 DASF (Derivation of Atomic Spectrum Fitting) Model

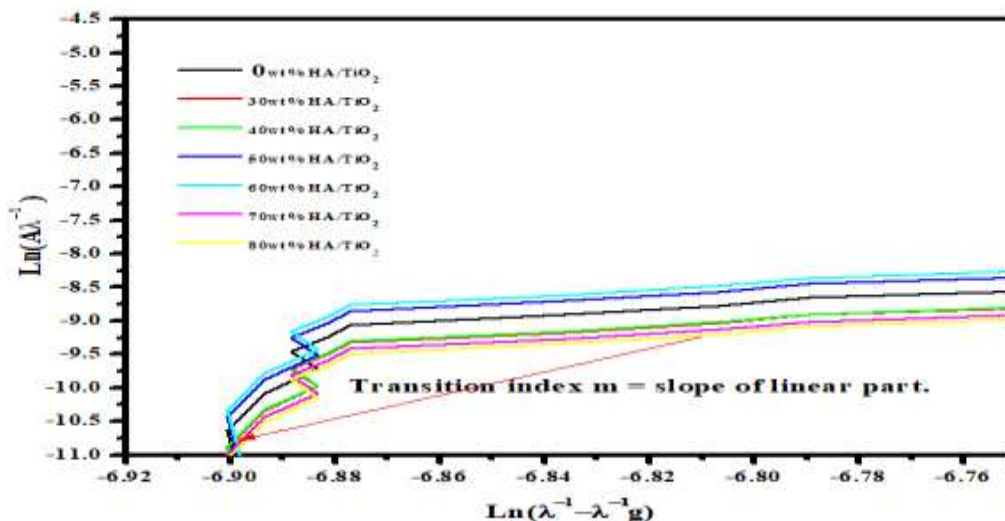




**Figure 3.7** Variation of  $d\{\ln [A(\lambda)/\lambda]\}/d(1/\lambda)$  versus  $\lambda^{-1}$  ( $\text{nm}^{-1}$ ) Bandgp energy of HA/TiO<sub>2</sub> at different HA wt% (a) 0HAwt% (b) 30wt% (c) 40wt% (d) 50wt% (e) 60wt% (f) 70wt% (g) 80wt%. Using DASF models.

From the above Figure 3.7, is the DASF method for optical band gap determination at different wt% of HA/TiO<sub>2</sub>. To estimate the value of the band gap energy using DASF model, a plot of  $d\{\ln [A(\lambda)/\lambda]\}/d(1/\lambda)$  versus  $\lambda^{-1}$  ( $\text{nm}^{-1}$ ) were established in equation 18.0 starting from ASF model, without any presumption about the type of transition, rather it involves a complete spectrum fitting techniques. Hence, the band gap energy  $E_g$  was obtained from the intercept with the  $\lambda^{-1}$  ( $\text{nm}^{-1}$ ) axis, by substituting the value of  $\lambda^{-1}$  ( $\text{nm}^{-1}$ ) in each case in equation 20.0 yield the exact value of band gap energy at each wt% of HAP on TiO<sub>2</sub>. Therefore, from the above prediction, in figure 3.7 (a, b, and c) the band gap energy value was calculated to be 3.11eV, 3.09eV and 3.11eV. Moreover, as the percentage weight of HA increases as showed in figure 3.7 (d, e and f) the estimated value of band gap energy was observed to be 3.11eV, 3.09eV, and 3.11eV respectively. Finally, in figure 3.7 (g) the band gap energy was found to be 3.09eV at 80wt% HAP. In these models, the band gap energy value slightly decreases at a specific range of (3.11 – 3.09) eV at (0 – 40) wt% HAP as depicted in figure 3.7 (a, b, and c), likewise in the same figure (d and e) at 50wt%, 60wt% also in (f and g) at 70wt%, 80wt% there was a negligible increased and decreased in the band gap energy values of 3.11eV, 3.09eV and 3.11eV, 3.09eV respectively, showing an infinitesimal band gap different values of 0.02eV which absolutely indicate a complete spectrum fitting techniques. Further investigation shows that addition of HAP causes breaking of the regular structure of hydroxyapatite and titanium dioxide leading to a decrease in the band gap, this agreed with

the result of [47]. In addition, this decreasing is due to an increase in the disorder and consequently the more extension of the localized states within the gap as a result of increase in the percentage weight, which is in accordance with the findings of [48]. Hence, from the above findings it is clearly shown that, the values obtained from DASF model is more precise and accurate than Taus and ASF models. Figure 3.8 displayed the method of how the optical transitions were determined at different weight percentage of hydroxyapatite. The value of  $m$  (optical transition) was determined from the slope of the linear part of  $\ln(A\lambda^{-1})$  versus  $\lambda^{-1}-\lambda_g^{-1}$  plots and were estimated using equation 28, This method helps us to calculate  $m$  values for all the film studied here without any presumption of the nature of transition, the obtained values are found in table 1.0. All the transition values are varied within the range of 1.24 – 1.27 for different wt% of HA/TiO<sub>2</sub> and are approximately almost about 1/2, which disclosed direct allowed transition; this result is in good agreement with the optimum  $m$  value obtained from ASF for the present samples, and its agreed with the result obtained by [49]



**Fig. 3.8** DASF plot indicating the nature of optical transition ( $m$ ) in the HA/TiO<sub>2</sub> thin film.

### Conclusions

In this work, a new method (called DASF) was proposed and described easily and rapidly obtained the optical properties of HA/TiO<sub>2</sub>, focus on band gap determination using three different model, and the nature of optical transitions. The main advantages of the DASF method are: (a) avoiding the film thickness measurement, (b) only measurement of the film absorbance is enough and (c) no any presumption of the nature of optical transition and no any need to linear extrapolation. Hence the methods were evaluated through HA/TiO<sub>2</sub> synthesizes and analysis. In general, it was discovered that the optical parameter such as transmittance,

absorbance, absorption coefficient, extinction coefficient and refractive index, tend to increase as the percentage weight of HA increases. The values of the band gap obtained using ASF and DASF analysis methods were compared, and found to be in a good agreement and similar trends was observed, unlike Taucs model where large disparity in the values was noticed. In DASF optical band gap energy determination, the maximum value was found to be 3.11 eV at 80wt% of HAP and the minimum value equal to 3.09 eV at 0wt%, and in Tauc model, the maximum band gap energy was also observed at 3.61eV, while in ASF model there was increase and decrease in the energy gap with a range between (3.22 – 3.25) eV.

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## **AUTHENTIC LEADERSHIP, JOB CRAFTING AND EMPLOYEES PERFORMANCE: A PROPOSED MODERATING FRAMEWORK IN ADAMAWA STATE HIGHER INSTITUTIONS**

**Adamu Ahmed Girei,**

Department of Business Administration and Management,  
Federal Polytechnic Mubi,  
Adamawa State, Nigeria.

**Rafiatu Ahmed Digil**

Department of Business Administration and Management,  
Federal Polytechnic Mubi,  
Adamawa State, Nigeria.

**Rifkatu Ibrahim**

Department of Business Administration and Management,  
Federal Polytechnic Mubi,  
Adamawa State, Nigeria.

### **Abstract**

Employees' performance is a mechanism through which organizational sustainability and growth are achieved in the dynamic, competitive and technology driven business environment. This paper proposed a framework that suggests significant interaction between authentic leadership and employee's performance. The interaction among authentic leadership style and performance with job crafting as the moderator has been incorporated in the Framework. The framework will contribute to a better understanding of an interaction between authentic leadership style and employees' performance in Nigeria and other developing nations.

**Keywords:** Authentic leadership style, employees performance, job crafting

### **Introduction**

The performance of an organization depends on efficient and effective contribution of individual employees of the organization (Ölçer, 2015). Performance is the art to complete the task within the defined boundaries. Millcorvich and Bondream (1997) considered employees performance as the degree to which employees accomplish work requirements. Employees-Performance in every organization is central to the growth of the organization and that of the individual employee. Employees performance may include defined responsibility,

accomplishing targets, team input, employee competency, effectiveness and efficiency in doing work (Iqbal, Anwar & Haider, 2016; Siramiati, Surachman, Hadiwidjojo, & Rohman, 2016; Seng & Arumugam, 2017). It is conceptualized as the way to perform the job tasks according to the prescribed job description.

Despite the important role of employees' performance in achieving organizational success, in Nigeria, labor-productivity recorded a decline of 4.7 percent between 2015 and 2016 (NBS, 2017). The Computer and Enterprise Investigations Conference (CEIC) (2018) reported that Nigeria labor productivity dropped by 1.14 percent in September 2018 compared with a growth of 3.25 percent in the previous quarter. These are justified by the fact that the level of human capital investment is very low in most of the public institutions in Nigeria (Johnson, 2011). Abimbola; Omowumi and Dele (2017) explained that Nigerian universities performance is not encouraging and the leaders neglected the universities, sent their children to the best universities abroad and then misappropriate revenues to establish private Universities. Sunday (2020) reports that the higher institution in Nigeria has witnessed an incessant closure due to the management leadership styles, labor union strikes and conflicts which has affected employee job performance in the universities. To lend credence to this position currently, Nigeria Universities has been shut down since 14<sup>th</sup> February, 2022 and some ministers are busy celebrating their wards graduations abroad and building privately owned universities in their state the situation that forced the National Association of Nigeria Students (NANS) to block major roads to the nation Airport and still count with impending dangers.

Nigeria has recorded 13.2 million out of school children, which is highest in the world (UNICEF 2018) and the education sector was seriously in bad shape and requires serious concern and immediate attention (Buhari, 2017). In 2015 the West African Examination Council ceased to recognize 113 Nigerian secondary schools implicated in examination malpractice (World Education News and Reviews, 2019). Similarly, a mass media report lends further support to the prevalence of deteriorating educational standard in Nigerian, for example, Channel News (2018) reported that the federal executive council at its 92<sup>nd</sup> session declared state of emergency on education and directed that 15 percent of the budgetary allocation be given on education at both state and federal government level, as against 7.4 percent and 7.04 percent in 2017 and 2018 respectively.

To further lend credence to the problems of employees' performance in Adamawa State public higher institutions the management of federal polytechnic Mubi has issued a general circular on 9<sup>th</sup> November, 2020 observing with dismay the lackadaisical attitude with which staff performs their duties leading to poor performance and low level of productivity. Similarly, the management of Adamawa State College of health technology Mubi, Adamawa State University Mubi, Modibbo Adama University Yola (MAU, Yola), Federal college of education Yola (FCE, Yola), and College of Agriculture Ganye have issued a general circulars

on 10<sup>th</sup> February 2021, 16<sup>th</sup> June 2018, 16<sup>th</sup> January 2015, 4<sup>th</sup> May 2011 and 4<sup>th</sup> November, 2003 respectively observing the non-challant attitude to work exhibited by the staff including late coming and early closing from work, laxity and ineptitude to duties, absence to work by staff in their institutions leading to poor performance. Additionally, Adamawa State Polytechnic Yola in their 135<sup>th</sup> meeting of the polytechnic Management held on 13<sup>th</sup> February, 2018 resolved to punish any staff that demonstrate late coming and laxity at work.

Effective leadership is essential for organizations that are interested in improving employee's performance (Asiedu & Darko 2017). Despite the studies by (Abdullah, Islam and Al-Homayan 2016; Aunga & Masare, 2017; Babalola 2016; Danilwan, 2021; Desderio, Piason & Bhebhe, 2017; Joiceswarnalatha & MuraliKrishna 2017; Lestiowati and Fransisco, 2021; Ramadhanti, Singh and Kularajasingham, 2021; Rafia, Sudiro and Sunaryo, 2020; Udin, Riyadh & Dananjoyo, 2020; Mohiuddin, 2017; Nyakundi, Nyoni, Dandira, Chufama, Kandjinga, Jeremiah, 2021; Yücel, 2021; Rasool, Arfeen, Mohti, and Aslam 2017, Nazarian, Soares and Lottermoser 2017; Salman, Khan, Javaid, and Naeem u din 2016; Khuong and Khanh 2016) on leadership styles, literatures indicate that very few studies have looked at the effects of Authentic leadership style on employees performance. Soderlund and Wennerholm (2021) explained that the growth of the need for authentic leadership comes from the upswing of worldwide cooperate scandals and crises. The corporate scandals and crises have created a higher demand for new leadership styles that can restore the trust and accountability of the leaders. It is the thrust of this paper to examine the authentic leadership and employee's performance in public higher institutions in Adamawa State through the moderating role of job Crafting.

## **Literature Review**

### **Concept of Employee's Performance**

Employee's performance is associated with the employees possessing the requisite knowledge, objectives and capabilities to meet the work standard by the organization (Al-Harthy & Yusof, 2016) or performing defined responsibility, accomplishing targets, employee competency, effectiveness and efficiency in doing work (Iqbal, Anwar & Haider, 2016; Khuong, *et al.*, 2016). Researchers have classified employees performances in different ways such as task performance and contextual performance (Babalola, 2016; Al-Harthy *et al.*, 2016; Saboor, Mukhtar, & Sadiq, 2015; Saeed, Mussawar & Lodhi, 2013; Devonish & Greenidge, 2010), task, contextual and adaptive respectively (Pradhan & Jena, 2017), task and dispositional performance (David & Eguzoikpe 2014), task, citizenship and counter-productivity (Robbins & Judge, 2017) among others. Pradhan and Jena (2017) explained that the task performance is further divided into technical-administrative task performance and leadership task performance. Task performance means performing assigned responsibilities to achieve organizational goals (Pradhan & Jena, 2017; David & Eguzoikpe, 2014) and

contextual performance means voluntary actions aimed at helping co-workers (Saboor, Mukhtar & Sadiq, 2015). Task performance is rewarded but mostly contextual performance is free cost, based on the employment contract every employee is responsible for performing better on tasks given as well as the duties involved in the job (Seng & Arumugam, 2017). An individual's ability to acclimatize and provide necessary support to the job profile in a dynamic work situation is referred to as adaptive performance (Hesketh, & Neal, 1999). Markova and Ford (2011) argued that readiness of workers to use their creativeness, skills, and knowledge determines the success of an organization.

### **Authentic Leadership**

The concept of authentic leadership has gained much relevance in the last few years following the unexpected changes that the organizations and the contemporary societies had suffered (Tijani & Okunbanjo, 2020; Duarte, Ribeiro, Semedo & Gomes 2021; Bento & Ribeiro, 2013). Authentic leadership style is emerging as a dominant one (Christy & Duraisamy, 2016; Gardner et al., 2005; Wong & Laschinger, 2012). Authentic leaders perform their actions according to personal values and beliefs which creates credibility and makes them get the respect and trust of followers (Besen, Tecchio & Fialho, 2017). Walumbwa, Luthans, Avey and Oke (2011) explained that authentic leadership matter in work groups in terms of members' cognitions, behaviors and performance.

Authenticity is a philosophical and psychological concept with origin in Greek philosophy that means being true to oneself (Soderlund and Wennerholm, 2021). Authentic leadership is a style of leadership in which the leader is true with him-self while leads and is seen by the led ones as a sincere, honest and complete person (Bento & Ribeiro, 2013) or a process that promotes positive psychological capacities. Authentic leadership is directly related to positive organizational behavior, based on authenticity, trust and providing support for the organizational best practices. It is also a style that is consistent with a leader's personality and core values and that is honest, ethical and practical (Besen, Tecchio & Fialho, 2017). This form of leadership is based on the understanding and interpretation of observed or experienced evaluation processes, as well as on ethics in decision-making. Walumbwa, Avolio, Gardner, Wernsing and Peterson (2008) observed that authentic leadership style dimensions ranges from self-awareness, relational transparency, internalized moral perspective, and balanced processing. Authenticity is concerned with personal experiences and ways of acting in accordance with what one really thinks, believes and behaves.

### **Job Crafting**

The extant literature reveals that the term "job crafting" emerged in the early 2000s as a bottom-up perspective on job redesign in which employees take an active role in customizing their job (Vanbelle, 2017). Wrzesniewski and Dutton (2001) defined Job Crafting as the

physical and cognitive changes individuals make in their task or relational boundaries at work. job crafting is conceptualized as proactive behaviors through which employees change their levels of job demands and job resources, that is the characteristics of their work to gain a better person–job fit (Petrou et al., 2012; Tims et al., 2012; Tims et al., 2014). Petrou, Demerouti and Schaufeli (2018) explained job crafting as a potential strategy employees use to react to and deal with organizational change. Irvin (2017) observed that job crafting (JC) involves employees changing certain aspects of the way they operate, interact with other employees, and how they think about their job.

### **Authentic Leadership Style and Employees Performance**

Walumbwa *et al.*, (2008) reported that authentic leadership leads to increase in job performance and other positive attributes like job satisfaction and work engagement. Duarte, Ribeiro, Semedo & Gomes (2021) conducted study among 214 employees working in different business sectors on authentic leadership and improved individual Performance: Affective Commitment and Individual Creativity's Sequential Mediation. The results reveal a statistically significant positive relationship between authentic leadership and employees' workplace performance. Daraba, Wirawan, Salam & Faisal (2021) investigated among 116 respondents working from one of the largest institutions under the Minister of Home Affairs of Indonesia. The results reveal that employees' perception of leaders' authenticity could directly influence their performance or indirectly via employees' PsyCap. Wong and Laschinger (2012) investigated on a random sample of 600 registered nurses working in acute care hospitals across Ontario in Canada. The study revealed that authentic leadership significantly and positively influenced staff nurses' structural empowerment, which in turn increased job satisfaction and self-rated performance. Peterson et al. (2012) found out that authentic leadership behavior exhibited by leaders is positively related to followers' job performance. Ribeiro, Duarte and Filipe (2018) conducted a study of 177 employees drawn from 26 small and medium-sized organizations operating in Portugal. The organizations were selected from different sectors, including office supplies, food, construction and automobiles. The findings show that authentic leadership has a positive impact on OCB, employee creativity, and individual performance.

### **Job Crafting and Employees Performance**

Empirical work has emerged that links job crafting to job performance in the western and Asia part of the world (Laurence, Fried, Yan & Li, 2020). Dan, Rosca & Mateizer (2020) observed that a positive relationship exist between job crating and job performance. Bakker, Hetland, Olsen, Espevik, De Vries (2020) investigated on job crafting and playful work design: Links with performance during busy and quiet days among a total of 77 Norwegian naval cadets. Results of multilevel modeling showed that job crafting (daily seeking job resources, seeking

challenges, and playful work design) were each positively related to job performance. Wang, Li and Chen (2020) conducted a meta-analysis on a sample of 51 empirical studies regarding social factors (i.e., organizational insiders and outsiders) and job crafting, and how these social factors contribute to employees outcomes through their job crafting. Their study showed that employee job crafting positively affect job performance and well-being. Laurence, Fried, Yan & Li (2020) investigated on the role of “enjoyment of work” and “driven to work” and job-crafting as a motivations in Japan and China among 154 supervisor–employees using dyadic method. It was reveals that job crafting affect employee’s performance among others. Dubbelt, Demerouti and Rispens (2019) investigated among 111 employees of Eindhoven University of Technology, Netherlands on the value of job crafting for work engagement, task performance, and career satisfaction: longitudinal and quasi-experimental evidence. It was found out that job crafting positively affected work engagement, task performance, and career satisfaction. Park, Lim, Kim & Kang (2020) sampled among 250 human resources professionals working in South Korea companies and have found out that revolving relationships existed among job crafting, work engagement and adaptive performance. Dan, Rosca & Mateizer (2020) conducted research on job crafting and performance in Firefighters: The role of work meaning and work engagement among a sample of 1,151 firefighters from 27 Romanian fire departments using paper-and-pencil questionnaire. The Structural equation modeling result indicated the existence of both a direct and indirect effect between job crafting and job performance through work meaning and work engagement. Mishra, Singh & Tripathy (2020) conducted study among 175 banking employees of SBI bank of India using a cross-sectional and correlation design. The study examined Job crafting and the relationship of individual characteristics for sustainable development of organization. The study result reveal that for every unit increase in job crafting 55 % unit increase in the job performance is recorded holding the other variables constant.

### **Job Crafting as a Moderator**

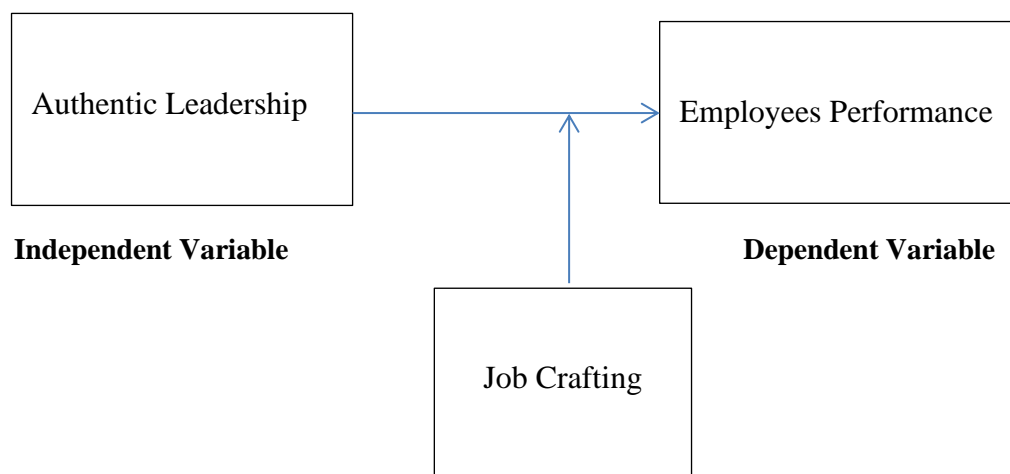
Soeter (2017) conducted a study among 126 Dutch-speaking employees using a baseline questionnaire. The study examined job crafting as a possible moderating variable between failures and learning behavior. It was found that Daily failures and learning behavior are not significantly related and Job crafting is not a significant moderator to this relationship. Pool (2016) investigated among a sample of 257 teachers in Deltion College, Netherlands. The aim of the study was to identify to which extent does Job crafting mediate or (negatively or positively) moderate the relationship between Human Resource Management and Work engagement? The finding revealed that job crafting did not moderate the relationship. It was suggested that future research be carry out to further investigates the relation between HRM, Job crafting and Work engagement in different cultural setting. Vogel, Rodell and Lynch (2016) investigated engaged and productive misfits: how job crafting and leisure activity



mitigate the negative effects of value incongruence among 193 US respondents working in finance, banking, information technology, education, and health care using email survey. The results suggested that both job crafting and leisure activity moderate the relationship and indeed act as a buffer, mitigating the otherwise negative effects of value incongruence on employee engagement and job performance.

### Theoretical Underpinning

Social learning theory is a theory of learning process and social behaviour which proposes that new behaviors can be acquired by observing and imitating others. The Social Learning theory postulates that individuals learn behavior from their work environment via physical observations, imitations and modeling. This suggests that an individual's behavior at work is determined by perception regarding the kind of behaviors that most others do in a social setting and perception regarding the kind of behaviors that most others approve or disapprove in an organization. Social learning theory is adopted in this study because authentic leader's behaviors centered on exhibiting positive organizational behavior, based on authenticity, trust and providing support for the organizational best practices. In line with these behaviors and social learning philosophy if the employees observed leaders, imitates and take them as models it will go a long way in improving employees performance (Walumbwa, David, Mayer, Wangc, Wang, Workman , Christensen, 2011). Given the relative support for social learning theory across various life situations and the underlying principle of social learning that individuals learn behavior from their work-based referent others via observation and imitation, it is predicted that this theory would provide a support for good leaders - subordinates relationship that would improve employees performance.



**Figure 1.1 Proposed Theoretical Frameworks**

The inclusion of moderating variable in this framework as suggested by previous studies (Baron & Kenny, 1986; Peng, 2018, Preacher, Rucker & Hayes 2007; Wong and Laschinger, (2013); Memona, Cheahb, Tingd, Chuah and Chamf 2019; Wingerden and Poell (2017); Langeveld (2017) is an answer to the clarion calls which is yet to be investigated and such consideration could increase our theoretical understanding and provide on how job crafting buffers the effect of authentic leadership style on employee performance. To end this, the primary focus of paper is proposed a framework of moderating role of job crafting on the relationship between authentic leadership style and employee performance.

### **Methodology**

For the purpose of this study descriptive survey design will be adopted. This is because the study will seek to predict and explain the relationships between authentic leadership and employees' performance in public higher institutions in Adamawa State. The sample size of the study will be determines using Yaro Yamane (1967) scientific guideline for determining sample size for research activities. A structured questionnaire with closed ended multiple choice questions will be used for this research as a method of data collection. The study will employed the use of correlation and regression analysis as inferential statistics for data analysis. To measure employee's perception of head of department/unit authentic leadership 16 items from Avolio, Gardner & Walumbwa (2007) Authentic Leadership Questionnaire (ALQ) will be use. Example of item "My head of department/unit demonstrates beliefs that are consistent with actions". To measure job crafting variable 21 items developed by Tims, Bakker and Derks (2012) will be use. Example of item "i decide on how to improve work better". To measure employee performance Role Based Performance Scale (RBPS) developed by Welbourne *et al.*, (1997) will be adopted in this paper. Example of item: "I put more effort to achieve quantity of work output".

### **Conclusion**

Authentic leadership style and job crafting are found as an influential factor to employee's performance. The employee's performance is considered the backbone of any organization as it leads to profitability and sustainability. Poor performance is detrimental to the organization's success. This paper is an attempt to contribute to theory building of authentic leadership style, job crafting and employee's performance as well as making meaningful contribution to management strategic decisions. The paper therefore, proposes to empirically assess the direct effects of authentic leadership on employees' performance. It will also assess the moderating effects of job crafting. This paper will therefore bridge the literature gap by providing first-hand information regarding the relationship between authentic, job crafting and employee's performance in Public higher institutions and provide bases for improving effective functioning of the Nigeria's public institutions, particularly in Adamawa State. Therefore, it is

suggested that an empirical investigation on authentic leadership style, job crafting and employee's performance be carried out in future.

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## GENERAL-PURPOSE IMAGE TAMPERING DETECTION TECHNIQUES: A REVIEW OF RECENT ADVANCES

**Abdulkadir Maigari Turaki,**

Department of Computer Science,  
Federal Polytechnic Bauchi,  
Bauchi State, Nigeria.

**Fatima Ahmed Abubakar,**

Department of Computer Science,  
Federal Polytechnic Bauchi,  
Bauchi State, Nigeria.

**Ahmad Atika Jibrin,**

Department of Computer Science,  
Federal Polytechnic Bauchi,  
Bauchi State, Nigeria.

**Suberu yusuf,**

<sup>4</sup>Department of Computer Science,  
Federal Polytechnic Bauchi,  
Bauchi State, Nigeria.

**Sunusi Abdulhamid Dantata**

Department of Computer Science,  
Federal Polytechnic Bauchi,  
Bauchi State, Nigeria.

### **Abstract:**

Image tampering is the action of adding or removing important features from an image to change its semantic meaning for illegal or malicious purposes. The development of sophisticated computers and image editing software has made the tampering of digital images easy and undetectable by the human visual system. As a result, the tampering of images for malicious purposes is now rampant in our society leading to many ethical and moral consequences, such as the spread of fake news, wrong verdicts, and damage of reputation among others. For these reasons, it is important to have tools that can help us determine the authenticity of digital media. The earliest methods for detecting image tampering focused on detecting specific image tampering, they could not be used for detecting multiple image

tampering. However, practical image tampering often involves multiple tampering operations. To address this problem, recent studies in image tampering detection have focused on designing general purpose or universal approaches capable of detecting more than one image tampering type. This paper presents a comprehensive literature review of the recent development in general-purpose or universal image tampering detection techniques. The paper discusses and summarizes recent general-purpose image tampering detection approaches, along with a detailed discussion on the datasets and evaluation metrics used. Comparative analysis of the performance of the reviewed methods, some discussion on the challenges faced by the current methods, and scopes for future directions are also presented in this review. The main goal of this paper is to help fellow and prospective researchers in digital image forensic by collecting the current trends, challenges, and some future direction in the development of general-purpose image tampering detection methods.

**Keywords:** image tampering; general purpose; tampering detection; image forensics; review

## Introduction

In recent times, digital media including images have become the principal means of conveying information due to their expressive potentials and the ease of distribution, acquisition, and storage [1]. The efficacy of digital images in conveying information has made them more preferable than text information as a means of communication. Consequently, it is becoming common more than ever to see an image representing a prime source of evidence in legal proceedings, crime investigations, and, a source of information by mass media and publishing agencies. However, the nature of the digital image has raised a lot of questions in most of these positive aspects where they are utilized. Digital images can be easily altered to convey false or misleading information. The advent of sophisticated computers and user-friendly image editing software allows anyone with rudimentary image editing skills to alter them easily without leaving behind any human perceptible traces [2]. Thus, image modifications for harmful reasons have become commonplace in our society, resulting in a lot of ethical and moral consequences, such as the spread of fake news, erroneous verdicts, and reputational damage among others [3]. Therefore, it is necessary to develop strategies and methods to allow the verification of the authenticity of digital images before using them to make crucial decisions.

To determine the authenticity and processing history of digital images, numerous image manipulation detection methods have been developed recently. The existing methods work based on the idea that each image manipulation operation creates unique traces that change the underlying statistics of an original image uniquely. As a result, to detect image tampering, researchers devised algorithms that recover these traces and utilize them to identify if and how an image is tampered with. Although these methods have been successful in detecting several

types of image manipulations, such as median filtering [4], contrast enhancement [5], JPEG compression [6], copy-move [7], and image splicing [8], they cannot identify more than one type of image tampering. The disadvantages of these techniques are that they require multiple tests to determine if an image is altered or genuine [3]. Thus, methods capable of identifying multiple image manipulation operations are required.

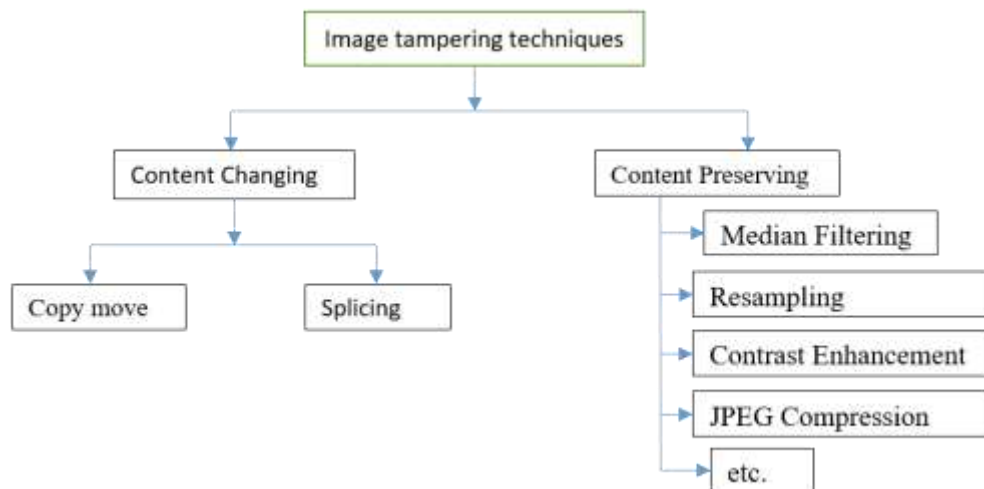
To address these limitations, recent studies in image tampering detection have concentrated on building general-purpose techniques capable of detecting multiple types of image manipulation. Several general-purpose image tampering detection techniques [9-11] based on handcrafted features such as Spatial Rich Model (SRM) [12], Local Binary Pattern (LBP) [13], etc. have been proposed, with outstanding results. Moreover, with the success of deep learning methods, particularly CNN, in many visual identification tasks, current image forensics researchers [14-16] also seek to use the strength of deep learning methods to solve the problem of digital image tampering detection. The deep learning approaches can extract and learn image manipulation fingerprints from images automatically. Thus, their performances are significantly superior to that of earlier approaches.

This paper presents a comprehensive literature review of the recent developments in general-purpose or universal image tampering detection techniques. The paper discusses and summarizes recent general-purpose image tampering detection methodologies, along with a detailed discussion on the commonly used datasets and evaluation metrics. Finally, a comparison of the performance of the reviewed methods, some discussion on the challenges faced by the current methods, and scopes for future directions are also discussed. Several related reviews [17-21] have been proposed in the literature, however, to the best of our knowledge, this is the first review focusing entirely on recent general-purpose image tampering detection methods. Our goal is to help fellow and prospective researchers in digital image forensic by compiling the current trends, challenges, and some future direction in the development of general-purpose image tampering detection methods.

### **Digital Image Tampering Techniques**

In the context of digital image forensics, image tampering refers to any manipulation or alteration in an image to change its semantic meaning for illegal or malicious purposes [1,22]. Although digital images can be manipulated by photo editing tools to correct some flaws in the image or to make it look more perfect, however, if such actions are aimed at removing or creating objects that never existed for malicious purposes, such modification is considered as image tampering. The advent of high-performance photo editing software such as Photoshop and GIMP has made digital image tampering relatively easier, anyone with basic photo editing skills can tamper with the original information of an image. As a consequence, digital image tampering has now become ubiquitous in our daily lives leading to serious moral, ethical and legal issues [9]. Digital image tampering can be broadly categorized into **content changing**

**tampering** (e.g. copy move and splicing) and content **preserving tampering** (e.g. Median Filtering and resampling) [23]. However, practical tampering often involves both tampering types. The content preserving tampering such as median filtering is used for smoothening the boundaries of the tampered regions in content changing tampering such as copy-move to make the traces of image tampering less visually detectable [22]. In this section, we first present the different types of content changing tampering followed by some content preserving tampering operations often used for hiding image tampering artifacts reported in the literature. Figure x. illustrates the different types of image tampering techniques.



**FIGURE 1.** CLASSIFICATION OF IMAGE TAMPERING TECHNIQUES

**Copy Move:** One of the straightforward methods of altering the semantic meaning of a digital image is by removing an unwanted scene or object from the given image or creating a scene or object that never existed. In such circumstances, the forger needs to replace the region of the object removed or introduce a new object or scene in the image. A typical solution here is to copy a portion of the same image and paste it on the region where an object was removed or where a new object needs to be created [1]. When an image is tampered with by copying and pasting portions from the same image to either delete an object or create an object that never existed, such type of image tampering is known as copy-move [23]. Copy move, also known as cloning, is the most common and most studied image tampering. When carried out perfectly, it is usually difficult to detect copy-move visually as it does not leave behind any visual perceptible artifacts. To create a convincing copy-move tampering, the forger often performs some post-processing operations (content preserving tampering) such as filtering and geometric transformation (resize, rotate or translate) on the copied region to make it match



perfectly with its new surroundings. These operations hide the traces of copy-move making it difficult to be detected [24].

**Splicing:** Splicing, also known as cut and paste, is performed by copying a portion from a source image and pasting it into a target image to form a composite image. Unlike copy-move which usually involves a single image, splicing involves two or more images [1]. Splicing operations are very likely to introduce some inconsistencies between the characteristics of the pasted region and the rest of the image. Detecting splicing is usually performed by studying these inconsistencies. However, splicing detection is often more challenging than copy-move as the inconsistencies introduced are visually less perceptible than traces introduced by copy-move [25].

**In-painting:** In-painting is the action of drawing or filling some missing content on the image to fill the holes or gaps left by the object removal operation. This is achieved by exploiting the information in the region surrounding the holes. The hole is gradually filled from the periphery to the center resulting in a perceived continuity in the whole image [redi]. In-painting alters the original image and the tampered region. The tampered region usually have distinct noise, lighting, and compression rate when compared to the rest of the same image [26].

**Resampling:** Resampling is one of the most common image post-processing operations performed by applying geometric transforms such as rotation and scaling to an image. Resampling can hide the traces of the previous tampering such as copy-move or splicing [27]. The resampling process, however, produces fingerprints in the image histogram, and thus provides a useful clue for image tampering detection. Resampling in itself is not a type of image tampering, however, most forgers use it as a means of creating a convincing image tampering. For example, when performing image splicing, rotation, scaling or translation may be used to ensure that the spliced region matched perfectly on the new image [28].

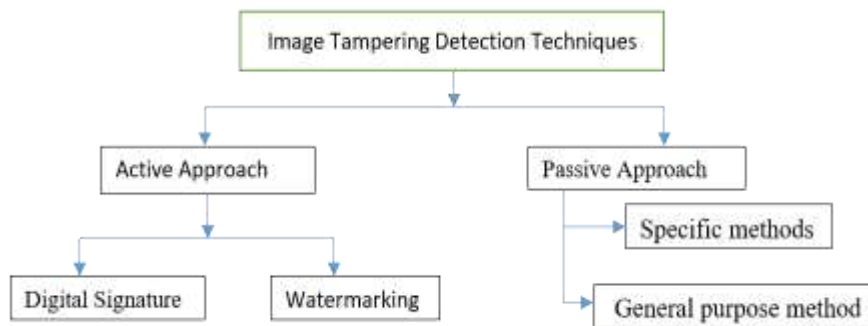
**Median Filtering:** Median filtering is a widely used de-noising and smoothing post-processing operation which is often used to erase image tampering traces and statistical traces of blocking artifacts introduced by JPEG compression [29]. The application of median filtering may interfere with or diminish subtle traces of the previous manipulation and this may decrease the reliability of forensics methods [30]. Therefore, the detection of median filtering is a crucial step in revealing the processing history of an image under investigation.

**Contrast Enhancement:** Contrast enhancement is also a post-processing operation used to alter the illumination effect of an image to increase its quality. Contrast enhance is performed through histogram equalization, which involves remapping the intensity values in the input image so that the output image has a uniform distribution of intensities [31]. Contrast enhancement can also be used by forgers to change the semantic meaning of an image or to conceal the traces of image manipulation. Thus, contrast enhancement detection plays a vital role in the forensics analysis of digital images.

### Image Tampering Detection Techniques

Image tampering detection methods have become a requirement of the present time as image tampering is increasing every day. Image tampering is the action of adding or removing important features from an image to change its semantic meaning for illegal or malicious purposes [32]. Digital image tampering detection mechanisms aim to detect such modifications or tampering. Image tampering detection approaches can be broadly grouped into two different categories, active methods and passive methods [33-34]. Figure 2 shows a hierarchical organizational structure for image tampering detection methods, stressing the difference between active and passive approaches.

**Active Methods:** In the active approaches also known as data hiding approaches, a digital image is authenticated by inserting some relevant information such as watermarks or digital signature in the image at the time of capture [33]. The active approaches are very effective since any attempt to tamper with the image will inevitably destroy the inserted watermarks or digital signature. However, since inserting watermarks or digital signatures requires a specialized imaging device, these approaches have gained little application/utilization. Therefore, the passive approaches also known as blind approaches are now regarded as the most preferred approaches for image tampering detection tasks.



**Figure 2.** classification of image tampering detection techniques

**Passive Methods:** The passive approaches work in the absence of watermarks or digital signatures i.e. does not rely on previous information to determine if and how an image is tampered, but operate on the assumption that image tampering operations leave behind some traces and inevitably destroy some inherent properties of an image which can be extracted and analyzed to determine the origin of a digital image and the integrity of its content [34]. The passive image tampering methods can be further classified into two classes, namely, tampering specific and general-purpose methods [35]. The tampering specific or dependent methods are designed to detect a specific type of image tampering. Most of these methods are tailored toward the detection of the two major content changing image tampering i.e. copy move and

splicing [36]. On the other hand, the general-purpose or universal image tampering detection methods are designed to detect multiple types of image tampering by looking for general inconsistencies in images that appear due to tampering operations [37]. To create convincing tampering, often some post-processing and geometric transformation operations such as median filtering, JPEG compression, and resampling are applied to copy moved regions or spliced regions to smooth the boundaries of the tampered regions. A more general technique that could detect multiple types of image tampering can be built by analyzing the effect of post-processing and geometric transformation operations performed independent of the kind of tampering [22]. The general-purpose approaches provide universal strategies to perform image forensics irrespective of the type of tampering.

The remainder of this paper is organized as follows. Section 2 presents the commonly used datasets by the reviewed methods. Section 3 discusses and summarizes the recent methods in general-purpose image tampering detection. The evaluation metrics along with the comparison of the review methods are presented in section 4. Finally, the challenges along with future scopes and conclusions are added in sections 5 and 6, respectively.

### **General Purpose Image Tampering Detection Datasets**

Unlike the specific image tampering detection approaches, there are no benchmark datasets for evaluating the general-purpose image tampering detection approaches. Therefore, the researchers need to prepare a dataset of both the original and tampered images from authentic and uncompressed image datasets for training and evaluating their models. In this way, researchers can recreate different image tampering operations and conduct experiments on an adequate and customized dataset. Several authentic image datasets have been used as the primary data source for the training and evaluation of general-purpose image tampering detection approaches. Some of these datasets were originally intended to benchmark camera model identification and image steganalysis techniques, while others to evaluate and benchmark content-based image retrieval and object detection models. In this section, we present a review of the major sources of datasets used for synthesizing the datasets used for training and evaluating the general-purpose image tampering approaches from the literature. One of the first and widely used datasets for the purpose of general-purpose image forensic is the Uncompressed Image Database (UCID) [38]. The UCID dataset was released in 2003 to serve as a benchmark dataset for evaluating image retrieval, image compression, and color quantization techniques. The dataset consists of over 1300 uncompressed images of size  $384 \times 512$  or  $512 \times 384$  in TIFF format together with a ground truth of a series of query images with corresponding models that an ideal Content-Based Image Retrieval (CBIR) algorithm would retrieve. All the images in UCID were captured using a single camera and comprises images on a variety of topics including natural scenes and man-made objects, both indoors and outdoors. Owing to the uncompressed format, the UCID dataset has been employed in

many specific and general-purpose image tampering detection systems as a source for synthesizing training and evaluation datasets.

Another dataset with a wide application in the development of general-purpose image forensic approach is the BOSSBASE [39] dataset. Released in 2010 originally for research in image steganalysis field, the BOSSbase database today forms a major source of datasets used in synthesizing the training and evaluation datasets for both specific and general-purpose image tampering detection techniques. The dataset consists of a training set and testing set along with the HUGO algorithm that can be used to create the steganography images. The training dataset consists of 10,000 grayscale cover images with a dimension of  $512 \times 512$ . The testing set consists of 1000 grayscale images with a dimension of  $512 \times 512$ . The raw images were captured using 7 different cameras and stored in PGM format.

Another dataset that has gained wide applications in the synthesis of the training and evaluation datasets of general-purpose image tampering detection models is the Dresden image dataset. The Dresden image dataset was released in 2010 by [40] specifically to develop and benchmark camera-based digital forensic approaches. The dataset contains more than 14,000 authentic images of various resolutions captured with 73 different cameras drawn from 25 different models to ensure that device-specific and model-specific characteristics can be disentangled and studied separately.

The Raw Image Database (RAISE) [41] dataset is a wide collection of authentic and diverse image datasets intended to serve as a common benchmark for comparing, testing, and evaluating present and future generation forensic algorithms. The dataset contains 8156 uncompressed high-resolution images of various sizes, depicting different scenarios and subjects. The dataset is properly annotated and is publicly available together with accompanying metadata. It comprises 4 subsets called RAISE-1K, RAISE-2K, RAISE-3K, and RAISE-4K. RAISE dataset has been used by several authors to create different image tampering for the training and evaluation of general-purpose image tampering models, thus, it's also a powerful resource for general image tampering researchers.

The IEEE Information Forensics and Security Technical Committee (IFS-TC) image forensic datasets were released in 2013 during an image forensic challenge [42]. The datasets consist of both original and tampered images involving two tampering techniques, namely, image splicing and copy-move. Each tampered image was accompanied by a ground-truth binary map that depicted the tampered region in the image. The dataset consists of 500 tampered images and 1,000 authentic (original) images, all of which are of the same size and in PNG format. While this dataset was specifically designed for evaluating and benchmarking copy-move and image splicing detection models, it has also been used by several authors as a primary data source for training and evaluating general-purpose image tampering detection approaches.

The Microsoft Common Object in Context (MS COCO) dataset [43] originally intended for advancing the state of the art in object recognition has also been used to create different image forgeries for the training and evaluation of general image tampering detection approaches. The dataset comprises over 300k images of complex everyday scenes containing common objects in their natural context in JPEG format and it comes along with the class annotation and segmentation annotation.

Other datasets that are used for synthesizing the training and evaluation datasets of general-purpose image tampering include NRCS [44], SZUBase [45-46], Kaggle Camera Model Identification (KCMi) dataset [60], and images from different cameras. The NRCS database contains 2,728 JPEG compressed images. The database was created by the United States Department of Agriculture and includes high-resolution photographs from a wide range of agricultural categories. SZUBase is a dataset collected in [46] with 40000 grayscale images of size  $512 \times 512$ . The KCMi dataset was released by Kaggle in collaboration with IEEE in 2018 during a camera model identification challenge organized by the duo. The dataset was captured using 10 different camera models with 275 images from each device.

Table 1 provides a summary of the datasets used in the training and evaluation of general-purpose image tampering techniques. In particular, the table presents the dataset names, released year, image size, format, original purpose of the datasets and the number of samples in each of the datasets.

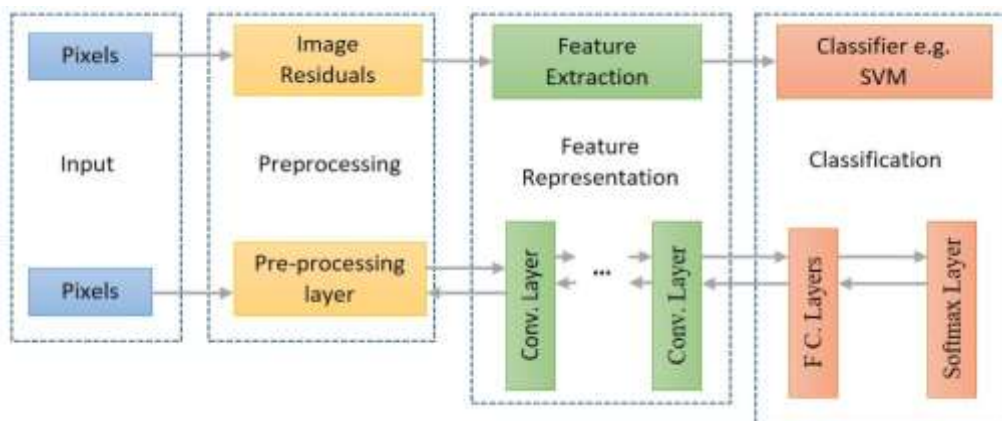
**Table 1.** Summary of the datasets used in the literature of general-purpose image tampering detection. The “L”, “C”, and “U” in the **format** column correspond to Lossy compression, Lossless compression, and Uncompressed, respectively.

S/N	Dataset Name	Release Year	Image size	Format	Purpose	Number of samples
1	Dresden [40]	2010	Various	L-JPEG, U-NEF	Digital image forensic	25137
2	BOSSbase [39]	2010	512x512	U-PGM	Image Steganography	10,000
3	UCID [38]	2004	Various	U-TIFF	image retrieval, compression and color quantization	1338
4	RAISE [41]	2015	Various	C-TIFF, U-NEF	Image Forensic	8156
5	IEEE-IFS-TC [42]	2013	Various	C-PNG	Image Forensic	1050/1150

6	SZUbase [45]		512x512			Image Steganography	-
7	NRCS [44]	2004	1500x2100	U-TIFF, L-JPEG			11,036
8	Kaggle Camera [60]	2018	Various	L-JPEG, C-TIFF	Camera Model Identification		2750
9	MS COCO [43]	2014	Various	L-JPEG	Object detection and segmentation		328k

### General Purpose Image Tampering Detection Methods

General-purpose image tampering approaches are employed to detect multiple or a group of image tampering operations. These techniques are generally based on, detecting the traces left behind during the post-processing or geometric transformations operations and the general disturbance in images that may appear due to image tampering operations [22]. The methods used for detecting general-purpose image tampering can be categorized into two classes, namely, handcrafted features and deep learning-based methods, which are discussed in this section. Fig 3. Shows the general architecture of image tampering detection systems based on handcrafted (top) and deep learning (bottom) methods. The forward and backward arrows in the bottom flowchart indicate forward and backward propagation directions. We use “Conv.” and “FC” to represent Convolution and Fully Connected layers, respectively.



**FIGURE 3. ARCHITECTURES OF IMAGE TAMPERING DETECTION SYSTEMS**

### Handcrafted Feature-Based Methods

Handcrafted methods or the traditional methods extract intrinsic statistical properties artificially from input images and most often employ machine learning algorithms for

classification. The handcrafted methods mainly build image tampering detection methods in two steps: feature extraction and classification [37]. In the feature extraction step, a set of handcrafted features is extracted from each image to capture the impact of image tampering operations. In the classification step, classifiers such as SVM or ensemble classifiers are learned based on the extracted features. The design of good discriminative features is the key step in this approach and largely impacts the detection performance. Thus, several studies have proposed the use of different discriminative features, which are discussed in this subsection.

The first general-purpose image forensics method utilizing this technique was proposed by Qiu et al. [9] where they suggested the use of steganalytic features such as LBP (Local Binary Pattern) and SRM (spatial rich model) in the design of a general-purpose image tampering system. The proposed method modeled image tampering detection problems as steganography and evaluate LBP and SRM steganalytic features on the detection of five types of image manipulation operations, including Gaussian blurring, gamma correction, lossy JPEG compression, median filtering, and re-sampling. The method achieves high detection accuracies in detecting individual and multiple tampering operations.

The work of Fan et al. [47] introduced a general purposed image manipulation detection approach where image manipulation fingerprints are learned from Gaussian mixture model (GMM) parameters of small image patches processed by different image manipulation operations. The proposed method can detect a tampered image by comparing the average patch log-likelihood values calculated on overlapping image patches under different GMMs of original and tampered images. Six tampering operations, median filtering, Gaussian filtering, WGN (White Gaussian Noise), UnSharp Masking (USM), JPEG Compression, and resampling are considered in the study. The proposed model shows excellent performance in detecting both individual and multiple image tampering on small and large images.

Li et al. [10] also proposed a universal image tampering approach using residual-based features and powerful steganalytic features called the Spatial Rich Model (SRM). The technique is based on SRM features, extracted from image residual, obtained from the original input image using high pass filtering technique. Using this approach, they were able to obtain universal feature sets which they used in building the proposed model. The technique was able to detect multiple image tampering operations and some anti-forensics operations effectively and universally.

In [11], Farooq *et al.* investigated and demonstrated the performance of SRM and LBP in detecting multiple image tampering. They embedded LBP in SRM sub-models to capture detailed statistics of the quantized version of image noise residuals. The extracted features were used for classification using an ensemble classifier. Synthesized datasets from the first IEEE IFS-TC image forensics challenge [42] were used for the experiment. The experimental

results demonstrate that using LBP in conjunction with the SRM feature makes the model capable enough to detect almost all types of forgeries with an accuracy of 98.4%.

Peng *et al.* [48] designed a universal feature set for multi-purpose image forensics capable of detecting different kinds of image manipulation operations concurrently using residual-based features. To remove the effect of image content on the robustness of the proposed features, they introduced a residual group with several high pass filtered residuals from which a partial correlation coefficient is exploited. The partial correlation coefficient is then combined with the autoregressive coefficient and transition probability to form the proposed composite feature sets which are used to measure how manipulations affect the pixel neighborhood correlations in a linear and non-linear fashion. The composite feature set is then fed to a multi-classifier which performs the final classification. The proposed method achieved excellent performance in identifying several image manipulations.

The summary of the handcrafted methods, their targeted image tampering, features used, classifiers and performances are listed in Table 2.

**Table 2.** Comparative analysis of general-purpose image tampering methods using handcrafted techniques

S/N	Methods	Targeted Tampering	Feature	Classifier	Dataset	Performance
1	[9]	Gaussian blurring, gamma correction, lossy JPEG compression, median filtering, and re-sampling.	LBP and SRM	Ensemble Classifier	IEEE IFS-TC Image forensic database	Acc= 96.89% (SRM), Acc= 92.24% (LBP)
2	[47]	median filtering, Gaussian filtering, WGN (White Gaussian Noise), UnSharp Masking (USM), JPEG Compression and resampling	Patch likelihood of different Gaussian Mixture Model (GMM) of original and tampered images	Decision threshold	Images from 4 different cameras	Acc => 92.67%
3	[10]	Gamma correction, Histogram equalization, Unsharp masking sharpening, Mean filtering, Gaussian filtering, Median	Residual based features + SRM	Ensemble classifier	Bossbase	Acc = 98.41%



		filtering, Wiener filtering, up-sampling, down-sampling, and JPEG compression				
4	[11]	Gaussian Blurring, Gamma Correction, JPEG Compression, Median Filtering, Up sampling, Down sampling, Contrast Enhancement, Cropping, Copying, and Image Splicing	LBP with SRM	Ensemble classifier	IEEE IFS-TC image forensics datasets	Acc = 98.40%
5	[48]	Gaussian blurring, median filtering, re-sampling, and JPEG compression	Residual based features	Multi-classifier	BOSSbase and RAISE database	Acc = 95.20%

Although the handcrafted methods have yielded promising results, the extraction of handcrafted features suffers from high computational costs and their performance can be severely affected by post-processing operations such as JPEG compression and resampling. Moreover, since the feature extraction and classification steps are disconnected, they can not be optimized simultaneously. This implies that the guidance from the classification step will not be used to extract useful features in the feature extraction phase. Thus, it is desirable to develop a multi-purpose image tampering approach that can learn effective and robust features adaptively with joint feature extraction and classification steps.

### Deep Learning-Based Methods

In recent times, deep learning has attracted increasing attention due to its satisfactory results in several image processing and computer vision applications [49]. Inspired by these successes, the forensics community has recently focused on applying deep learning-based methods for general-purpose image tampering detection. Unlike the handcrafted feature-based methods, the deep learning methods directly learn effective features automatically from the input images through convolution, pooling, and activation operations, and the feature extraction and classification steps can be optimized simultaneously.

In a quest for better general-purpose image tampering detection methods, several methods utilizing the deep learning method have been proposed recently. For example, the work of Bayar and Stamm, [3] presented a universal image manipulation detection technique that utilizes a deep learning approach. The proposed method is based on a new convolution layer called “constrained convolution layer”, capable of suppressing image content to learn image

manipulation operation directly from data. Their method could effectively detect specific and multiple image manipulation operations in both uncompressed and compressed images format, and it showed superiority over SRM based general-purpose image manipulation approaches.

Tant *et al.* [50] illustrated a CNN and nearest-neighbor interpolation-based multipurpose image manipulation method. The nearest neighbor interpolation is employed in the preprocessing layer to magnify the input images to enlarge the differences between image manipulation operations. In the network design, the authors used multi-scale convolutional layers in the first few layers to learn hierarchical representations for different image tampering operations. However, since the multi-scale Conv layers are generally a highly non-linear function of the input, the mlpconv layers are employed to improve the network's nonlinear modeling capability. Moreover, they employed shortcut connections between the mlpconv layers to increase the depth of their network and at the same time preventing information loss. The proposed model is used for the detection of Median filtering, Mean Filtering, Gaussian Filtering, Contrast Enhancement, resampling, and JPEG compression in small image blocks. The method achieves high accuracies of 93.77% and 95.91% in 32x32 and 64x64 image blocks, respectively.

In [51], Boroumond and Fridrich introduced a method for detecting the processing history of an image that could correctly detect multiple processing operations. It is based on CNN with an IP layer accepting statistical moments of feature maps. The proposed CNN model was trained in three phases. The first phase involved training a "moment extractor" module on small images (512x512) which was then used in Phase II to extract moments from all (arbitrarily sized) training images. In the last phase, the IP layers were trained to map the extracted moments to tampering operation classes. Four types of processing operations were considered: low-pass filtering (blurring), high-pass filtering (sharpening), de-noising (content-adaptive low-pass filtering), and tonal adjustments, such as histogram equalization, gamma correction, and contrast enhancement. The proposed model could correctly classify images of different sizes and shows robustness against JPEG compression.

In [52], the authors proposed a universal image forensics method based on a deep Siamese Convolutional neural network. The proposed method takes as input a pair of image patches and decides whether they are identically or differently processed. Five image tampering operations, Gaussian Blurring, Median Filtering, Resampling, Noise Addition, and Gamma Corrections were considered and the experimental results demonstrate that the proposed method could detect both known and unknown image tampering operations with high detection accuracies.

Chen *et al.* [53] presented a method that can simultaneously detect 11 different types of image manipulations based on densely connected convolutional neural networks. The approach replaced the standard convolution layers in CNN with a dense connectivity pattern of

denseNet [54] to strengthen the transmission of features related to image manipulation detection. The approach achieves high accuracies on different datasets and shows robustness against JPEG compression.

In [55], the authors described a multiple image tampering technique based on CNN and frequency domain features of image residuals. The authors designed a two-layer CNN that extracts frequency-domain features of image residuals derived from the input images. The extracted features are used to classify seven different types of image manipulations using softmax and extremely randomized tree classifiers.

Camacho and Wang [56] proposed a general-purpose image manipulation approach that introduced a new initialization technique in the first layer of CNN to address the challenging nature of general-purpose image manipulation detection. The authors presented a method for creating random high-pass filters that could operate without constraints, based on the groundbreaking work of the famous Xavier initialization [57]. The method obtained high detection accuracies for image tampering such as median filtering, Additive White Gaussian Noise (AWGN), and resampling in both binary as well as multiclass classifications.

In a related work to their previous work, the authors of [56] recently proposed a data-dependent scaling strategy for first-layer filters initialized by various algorithms [58]. The proposed method took into account natural image statistics and was able to ensure that the amplitude (i.e., variance) of data flow in a CNN remained stable, which was useful for general-purpose image manipulation detection. A comparative study on the output variance of the different initialization algorithms before and after applying the proposed data-dependent scaling approach shows that the proposed method worked well with the different initialization approaches and different CNN architectures when tested on the task of detecting both individual and multiple image tampering operations.

The authors in [14] proposed a multi-purpose image tampering approach based on reinforcement learning that could design a deep neural network automatically without manual intervention. The method consists of a learning agent which is trained to choose layers of CNN sequentially according to the Q. Learning algorithm [59] within a tailored state-action search space designed to learn suitable network, the e-greedy strategy, and experience replay for searching an optimal network and speeding up the search process, respectively. The proposed model is evaluated on a dataset generated from SZUbase [45-46] image database. The method obtains an average detection accuracy of 88.62% on the detection of the eleven image tampering operations.

Aminu and Agwu [15] presented a general-purpose image tampering detection approach based on CNN and Local Optimal Oriented Pattern (LOOP). The LOOP is employed in the preprocessing layer to capture the different tampering traces that might be introduced by different tampering operations. The Proposed CNN is then fed the LOOP maps from the preprocessing layer, which extracts and learns the representations of different image

tampering traces. The final classification is then performed by three classifiers, softmax, xgboost, and Extra Tree. Five tampering operations including, Contrast Enhancement, Median Filtering, Gaussian Blurring, Gamma Correction, and JPEG Compression were considered in the study. The method achieves high detections rates in both individual and multiclass image tampering detection. However, the performance of the proposed model degrades in JPEG compressed and small images.

In [16], the authors designed a general-purpose image tampering detection approach based on deep learning. They proposed the use of residual dense blocks in building their model to exploit the local dense connections and global residual learning for better classification. The network input and high-level hierarchical features produced by proposed residual dense blocks are fused globally for better information propagation throughout the entire network. The architecture achieved overall detection accuracies of 95.09% and 97.31 % for BOSSBase [39] and Dresden [40] datasets, respectively in multiple image tampering detection.

Ali *et al.* proposed a deep learning method in [61] that could identify several instances of image manipulation based on double compression artefacts. The proposed model was trained utilizing the difference between the original and corresponding recompressed images. The technique recognized both image splicing and copy moves and had an overall validation accuracy of 92.23 %.

The authors of [62] proposed a multi-scale residual deep CNN technique for general-purpose image tampering detection. The proposed approach uses a multi-scale residual module for adaptably extracting image tampering artifacts from the input images and feature extraction blocks intended to extract high-level image tampering artifacts from the output of the multi-scale residual module. With overall accuracies of 97.07% and 97.48% on the Bossbase and Dresden datasets, respectively, the proposed approach could detect six separate image tampering operations.

In [63], the authors introduced a general-purpose technique for detecting image tampering and manipulation operation chains that was based on CNN and a recent local feature descriptor called LOOP. The authors combine the discriminative powers of the local feature descriptor and the feature extraction capabilities of CNN in order to create a powerful general-purpose image tampering detection method.

Table 3 provide a summary of the various general-purpose image tampering detection methods using deep the learning techniques. In particular, the table highlights the targeted image tampering, features, network type, and datasets used by each method alongside the performance of each method with respect to tampering detection accuracy.

Although the deep learning approaches have improved on the performance of the handcrafted approaches, they often fail in the presence of anti-forensics methods and their performances degrades in the JPEG compressed and low-resolution images. Thus, the development of

general-purpose image tampering approaches that will be robust against anti-forensics methods and JPEG compression remains an open challenge.

**Table 3.** Comparative analysis of general-purpose image tampering methods using deep learning techniques

S/N	Methods	Targeted image Tampering	Feature	Network Type	Dataset	Performance
1	[3]	Median filtering, Gaussian Blurring, resampling, JPEG Compression, and AWGN	Prediction error filters	CNN - ERT	IEEE IFS-TC image forensics, 34 new camera models, and Dresden database	Acc = 99.97%
2	[50]	Median filtering, Mean Filtering, Gaussian Filtering, Contrast Enhancement, resampling, and JPEG compression	Deep Features	CNN- Nearest Neighbor interpolation Algorithm	BOSSbase, UCID database, and NRCS	Accuracies of 93.77% and 95.91% in 32x32 and 64x64 image blocks, respectively.
3	[51]	Low-pass filtering (blurring), high-pass filtering (sharpening), de-noising (content-adaptive low-pass filtering), and tonal adjustments, such as histogram equalization, gamma correction, and contrast enhancement.	Deep features	CNN	BOSSbase	Acc = 97.99%
4	[52]	Gaussian Blurring, Median Filtering, Resampling, Noise Addition, and Gamma Corrections	Deep Features	Deep Siamese - CNN	Dresden	Acc =99.64%

5	[14]	Median filtering, Wiener Filtering, Average Filtering, Gaussian Blurring, Unsharp masking, Gamma Correction, Histogram Equalization JPEG Compression, JPEG 2000, scaling, rotation and	Deep Features	Auto-Generated CNN with Reinforcement Learning	SZUbase, BOSSbase and UCID.	Acc = 88.62%
6	[15]	Gamma Correction, Median Filtering, Gaussian Blurring, JPEG Compression, and Contrast Enhancement	Local Features and Deep features	CNN-ET, XGBOOST	IEEE Image Forensics Database, BOSSbase and MS COCO database	Acc = 99.81%
7	[53]	Median filtering, Wiener Filtering, Average Filtering, Gaussian Blurring, Unsharp masking, Gamma Correction, Histogram Equalization JPEG Compression, JPEG 2000, scaling, rotation and	Deep features	Dense - CNN	Image from diff cameras, BOSSbase, and UCID	Acc = 98.08%
8	[55]	Average filtering, Gaussian filtering, Laplacian filtering, Median filtering, Rescaling operation, Rotation operation, and Wiener filtering	Frequency domain features of image residuals	CNN - ERT	IEEE IFS-TC image forensics and others	Acc = 84.52% (32x32) , Acc = 81.64% (64x64)

9	[56]	Median filtering, Gaussian blurring, Additive Gaussian noise, Resampling, and JPEG compression	Deep Features	Different CNN architectures	Dresden	Acc= 96.45 (conv. Based Scaling) and Acc = 96.42 (covariance based scaling)
10	[58]	Median filtering, Gaussian blurring, Additive Gaussian noise, Resampling, and JPEG compression	Deep Features	CNN	Dresden	Acc = 99.67
11	[16]	Median filtering, Gaussian Blurring, resampling, JPEG Compression and AWGN	Deep Features	Residual Dense-CNN	Dresden and BOSSbase	Acc = 95.09 (BOSSbase), Acc = 97.31 (Dressden)
12	[61]	Copy move and Image slicing	Image difference	CNN	CASIA 2.0	Acc = 92.23
13	[62]	Additive White Gaussian Noise (AWGN), Median Filtering, Gaussian Blurring, Resampling, JPEG Compression, and Contrast Enhancement	Prediction error filters	Multiscale Residual Deep CNN	Dresden and BOSSbase	Acc=97.07 (Bossbase), Acc = 97.48% (Dresden)
14	[63]	Gamma Correction, Median Filtering, Gaussian Blurring, JPEG Compression, and Contrast Enhancement	Deep Features	CNN-ET and CNN- XGBOOST	IEEE Image Forensics Database, BOSSbase and MS COCO database	Acc = 99.15%

### Performance Evaluation Metrics

Deciding on a particular performance metric may depend on many factors, including the forensic problem and the nature of datasets to be used. Since there are no benchmark datasets for training and evaluating the general-purpose approaches, researchers usually generate

synthetic images from available datasets. These synthesized datasets consist of both the tampered and original images in an equal proportion. While these may not be the case in real-world scenarios, the majority of the general-purpose image tampering approaches are trained and evaluated with datasets consisting of an equal number of each class. Therefore, the accuracy and confusion metrics are the most preferred metrics in evaluating the general-purpose image tampering detection approaches. However, in an experimental setting with imbalanced data from different classes, the accuracy metric in general results in biased value and thus is not preferred.

The image tampering detection model's accuracy is defined as the percentage of correctly classified samples among all samples which can be formulated as in equation (1).

$$Accuracy = \frac{TP + TN}{TP + FP + TN + FN} \quad (1)$$

where TP, TN, FP, and FN stand respectively for true positive, true negative, false positive, and false negative numbers of classified samples.

The confusion matrix shown in table 4 is a table used to describe the performance of a classification model on a set of test data for which the true values are given. True positive (TP) and true negative (TN) are the correct predictions made by the model while False positive (FP) and false-negative (FN) are the errors made by the model. All the four terms used in computing the accuracy above are drawn from the confusion matrix as can be seen in the mathematical formulations. The accuracy metrics is used for measuring the predictive performance of a model in individual image tampering while the confusion matrix measures the performance of models in multiple image tampering or a group of image tampering detection. Although other metrics such as recall, precision and AUC have been used in individual image tampering detections, they have gained little or no applications in the design of general purpose image tampering detection methods.

**Table 4.** confusion matrix

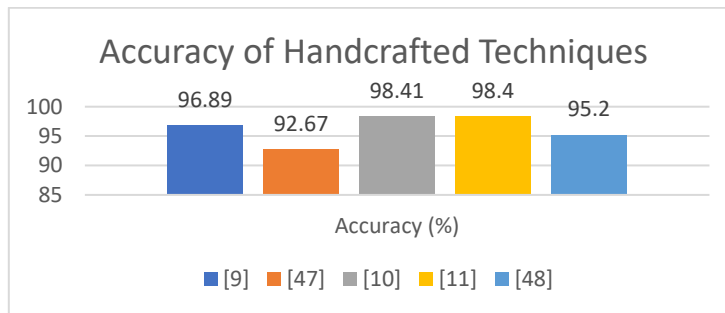
	<b>Predicted Positive Class</b>	<b>Predicted Negative Class</b>
<b>Actual Positive class</b>	True Positive (TP)	False Negative (FN)
<b>Actual Negative class</b>	False Positive (FP)	True Negative (TN)

### Performance Analysis

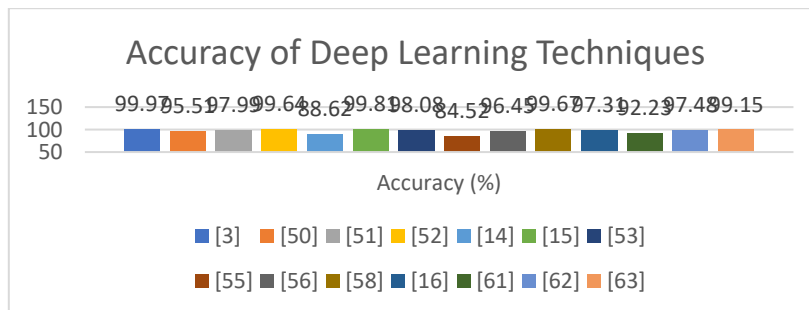
This section provides a comparative analysis of the performance of both the handcrafted and deep learning-based approaches for general-purpose image tampering detection with respect to the detection accuracy. Figures 4 and 5 illustrate the accuracies achieved by various handcrafted and deep learning-based general-purpose image tampering techniques



respectively. The maximum accuracy in the handcrafted approaches is achieved by [10], whereas the method of [3] achieved the highest accuracy in the deep learning-based approaches. The Deep learning techniques are found to be more robust than the handcrafted feature-based techniques with respect to detection accuracies as they are capable of automatically learning and extracting image tampering clues directly from input images without the need for complex pre-processing steps associated with the handcrafted approaches which may introduce noise that may interfere with the needed image tampering artifacts. Moreover, since the feature extraction and classification phase of the deep learning approaches are connected, insights from the classification phase can be used to guide feature extraction in the feature extraction phase. However, the deep learning approach requires a huge amount of data, more computational resources, and training time as compared to the handcrafted-based methods.



**Figure 4.** General purpose image tampering detection accuracy comparison between different handcrafted methods



**Figure 5.** General purpose image tampering detection accuracy comparison between different deep learning methods

### Research Challenges and Future Scopes

From the above review, it is clear that a lot still needs to be done in this field and various challenges need to be addressed. A major challenge of the existing general-purpose image tampering detection approaches is that they failed in the presence of anti-forensics methods.

Thus, efforts can be directed at strengthening the robustness of the current general-purpose image tampering approaches and the development of methods capable of detecting both image tampering operations and anti-forensics methods. Furthermore, another future direction worth exploring is the extension of general-purpose image tampering detection to other media, specifically videos. Videos today are even more powerful information carriers than images in communication and are often used as evidence in trials. Therefore, the development of robust general-purpose video tampering detection approaches can represent an interesting area for new digital forensic researchers. Finally, dataset selection is also a significant factor in the evaluation of the general-purpose image tampering detection methods. Unlike the specific image tampering approaches, there are no prepared benchmark datasets for evaluating the general-purpose approaches. Image tampering operations such as median filtering, scaling, JPEG compression, contrast enhancement, and Gaussian blurring, etc. are performed during pre-processing phase using different data sources. This leads to the use of different datasets by different authors. In such a case, the experiments cannot be repeated efficiently and the obtained results cannot be generalized easily. Thus, the accuracy claimed by various studies cannot be compared as they have used different datasets, scaling, and compression schemes. Therefore, efforts can also be directed toward the creation of a benchmark dataset that will contain all the known image tampering operations.

## Conclusions

In this paper, we have elaborated on the methods, datasets, and evaluation metrics used in recent times for developing general-purpose image tampering detection solutions. Other existing reviews have focused on both tampering specific methods and other forms of image tampering. None of them covered a detailed review of general-purpose or universal image tampering detection methods. Hence, this paper discusses and summaries recent general-purpose image tampering detection approaches, along with a detailed discussion on the datasets and evaluation metrics used. Comparative analysis of the performance of the review methods, some discussion on the challenges, and the scopes for future directions are also presented in this review. From the review, it can be concluded that the deep learning approaches provide better solutions than the traditional methods and are the most widely used methods in recent times.

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## COMPARATIVE STUDY OF EFFECTS OF AGE AT HARVEST ON THE NUTRITIONAL COMPOSITION *Celosia argenta* and *Amaranthus cruentus*

**\*Lawal I.A,**

\* Science Laboratory Technology Department,  
The Oke-Ogun Polytechnic, Saki,  
Oyos State, Nigeria.

**\*Azeez G.O,**

\* Science Laboratory Technology Department,  
The Oke-Ogun Polytechnic, Saki,  
Oyos State, Nigeria.

**\*Imran M.O**

\* Science Laboratory Technology Department,  
The Oke-Ogun Polytechnic, Saki,  
Oyos State, Nigeria.

**\*\*Bolale E.O**

\*\*Science Laboratory Technology Department,  
Adeseun Ogundoyin Polytechnic, Eruwa.

### ABSTRACT

Leafy vegetables are regular ingredient in the diet of the average Nigerians. Maturity at harvest can significantly impact product composition and the nutritive value of the crop. The physiology of growth, development, maturation, ripening and senescence results in pronounced chemical as well as physical changes in the edible plant part. The research that investigated the effects of age at harvest on the proximate, mineral, vitamin and phytochemical compositions of *Celosia argenta* and *Amaranthus cruentus* was conducted at the Oke Ogun Polytechnic Saki. A garden was made for the planting of the selected leafy vegetables. The samples were harvested at three harvesting ages; 5, 7 and 9 Weeks After Sowing (WAS). Laboratory analysis was done on the air dried edible portions. The results shown that age at harvest significantly affected the proximate (CHO (60.80 – 43.41)), minerals (K (300 - 238.15mg/g)), antioxidant (flavanoid (0.96 – 0.25mg/g) and vitamins (1.46-0.83mg/g) concentrations while the effect was not significant on that of antinutrients ( phytate (2.07-0.34)). It was therefore concluded that the optimum time of harvesting Amaranth is between 6 to 8 weeks after sowing, while that of celosia is anytime from the 7<sup>th</sup> WAS.

**Keywords:** Maturation, Phytochemical, Proximate, Composition, Antioxidant

## INTRODUCTION

Vegetables are the fresh and edible portions of herbaceous plants, which can be eaten raw or cooked (Onwordi *et al.*, 2009), they contain valuable food ingredients which can successfully utilized to build up and repair the body. Vegetable are variable in maintaining alkaline reserve of the body. They are valued mainly for this high carbohydrate, vitamins and minerals contents. Vegetable may be edible roots, stems, leaves, fruits or seed. Each group contribute to diet in its own way. *Amaranthus hybridus*, *celosia argenta*, *corchorus* and *Abelmoschus* esculent are popular edible vegetable in Nigeria (Oyedele *et al.*, 2006).

Vegetables contain both essential and toxic elements over a wide range of concentration. The concentration of these elements is a function of the concentration in the soil in which the vegetables is planted. Leafy vegetables are regular ingredient in the diet of the average Nigeria with their level of consumption, they can provide appreciable amount of nutrient minerals (Onwordi *et al.*, 2010). Vegetables are the cheapest and most readily available sources of important proteins, vitamins, minerals and essential amino acids. Vegetable also act as buffering agents for acidic substances produced during the digestion process (Onwordi *et al.*, 2010).

Leafy vegetables obtained reach their quality attribute at various stages of growth and development of leaves. Maturity at harvest is critical especially for product of good quality (Kader, 2002).

Leafy vegetables such as lettuce, escarole, spinach, rocket, watercress and other leafy greens are generally characterized as very perishable commodities, with high respiration and water loss rates. Cabbages are a notable exception as they may be stored for long periods. Leafy vegetables obtained from leaves reach their best quality attributes at various stages of growth and development of the leaves. Consequently, there is a wide range of possibilities for harvesting, depending on the final destination of the product, the desired quality attributes, and their resistance or tolerance to withstand handling and processing (Hughes, 2009). To meet the demand for nutritionally balanced food for the world's increasing population and relieve the intense pressure on land use and natural resources, plant species used as food must be diversified (Hughes, 2009). Wild leafy vegetables are harvested by rural community from crop fields at different stages of plant growth (Modi *et al.*, 2006). It is likely that for some wild leafy vegetables there is a preferred stage of plant development when flavour and palatability are favourable for human consumption (Albert, 2007).

*Celosia* is most commonly seen in West Africa, from Sierra Leone to Nigeria. *Celosia argentea* is also present in Ethiopia, Somalia, and Kenya, other parts of East Africa, Mexico and Central Africa. *C. argentea* is an important cultivated vegetable in the rainforest zone of Nigeria, Benin, Cameroon, Gabon, and Togo. The well known species of *celosia* are *Celosia argentea*, *Celosia Cristata*, *Celosia spicata* and *Celosia isertii* (Adegbaju *et al.*, 2019).

*Amaranthus* species are a highly popular group of vegetables that belong to different species. *A. cruentus* and *A. hypochondriacus* are the grain type, while the rest are the vegetable type. Both leaves and seeds contain protein of an unusually high quality. The grain is milled for flour or popped like popcorn. The leaves of both the grain and vegetable types may be eaten raw or cooked. Amaranths grown principally for vegetable use have better tasting leaves than the grain types. Amaranth consists of 60-70 species, 40 of which are considered native to the Americas. Over 400 varieties within these species are found throughout the world in both temperate and tropical climates, and fall into one of four categories: grain, vegetable, ornamental or weed. In Nigeria especially Yoruba community all species are referred to as “tete” even though they may add a second name to indicate a particular variety or species. The Hausas refers to them as “alaiyaho while Igbos call them “imne”. *Amaranthus* is highly nutritious, both the grain amaranth and leaves are utilized for human as well as for animal food. Boiling and squeeze washing lead to more loss than blanching especially vitamin c content (Babalola *et al.*, 2010).

Vegetable amaranth has received significantly less research attention than grain amaranth. However, it has been rated considerably higher in minerals, such as calcium, iron, phosphorous and carotenoids (Alegbejo, 2013). When nutrients are translocated from the topmost parts of vegetables to the other portion and harvest is done with the method of detopping, the consumers will be consuming it without knowing that the required nutrients have been translocated to the other parts not harvested. Since detopping is the common method generally adopted in Nigeria, it is important to determine the best age at harvest to get the highest yield and optimum nutrient around the topmost part of leafy vegetables (Alegbejo, 2013). The main aim of this study was to determine and compare the best age of harvesting *Amaranthus cruentus* and *Celosia argentea* to obtain highest yield of nutrients.

## MATERIALS AND METHODS

### Study site

The experimental garden was established on a plot of fertile soil at the back of the department of Science Laboratory Technology of the Oke Ogun Polytechnic, Saki. The experiment was carried out during the raining season of 2021 (for 63 days from July 4<sup>th</sup> 2021 to September 4<sup>th</sup> 2021).



*Celosia argentea*



*Amaranthus cruentus*



**Figure 3: Image of the vegetables grown**



**Full image of the garden**

**Map of the study area**

**Fig 1: map of Saki West Local Government**



The experiment was conducted during the major raining season, no watering was done.

**Plant material, sowing and harvest**

The samples seeds were obtained from the seed seller at Gbawojo market in Saki. All the samples seed were sprinkled onto the prepared plot, then, the soil was disturbed with hand to

cover the seed and harvesting was done first at 5<sup>th</sup> week after sowing (5 WAS), followed by 7<sup>th</sup> week after sowing (7 WAS) and lastly 9<sup>th</sup> week after sowing (9 WAS).

### Laboratory work

The fresh leaves were washed with well water to remove the unwanted matter and air dried until properly dried with continuous turning to avert fungal growth. The samples were crunched and sieved through a 2mm sieve size to obtain fine form of it followed by laboratory analysis.

### Proximate analysis

This includes, Moisture content, Ash content, Crude fibre content, Crude protein content and Carbohydrate content. They are all examined using standard analytical method.

### Mineral Content Analysis

Mineral concentration, antioxidant and antinutrient analysis were also carried out using a standard mineral content method of analysis.

### Digestion

About 0.5g of the sample was weighed into 100ml beaker, nitric acid and perchloric acid was mixed in the ratio 1:2. The mixture in the sample was placed on a hot plate to undergo digestion at 150<sup>o</sup>c for 30 minutes; this depends on the nature of the vegetable sample until it changed to a colourless solution or a milky solution. The beaker was covered with already washed glass and allowed to cool, after which distilled water was added to make 25ml. the same thing was done for other samples.

### Data Analysis

All the data collected were subjected to analysis of variance (ANOVA) using Microsoft Excel (version 2007) and IBM-SPSS (VERSION 21.0). Treatment mean were separated using the least significant difference where significant difference occurred at 5% level of probability.

## RESULTS AND DISCUSSION

### Results

**Table 11: Fresh leaves moisture content (%) Mean value  $\pm$  SD of triplicate result**

Vegetables	5 W.A.S	7 W.A.S	9 W.A.S
Amaranth	88.98 <sup>a</sup> $\pm$ 1.98	86.60 <sup>b</sup> $\pm$ 1.60	86.90 <sup>a</sup> $\pm$ 1.90
Celosia	90.66 <sup>a</sup> $\pm$ 1.66	92.00 <sup>a</sup> $\pm$ 1.00	81.75 <sup>b</sup> $\pm$ 1.75

**SD= Standard Deviation**

**Means with the same superscript are not significantly different**

**Table 12: Proximate composition (%) of the samples at harvest age of 5,7 and 9 was(weeks after sowing). Mean value  $\pm$  SD of triplicate result**

Sample Age	Protein	Fat	C fibre	Ash	Moisture	CHO
Amaranth 5WAS	24.46 <sup>e</sup> $\pm$ 1.00	0.54 <sup>c</sup> $\pm$ 0.01	3.50 <sup>a</sup> $\pm$ 1.00	1.15 <sup>a</sup> $\pm$ 1.00	9.83 <sup>d</sup> $\pm$ 1.00	60.52 <sup>c</sup> $\pm$ 1.00
Amaranth 7WAS	26.32 <sup>d</sup> $\pm$ 1.00	0.81 <sup>ab</sup> $\pm$ 0.01	2.77 <sup>a</sup> $\pm$ 1.00	1.71 <sup>a</sup> $\pm$ 1.00	11.67 <sup>bcd</sup> $\pm$ 1.00	46.73 <sup>e</sup> $\pm$ 1.00
Amaranth 9WAS	23.10 <sup>ef</sup> $\pm$ 1.00	0.51 <sup>c</sup> $\pm$ 0.01	2.50 <sup>a</sup> $\pm$ 1.00	1.09 <sup>a</sup> $\pm$ 1.00	12.00 <sup>bc</sup> $\pm$ 1.00	60.80 <sup>c</sup> $\pm$ 1.00
Celosia 5WAS	24.09 <sup>ef</sup> $\pm$ 1.00	0.63 <sup>bc</sup> $\pm$ 0.01	3.00 <sup>a</sup> $\pm$ 1.00	1.34 <sup>a</sup> $\pm$ 1.00	11.33 <sup>bcd</sup> $\pm$ 1.00	55.23 <sup>d</sup> $\pm$ 1.00
Celosia 7WAS	38.24 <sup>a</sup> $\pm$ 1.00	0.85 <sup>a</sup> $\pm$ 0.01	2.70 <sup>a</sup> $\pm$ 1.00	1.80 <sup>a</sup> $\pm$ 1.00	13.00 <sup>ab</sup> $\pm$ 1.00	43.41 <sup>ef</sup> $\pm$ 1.00
Celosia 9WAS	24.09 <sup>ef</sup> $\pm$ 1.00	0.54 <sup>c</sup> $\pm$ 0.01	2.07 <sup>a</sup> $\pm$ 1.00	1.13 <sup>a</sup> $\pm$ 1.00	12.30 <sup>bc</sup> $\pm$ 1.00	59.67 <sup>c</sup> $\pm$ 1.00

SD= Standard Deviation

Means with the same superscript are not significantly different

**Table 13: Mineral concentrations of the edible portions at harvest age of 5,7 and 9 was(weeks after sowing) in mg/L. Mean value  $\pm$  SD of triplicate result**

Sample Age	K	Na	Fe	Mg	Ca
Amaranth 5WAS	300.51 <sup>a</sup> $\pm$ 1.00	35.14 <sup>a</sup> $\pm$ 1.00	13.05 <sup>b</sup> $\pm$ 1.00	65.93 <sup>d</sup> $\pm$ 1.00	26.37 <sup>de</sup> $\pm$ 1.00
Amaranth 7WAS	261.55 <sup>c</sup> $\pm$ 1.00	33.06 <sup>b</sup> $\pm$ 1.00	14.73 <sup>a</sup> $\pm$ 1.00	95.37 <sup>a</sup> $\pm$ 1.00	38.15 <sup>a</sup> $\pm$ 1.00
Amaranth 9WAS	241.07 <sup>d</sup> $\pm$ 1.00	18.08 <sup>a</sup> $\pm$ 1.00	6.00 <sup>cd</sup> $\pm$ 1.00	65.74 <sup>e</sup> $\pm$ 1.00	26.30 <sup>de</sup> $\pm$ 1.00
Celosia 5WAS	290.06 <sup>b</sup> $\pm$ 1.06	33.05 <sup>b</sup> $\pm$ 1.05	11.43 <sup>c</sup> $\pm$ 1.00	62.41 <sup>f</sup> $\pm$ 1.41	24.96 <sup>ef</sup> $\pm$ 1.06
Celosia 7WAS	267.23 <sup>c</sup> $\pm$ 1.23	34.21 <sup>b</sup> $\pm$ 1.21	9.87 <sup>c</sup> $\pm$ 1.00	58.89 <sup>c</sup> $\pm$ 1.80	23.56 <sup>cd</sup> $\pm$ 1.56

Celosia 9WAS	238.15 <sup>a</sup> ±1.15	34.23 <sup>b</sup> ±1.23	9.87 <sup>e</sup> ±1.00	69.44 <sup>g</sup> ±1.44	27.78 <sup>h</sup> ±1.08
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SD= Standard Deviation

Means with the same superscript are not significantly different

**Table 14: Antioxidant composition measurements at different ages of harvest; 5, 7 and 9 was (weeks after sowing) in mg/g. Mean value ± SD of triplicate result**

Sample Age	Total phenolic	Flavanoid	VitaminE	Vitamin A	Vitamin B <sub>2</sub>
Amaranth 5WAS	0.17 <sup>b</sup> ±0.01	0.25 <sup>b</sup> ±0.01	0.07 <sup>a</sup> ±0.00	0.76 <sup>b</sup> ±0.01	0.07 <sup>a</sup> ±0.00
Amaranth 7WAS	0.25 <sup>b</sup> ±0.01	0.28 <sup>b</sup> ±0.01	0.07 <sup>a</sup> ±0.00	0.72 <sup>b</sup> ±0.01	0.07 <sup>a</sup> ±0.00
Amaranth 9WAS	0.26 <sup>b</sup> ±0.01	0.17 <sup>b</sup> ±0.01	0.07 <sup>a</sup> ±0.00	1.23 <sup>b</sup> ±1.00	0.07 <sup>a</sup> ±0.00
Celosia 5WAS	0.78 <sup>b</sup> ±0.01	0.41 <sup>b</sup> ±0.01	0.07 <sup>a</sup> ±0.00	0.83 <sup>b</sup> ±0.01	0.08 <sup>a</sup> ±0.00
Celosia 7WAS	0.45 <sup>b</sup> ±0.01	0.77 <sup>b</sup> ±0.01	0.11 <sup>a</sup> ±0.01	0.86 <sup>b</sup> ±0.01	0.10 <sup>a</sup> ±0.01
Celosia 9WAS	0.55 <sup>b</sup> ±0.01	0.96 <sup>b</sup> ±0.01	0.10 <sup>a</sup> ±0.01	1.46 <sup>b</sup> ±1.00	0.12 <sup>a</sup> ±0.01

SD= Standard Deviation

Means with the same superscript are not significantly different

**Table 15: Antinutrient concentrations of the leaves (mg/g) of dry matter. Mean value ± SD of triplicate result**

Sample Age	Saponin	Tannin	Oxalate	Phytate
Amaranth 5WAS	0.34 <sup>bc</sup> ±0.01	0.08 <sup>b</sup> ±0.00	0.16 <sup>a</sup> ±0.01	1.22 <sup>de</sup> ±1.00
Amaranth 7WAS	0.54 <sup>a</sup> ±0.01	0.14 <sup>b</sup> ±0.01	0.15 <sup>a</sup> ±0.01	2.07 <sup>cd</sup> ±1.00
Amaranth 9WAS	0.37 <sup>abc</sup> ±0.01	0.09 <sup>b</sup> ±0.00	0.13 <sup>a</sup> ±0.01	1.34 <sup>cde</sup> ±1.00
Celosia 5WAS	0.12 <sup>d</sup> ±0.01	0.32 <sup>b</sup> ±0.01	0.14 <sup>a</sup> ±0.01	0.72 <sup>de</sup> ±0.01

Celosia 7WAS	0.40 <sup>abc</sup> ±0.01	0.40 <sup>b</sup> ±0.01	0.17 <sup>a</sup> ±0.01	0.19 <sup>c</sup> ±0.01
Celosia 9WAS	0.54 <sup>a</sup> ±0.01	0.64 <sup>b</sup> ±0.01	0.15 <sup>a</sup> ±0.01	0.34 <sup>c</sup> ±0.01

**SD= Standard Deviation**

**Means with the same superscript are not significantly different**

## Discussion

### Moisture content

The mean moisture content represented for fresh leaves samples (table11) showed a range of 88.98-86.60% for Amaranth and 92.00-81.75% for celosia. The mean moisture content increased from age 5 WAS to 7 WAS for celosia (90.66 – 92.00%) decreased in 9 WAS (81.75%) and firstly decreased for Amaranth ( 88.98 -86.60 %) 5-7 WAS and increased slightly from 86.60 % -86.90 % ( 7 WAS – 9 WAS).

### Proximate

The dry leaves moisture content (Table12 ) shows that the level of moisture in the dry matter of both amaranth and celosia increased but only celosia decreased at the 9WAS with the highest value obtained at 9WAS ( 12.00mg/L) for Amaranth and 13.00mg/L for celosia at 7WAS.

Plant age at harvest has a greater impact on the protein contents of leafy vegetables (Table 12). The mean protein contents of Amaranth increased till the age of 7 WAS (24.46mg/L - 36.32mg/L) and decreased marginally again until the 9<sup>th</sup> WAS (i.e 36.32mg/L -23.10mg/L). The same trend was observed for Celosia plant with highest level of protein obtained at 5 WAS followed by 5WAS and 9WAS (i.e 38.24mg/L and 24.09mg/L respectively). This is an agreement with the work of Kadoshnikov *et al.* (2005) that amaranthus are excellent sources of protein (17.2 – 32.6mg/L from dry weight of various samples).

Leafy vegetables are deficient in fats and this makes them good for health. Age at harvest has little influence on the crude fat contents of leafy samples (0.54 - 0.85mg/L). However, there was no regular relationship between age at harvest and crude fat contents.

Vegetables are good source of fiber which lowers the body cholesterol level consequently decreases the risk of cardiovascular diseases. The mean fiber content decreased progressively from 5 WAS to 9 WAS for Amaranth (3.5 - 2.5 mg/L). Consequently, the value slightly decreased as the plant age increased for Celosia (3.00mg/L- 2.07mg/L) and also decrease throughout the harvest ages (3.00, 2.70 and 2.07) at 5,7 and 9 WAS respectively. These results did not conform with the one reported by Oyeyemi *et al.* (2007) (i.e 16.08mg/g) for amaranth but agreed with that of 1.8mg/g ) for Celosia ( Islam ,2012).

The plant maturity and age did not significantly affect the ash content of these samples (Table

12). However, the highest level of ash was obtained at 7WAS for amaranth (1.71mg/L) and celosia (1.80mg/L). Conformity was observed when these results were compared to 1.35mg/L and 1.15mg/L for Amaranth and Celosia respectively (Adeniyi *et al.* (2018). Ash is the inorganic residue remaining after water and organic matter have been removed by heating and provides a measure of the total amount of minerals within a food ( Md Clement, 2003).

The carbohydrate content of these leafy vegetables was clearly affected by the influence of plant age at harvest (Table 13). The mean value obtained for Amaranth was (60.15, 46.73 and 60.80mg/L) with age 7 WAS showing the lowest mean value. This deviated from the response of Amaranth leaves where age 7WAS shown the latest value. The value obtained for celosia were 55.23mg/L, 43.41mg/L and 59.67mg/L with 9WAS showing the highest. As a matter of fact, these values were in line with the opinion of that carbohydrate may form 50 -80mg/g of the dry matter in the form of non starch polysaccharides.

### Minerals

The sodium contents of Amaranth decreased significantly with plant age at harvest (Table 13). Small increment was observed between harvest samples of age 5 and 7 WAS but a great clear differences was observed between harvest samples of age 7 WAS and 9 WAS were compared. The mean value of CHO obtained for *celosia* was 55.23mg/L(5 WAS), 43.41mg/L(7 WAS)and 59.67mg/L(9WAS). However, sodium concentration was maximized at age 5 WAS for Amaranth (35.14mg/l) and at age 5 WAS for Jute plant leaves ( 27.97mg/L) of dry weight. The amount of potassium (K) obtained at 5 week after sowing (WAS) was higher than that of both 7 WAS and 9 WAS. This means that the potassium concentration of amaranth decreases with increase in plant age. This follows the trend that, the K content of *celosia* decreases as plant age progresses. This was in agreement with the fact that K content was the highest at the 6th WAS and deviated from the one reported by that K content was highest at the 9th WAS. This could be seen in Table 13. This variation observed indicates that plant maturity contributes to potassium absorption and deterioration in leafy vegetables.

The content value of Iron (Fe) obtained for amaranth were very close to each other at age 5 WAS and 7 WAS (Table 13) and the value obtained at age 9 WAS was the least value (6.00mg/L). The mean value of Iron (Fe) obtained for *celosia* at age 5 WAS and 7 WAS were very close to each other (Table 13) and the value obtained at 7 and 9 WAS respectively.

The Ca content for amaranth was highest at the 7th week after sowing (38.15mg/l). This value was more than that of 5th and 9th WAS. That of *celosia* was highest at 9th WAS. This is in agreement with the report that Ca content for *celosia* was highest at 9th WAS. However, it is likely that older leaves may contain anti –nutrients (e.g oxalate and phylate) that decrease minerals bio-availability to humans.

Magnesium content (Mean value) of Amaranth increased then decreased; with harvest age of 7 WAS having the highest value (95.37mg/L). The magnesium content increased as the plant

age increased. (37.33mg/L at 9th WAS). However age at harvest had a very significant impact on the Mg contents of both *celosia* and okra. it decreased then increased for *celosia* and increased then decreased for okra leaves. The result obtained for Mg in this study did not conform with the report that age at harvest did not contribute significantly to the variation in magnesium content of leaves.

### **Antioxidants**

The concentration of vitamin E (tocopherol) was generally low. Table 14 shows that the vitamin E values had the range of 0.07 - 0.11mg/100g for both Amaranth and Celosia. The highest value obtained for Amaranth was at the 5 WAS (0.07mg/100g) and that for Celosia was at the 5th WAS (0.11mg/100g). There was no significant difference in these values at different ages of harvest.

The vitamin A (retinol) contents of both Amaranth and Celosia was highest at the 9th WAS, 1.23mg/100g Amaranth and 1.46mg/100g celosia. This result suggests that more retinol would be found in the leaves of older Amaranth plants and Celosia plants. However, from the perspective of human and animal nutrition, the low palatability and digestibility of older leaves may not favour large amounts of Amaranthus leaf intake but favours Celosia.

Vitamin B2 (riboflavin) also present in Amaranth and Celosia plants (Table 14) but its concentrations were generally low at every harvest maturity stage. No significant difference was observed in the result but still the highest value obtained for Amaranth was at the 7th WAS (0.07mg/100g while that of Celosia was at 9th WAS (0.12mg/100g).

Flavonoid acts as defense and signaling compounds in reproduction, pathogenesis and symbiosis. The result presented in table 14 depicts that to every 100g of dry weight equivalent of the leafy vegetables (*celosia* and Amranth) consumed less than 1 mg is supplied to the body. The maximum value of flavonoid obtained for *celosia* (0.96mg/100g) was at the 9th WAS for *celosia* and that for Amaranths (0.28mg/100g) was at the 7th WAS. With these values, plant maturity had negligible impact on the flavonoid contents of both *celosia* and amaranths leaves. The result was in contrast to that of this study as he detected high level of flavonoid ( 58.33-69.80mg/100g) in water leaf.

The total phenolic contents of *celosia* and okra leaves (dry matter) were very low (Table 14) with the highest concentration at the 5th WAS ( 0.78mg/100g) for *celosia* and 0.78mg/100g for amaranths at the 7th WAS.

### **Anti nutrient**

Table 15 shows the result for anti-nutritional components of Amaranth and jute in mg/g of mean value. The result shows that the plants contain low level of anti-nutritional factors  $\leq 5.25$  mg/g. The saponin contents of Amaranth reached the highest level at the age of 7WAS (0.537 mg/g) and that of celosia was highest at 9WAS also (0.54 mg/g).

The result for tannins shows that the concentration of tannin in Amaranth was maximized at the 7WAS and the content of tannin in Celosia is high in 9WAS (0.64mg/g). However, tannin in these plants will be lethal if it is  $\geq 5\%$ . This value is the agreed value that can complex with other nutrients.

The phytate contents of both plants ranged from 0.19mg/g – 2.07mg/g. This range is higher than that of other antinutrients. However, the effect of age at harvest was a bit significant.

For oxalate contents, the levels are generally less than 1.0mg/g. The influence of age at harvest was not clearly seen. However, the maximum value was recorded for both Amaranth and celosia at the 5WAS showing that increase in age at harvest decreases the concentration of oxalate and older leaves are safe to eat.

## CONCLUSION AND RECOMMENDATION

### Conclusion

In establishing the optimum time for harvesting of celosia, consideration has to be given to optimum eating quality based on appearance, and biochemical changes of leaves. The result of this study revealed that the proximate compositions of *amaranthus cruentus* and *celosia argenta* were affected by plant age at harvest. The value of protein, crude fat, crude fibre and ash were optimized at the 7Weeks after sowing (WAS) of Amaranth. The moisture content trend was not regular due to erratic rainfall for both fresh and dry sample. The value of protein, crude fat, crude fibre moisture and ash were optimized at the early stage of development of celosia development. The mineral elements K, Na and Fe of both amaranth and celosia decreases as the plant age increases with the exception of Mg and Ca which are highly optimized at the middle harvest time (7WAS) of Amaranth and celosia. The effect of age at harvest on the anti-nutrient contents is less significant and their concentrations were generally low (<2.1mg/g for Amaranth and < 1.0mg/g for *celosia*). The antioxidant composition measurements of both Amaranth and jute indicate that the flavonoid and total phenolic were optimized at the 7WAS while Vitamin A, E and B<sub>2</sub> of both vegetables increases as the plant age progressed. Therefore, the optimum time of harvesting Amaranth is between 6 to 8 weeks after sowing, while that of celosia is anytime from the 7<sup>th</sup> WAS.

### Recommendation

This research recommends that individuals should try the best they can to engage in self vegetable cultivation so as to optimize and target the best nutritious value of intended vegetables.

However, government and non-governmental organization that are working in human nutrition should continue to organize seminars so as to educate people on the effects of age at harvest on the nutritional compositions of leafy vegetables.



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## UNDERSTANDING NIGERIA AS A CIRCULAR NATION IN THE 21<sup>ST</sup> CENTURY AND ITS IMPLICATION FOR UNITY

**Ven Egesi Jonathan .C**

Imo State Polytechnic Omuma-Oru East,  
Imo State, Nigeria.

**Ven Duruji Simeon Ugochukwu. (PhD)**

Department of Religion and Cultural Studies,  
(A.I.F.C.E) Owerri-Nigeria

**Mrs Ijeoma Eze-Chukwunyere Nwebo (PhD)**

(A.I.F.C.E) Owerri-Nigeria.

### **Abstract**

Nigeria as a country being circular in its nature implies a situation where people from other religions and ethnic nationalities and backgrounds are considered duly and considered to be accorded the necessary privileges both in the scheme of things and other wise. Let the above be as it may. Since the amalgamation of the various parts of the country in the year 1914, the journey to the actualization of great things has seemed an arduous task as the amalgamated protectorates have found it sacrilegious to co-habit with each other making the various parts of the country look tensioned and delicate if not fragile. The question every right thinking Nigerian should ask him/herself and answer is this. How did we arrive at where we are today? Is it by intention or omission? How well can we tolerate ourselves and live together? If impossible, how then can we all actualize self determination other than breed bitterness and bigotry. The above statement form the gamut of this study. A handful of data collection techniques were used in this study as interviews, periodicals, journal and the internet. The functionalist theory was adopted for this study thereafter, the conclusion was drawn.

**Keywords:** Understanding, Nigeria, Circular Nation, Century and Implication

### **DEFINITION OF CONCEPTS.**

There is the persuasion here to briefly define certain concepts making up the question before delving into the analysis proper. Such terms include the following:

**UNDERSTANDING:** According to oxford languages online dictionary 2022, understanding is the ability to understand something ,in fact comprehension. It can also imply sympathetic awareness or tolerance.

**NIGERIA**

Nigeria is defined as an African country on the Gulf of Guinea, has many or rich natural landmarks and wildlife reserves protected areas such as cross River National park and Yankari National park, have waterfalls dense forest, Savanna and rare climate habitats .One of the most recognizable sites is Zuma rock, a 725m tall monolith outside the capital of Abuja that is pictured on the national currency.

**CIRCULAR NATION**

A circular nation or state is an idea pertaining to secularity ,whereby a state is or purports to be officially neutral in matters of religion , supporting no religion or irreligion. A secular state claims to treat all its citizens equally regardless of religion and claims to avoid preferential treatment for a citizen based on their religious beliefs, affiliation etc.

**CENTURY**

A period of one hundred years. It is considered a score in a sporting event , especially a batsman's score of a hundred runs in cricket.

**IMPLICATION**

This simply mean the conclusion tghat can be drawn from something although it is not explicitly stated. It also mean tghe action or state of being involved in something.

**INTRODUCTION**

By implication,Nigeria is a country with close 200 million population. While it boast of the major ethnic grouping, it has also hundreds of minor ethnic groups.It is on record too to mention that the country does not have one legalized or recognized ethnic group meaning that citizens are free to practice religions of their choice without harassment, assault or obligation. Be the above as it may, some people from other originalities have in recent times felt hell bent to coarce people who are not of the same faith with them to cease to exist. One thing that need to be said is the fact that no one individual, can occupy the whole country all alone. Can even one person live in isolation of others. Who doesn't need others in this wide whole country. It is disheartening that over and over again we hear certain set of people brag ownership right over the whole parts of thye country not putting into consideration the fact that the nation is too large for one person to singly occupy. If actually people bear that in mind, why do we kill ourselves in the name of religion. Human life cycle is too short. We really are on transit and after life, the society continues to be. In the present 21<sup>st</sup> century Nigeria is one characterized of too much killings, and the worst of it all is that despites peas from different quarters for killers to stop the killings nothing seem to be achieved. Such pleas seem to have been falling on deaf ears leaving much to be desired. One thing has been a plain truth,the killings in Nigeria

are sponsored by disgruntled elements and people who feel dissatisfied with the way positions and things are being shared in the country. This in real fact leaves much to be desired and also leaves a sore taste on the mouth.

### **UNDERSTANDING NIGERIA AS A CIRCULAR NATION**

Nigeria as we know is the most populous African country with a population of over 218 million in the year 2022. The country is home to the world's largest Muslim and Christian populations, simultaneously, Nigeria is divided in half between Muslims who live mostly in the north and Christians who live mostly in the south: indigenous religions, such as those native to the Igbo and Yoruba ethnicities, are in the minority. The Christians share of the Nigeria's population is on decline due to lower fertility rate compared to Muslims in the North. Most Nigerian Christians are Protestants (broadly defined), though about a quarter are Catholic. The majority of Nigerian Muslims are either Sunni or non-denominational Muslims. Many Sunni Muslims are members of Sufi brotherhoods or Tariqa. Most Sufis follow the Qadiriyya, Tijaniyyah or Mouride movement. A significant Shia minority also exists. There are also Ahmadiyya and Mahdiyya minorities. In terms of Nigeria's major ethnic groups' religious affiliations the Hausa ethnic group in the north is mostly Muslim, the Yoruba tribe in the west is divided among mainly Muslim and Christians with many followers of traditional religions, while the Igbo of the east and the Ijaw in the south are predominantly Christians with some practitioners of traditional religions. The middle belt of Nigeria contains the most of the majority ethnic groups in Nigeria and they are mostly Christian converts as well as members of traditional religions with few Muslim converts.

Twelve Muslim-majority northern states have incorporated sharia courts into their legal systems with the power and jurisdiction of these courts waxing and waning over the past two decades. In some of these states, sharia courts are optional arbitration courts for personal status issues whereas in others, sharia has effectively replaced the formerly secular state level legal system in both civil and criminal contexts. This has brought controversy due to its discriminatory practices towards religious and sexual minorities. Northern Nigeria has also been the site of ongoing Islamist insurgency which has led to the death and displacement of tens of thousands of people. Nigeria has one of the largest Muslim populations in West Africa. In Nigeria, about 52 percent of the population is Muslim. Most of Nigeria's Muslim population live in the Northern and central states. Islam was introduced to northern and central Nigeria in the middle Age as early as the 11<sup>th</sup> century and was well established in the major capitals of the region by the 16<sup>th</sup> century, spreading into the country side and toward the Middle Belt uplands. Shehu Usman Dan Fodio established a government in Nigeria.

### **THEORETICAL FRAMEWORK.**

Functionalism has been considered one of the main stream theories of sociology. Infact, it is considered the most outstanding or dominant theory in sociology because it discusses how important various components of the society could be to each other. William James is credited

to the founding of Functionalism though certain others became part of the school of thought. He (James ) founded it in the 19<sup>th</sup> century. The paradigm of this school of thought is that the society can be likened to a human organism having various parts. In essence what it means is that the various parts are coordinated into a whole. When there is any anomaly in one part of the society it will result in anomaly in all the parts. And the society can have tranquillity when there is no recorded chaos, perse.

Religion has been considered as an integral part of the society, infact, it is part of the sub – structure. Here we are using the language circular meaning multiple religion.

It is in this regard believed that any abnormality in religion as an integral part of the Nigerian society will definitely give birth to crisis no matter how. That makes our religion very important and delicate.

### **POSSIBLE WAYS OF IMPROVING GOOD/ CORDIAL RELATIONSHIPS IN NIGERIA.**

**Here are possible ways to improve relationships among Nigerians**

- 1) The study of peace education should be intensified in our high institutions.
- 2) Religious institutions should brace up to the challenge of canvassing for lasting peace in the country
- 3) 3) Individuals should realize that absence of peace which is chaos pays no one neither does it do anyone any good.
- 4) 4) There won't be any possibility of progress without peace and tranquillity that makes peace even most important.

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## IMPACT OF GLOBALIZATION, ECONOMIC GROWTH AND LABOUR PARTICIPATION ON NET MIGRATION IN NIGERIA

**Isere, Victoria Oshuare Merab**

Department of Humanities and Social Sciences  
School of General Studies  
Auchi Polytechnic, Auchi

**Bawa Hassan**

Department of Humanities and Social Sciences  
School of General Studies  
Auchi Polytechnic, Auchi

### **Abstract**

Migration is fuelled by a number of factors which include economic, educational, marital and work-related factors. It is also fuelled by global integration of world States. Globalization brings about economic, social as well as cultural interconnectedness and this greases the wheels of international migration. Globalization is a multi-dimensional process of unprecedented rapid and revolutionary growth in the extensiveness and intensity of interconnectedness on a global scale. This work portrays the contributions of economic growth, globalization, unemployment and labour participation to migration in Nigeria using Ordinary Least square. The findings reveal that there exists a negative significant relationship between net migration on one hand and foreign direct investment, economic growth and labour force participation on the other hand. Unemployment had a positive and significant relationship with net migration too. All these are true in the long run analysis. In the short run, FDI, LFP and one period lag of UNE were negative and statistically significant while current period UNE was positive and statistically significant. Only FDI and net migration had a significant unidirectional causality from net migration to FDI. The paper recommends that Government should help improve labour participation by fighting unemployment through better business environments that will ensure that remittances have a good place for investment in Nigeria amongst others.

Keywords: net migration, globalization FDI, Unemployment, labour participation

### **Introduction**

As observed by Dokos (2017), migration is as old as man but with globalization the movements have tremendously increased and even spiraling out of control. It is fuelled by a number of factors which include economic, educational, marital and work-related issues. It is

also fuelled by global integration of World States. As nationals migrate, the labour supply of both their origin and destination is affected. Labour would always move to find the highest price *ceteris paribus*. In developing countries, the need for improved supply of quality labour cannot be overemphasized. However due to the big variation in payment for labour, the migrants take the plunge; moving into developed countries. Economically, there may be some benefits for the country of origin if the funds of the migrant are repatriated back home. Such can form capital for business start ups leading to economic growth in the long run through employment generation besides other benefits. Migration is good. Since the 18<sup>th</sup> Century, globalization has increased following advancement in communication, business and transportation; leading to high growth of cross-border trade and all sorts of exchange (Onoja, 2020). Hence the popular phrase, the world is a global village.

Globalization is a process that involves interaction and integration among people countries and governments world-wide. (Wikipedia.org 2022). According to Utuk (2015), globalization is a multi-dimensional process of unprecedented rapid and revolutionary growth in the extensiveness and intensity of interconnectedness on a global scale. Its manifests in various forms like democracy, ideology, technology as well as information technology and communication (ICT). Globalization has many benefits for development but not without the other side of the coin – the disadvantages as relates to many aspects of national lives such as money laundering and other international financial crimes. Globalization is known to have the advantage of allowing better trade between nations (Odiai & Okweshime, 2008). Trade between nations is facilitated by movement of people as well as goods across international borders. So trade breeds migration; movement of people. As trade improves, people move, some permanently and many temporarily. As noted by Adesina (2019), migration is an important manifestation of globalization. Any careful study of trade figures between countries will likely reveal that as trade improved between countries, the people of both countries go across the borders of each other (Odiai & Okweshime, 2008) to both live and work. This has its own impact on labour availability at both ends of the migration spectrum.

Globalization brings about economic, social as well as cultural interconnectedness and this greases the wheels of international migration (Isere; Akuvuo and Ijeboi, 2010). It has brought motion into population of nations both developed and developing nations alike.

According to Onoja, (2020), globalization has had both negative and positive impacts on the Nigeria economy. Some positive impact of globalization includes increase in foreign investments which help to increase capital and technology that will eventually bring about economic development. This also leads to improved employment. Migrants remit some money back home to set up business and help improve the home economy. Onoja (2020) opined a negative impact of globalization as high level of importation and worsening of the production capacity of the country.

Prior empirical researches have investigated globalization – economic growth link like Idoko and Abu (2020); Osu (2020) and Utuk (2015); the globalization – unemployment link like Onoja (2020); Effiong, Udofia & Okon (2020); Ukpere (2011) and Odeleye (2016). The globalization-labour link (like Aremo & Alagbile (2010), Anugwom (2007) but none was found that investigated the migration-globalization-labour-economic growth link. It is against this background that this study examines empirically the impact globalization, economic growth and labour participation has had on net migration in Nigeria. This work portrays the contributory impact of economic growth, foreign direct investment (FDI), globalization, unemployment and labour participation to migration in Nigeria. The remaining part of this paper is organized into statement of problem, objectives, literature review, methodology, analysis and presentation of result and concludes with some recommendations.

### **Statement of the problem**

‘Going abroad’ is a popular slogan in Nigeria. The most common reason for going abroad in Nigeria is for economic reasons, followed by educational pursuit which eventually leads to the first reason anyhow. The government and people expect that migration would bring a lot of positive impact on Nigeria and Nigerians. With the level of emigration, it is expected that foreign direct inflows will be high and the impact positive. Has this been so? How has globalization helped migration in Nigeria? What about the level of unemployment? If globalization and economic growth has improved significantly viewing from the lens of net migration what have we learned as a country? Can the gains be harnessed to improve employment and efficiency of labour in Nigeria? Increased migration is the most visible aspect of globalization and its gains must be harnessed for the good of our motherland.

### **Research questions**

- a. Has net migration improved globalization?
- b. How has economic growth fared with regards to net migration?
- c. Has net migration positively improved foreign Direct Investment (FDI) inflow to Nigeria?

### **Objectives of the study**

This research is specifically set with the objectives of:

- a. Assessing the impact of economic growth on net migration;
- b. Investigate the impact of FDI inflows and labour on net migration; and
- c. Examine how globalization has impacted net migration in Nigeria.

### **Literature Review**

#### **Conceptual/theoretical framework**

This research is hinged on the Neoclassical theory of labour migration and the new economics of migration theory. The Neoclassical theory of labour migration views migration as a result



of differences between labour supply and demand being internationalized by differences in wage levels between countries and labour markets (Futurelearn.com, 2022). Migration is caused by differences in pay and access to jobs.

The new economic theory of migration is a critique of the Neoclassical and they argue that households send workers abroad to increase income relative to other households and reduce deprivation when compared with a reference group. This is typically the Nigerian situation as the migration decision are usually made typically by households or families collectively. Households see migration as a means to diversify risks (Stark & Bloom, 1985).

Influx of migrants create surplus labour supply which boosts output and further increases economic growth of migrants destinations. The same procedure somehow reduce unemployment in labour abundant nations while the inflow of foreign exchange helps to improve welfare in the migrant home country *ceteris paribus*.

Economic globalization intensifies migration and the population movements are huge and contain lots of information which helps to promote trade and more labour migration. The Boundless blog (2017) opined that globalization without migration is not possible as the latter is the movement of people and goods across borders more easily. People migrate to offer labour services and ideas in markets that have opportunities that are either totally absent or very scarce in their home countries. This is usually the cause of concern for destination countries as the fears that sudden surge in population may strain their countries resources are present.

Migration can also contribute decisively to Gross Domestic Product (GDP) as well as number of employed workers. Productivity is fundamental to long-term growth in GDP and welfare of nations (Mihi-Ramirez, Ojeda-Gonzalez, Miranda-Martel & Agoh, 2018). According to Tacoli & Okali (2001), migration has three important aspects viz factors that are related to global changes in production and trade which influence migration; constraints and opportunities specific to different groups (like omen and youths) and lastly, the contribution of migrants to their home and host countries.

### **Empirical reviews**

Researches dealing directly with migration and globalization, unemployment, economic growth and FDI were very scanty however Adeseye (2021) in an empirical study on the effects of migrants remittance on economic growth in Nigeria using SPSS, found a significant relationship between remittances and GDP while inflation had no significant relationship with remittances. The paper recommended increased influx of remittances for the economic growth of Nigeria. Osu (2020) did a study on globalization and economic growth in Nigeria over the period 1980 to 2018 using FDI portfolio, official development assistance (ODA) and trade openness as dependent variables in an Error Correction Model (ECM). The study obtained a

structurally stable model from which the ODA was emphasized. FDI had a negative impact on economic growth.

Bashir & Abubakar (2022) in their study covering the period 1970 and 2017 on net migration and economic growth using a AutoRegressive Distributed Lag (ARDL) bounds test revealed that there is a long term co-integrating relationship between net migration and economic growth. Their study found a negative significant relationship between net migration and economic growth and therefore recommended that the push factors such as poor wage in Nigeria be addressed. Idoko & Abu (2020) studied globalization and economic growth in Nigeria. They showed FDI to be an important component of globalization. Their study revealed an inverse relationship between trade and financial openness and economic growth. They pined that Nigeria was yet to benefit from globalization even though a long run relationship was found between globalization and economic development. They suggest diversification of Nigeria export base and provision of conducive business environment. Olarinde (n.d) also reported a positive relationship between migration and economic growth in her work on migration, human capital formation and economic growth in Nigeria.

### Methodology

This study uses annual time series data spanning 1990 to 2020 obtain from the Statistical bulletin of the Central Bank of Nigeria as well as the World bank indicators. GDP is used as a proxy for economic growth. Net migration is the difference in rate of emigration (leaving the country) and immigration (coming into the country) in Nigeria in a year. A positive net migration means that more people are entering Nigeria rhan those leaving. It is important to reveal that for the period under review, net migration was negative. This means that those leaving Nigeria out-number those coming in. this information is presented as appendix A. Labour participation rate is used as a proxy for labour market in Nigeria. labour participation rate is the proportion of the population aged between 15 and 64 that are economically active; while FDI is used as a proxy for remittances. The analysis is done using Johansen cointegration test to check for long run existence; unit roots test to check stationarity; Ordinary Least Squares (OLS) for coefficients of the various variables in the model. The results presented are summarized.

### Presentation and interpretation of results

The model for this study is given as

$$NMG = f(FDI, GDP, LFP, POP, UNE, GLB) \quad \dots 1.1$$

Which is linearly expressed as

$$NMG = \beta_0 + \beta_1 \ln FDI + \beta_2 \ln GDP + \beta_3 LFP + \beta_4 POP + \beta_5 UNE + \beta_6 GLB + \varepsilon \quad \dots 1.2$$

Where

NMG = Net migration

FDI = Foreign Direct Investment (proxy for remittances)  
 GDP = Gross Domestic Product (proxy for economic growth)  
 LFP = labour force participation (proxy for labour market)  
 POP = Population  
 UNE = Unemployment  
 GLB = Globalization

$\beta_1$  to  $\beta_6$  are coefficients to be estimated.

Apriorily it is expected that  $\beta_1$  and  $\beta_6 > 0$  and  $\beta_2, \beta_3, \beta_4,$  and  $\beta_5 < 0$

The error correction model (ECM) is specified as

$$\Delta NMG_t = \beta_0 + \sum_{i=1}^p \beta_{1i} \Delta \ln FDI_{t-1} + \sum_{i=1}^p \beta_{2i} \Delta \ln GDP_{t-1} + \sum_{i=1}^p \beta_{3i} \Delta LFP_{t-1} + \sum_{i=1}^p \beta_4 \Delta POP_{t-1} + \sum_{i=1}^p \beta_4 \Delta UNE_{t-1} + \sum_{i=1}^p \beta_4 \Delta GLB_{t-1} + \varepsilon_{t-1} \dots 1.3$$

Where p is the optimal lag length determined by Akaike Information Criteria (AIC).  $\Delta$  is the difference operator.

Augumented Dicky-Fuller unit roots tests revealed that all the variables except POP were stationary after first difference. POP was stationary at levels. Stationarity implies that the statistical properties of a process generating the time series does not change over time. The appropriate lag length was determined to be 2 as presented in the table below.

**Table 1 VAR Lag Order Selection Criteria**

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-425.4243	NA	21108.20	29.82236	30.15240	29.92573
1	-268.8115	226.8185	13.99019	22.40080	25.04109*	23.22770
2	-192.1488	74.01917*	4.065068*	20.49302*	25.44358	22.04347*

\* indicates lag order selected by the criterion

Source: Authors computation on Eviews

A test for the existence of long run done via Johansen co-integration technique was positive and revealed that existence of long run relationship among variables of the model. The result is summarized in table below.

**Table 2 Johansen Co-integration Result**

Hypothesized no. of CE(s)	Eigen value	Trace statistic	5% Critical value	Prob	Max-Eigen statistics	5% critical value	Prob
None *	0.937080	194.5112	125.6154	0.0000	80.21097	46.23142	0.0000
At most 1 *	0.788570	114.3002	95.75366	0.0015	45.06204	40.07757	0.0127

At most 2	0.599100	69.23814	69.81889	0.0556	26.50728	33.87687	0.2907
At most 3	0.586025	42.73086	47.85613	0.1392	25.57655	27.58434	0.0884
At most 4	0.310331	17.15432	29.79707	0.6286	10.77477	21.13162	0.6698
At most 5	0.162889	6.379543	15.49471	0.8507	5.156158	14.26460	0.7220
At most 6	0.041308	1.223386	3.841466	0.2687	1.223386	3.841466	0.2687

Source: Authors computation on Eviews

Both the Trace and Max-Eigen statistics indicate 2 co-integrating equations. This necessitated the estimation of both the long and short run model of the study. The long run regression result is presented/summarized in the table below.

### Table 3 Long run regression result

Dependent variable is NMG

Method: least squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNFDI	-0.031376	0.005721	-5.484628	0.0000
LNGDP	-0.078795	0.011159	-7.061272	0.0000
LFP	-0.006649	0.002123	-3.132660	0.0045
POP	6.76E-06	1.46E-05	0.462971	0.6476
UNE	0.002620	0.000749	3.495712	0.0019
GLB	4.47E-05	0.000426	0.104788	0.9174
C	0.299936	0.091270	3.286253	0.0031
R-squared	0.958067	Adjusted R-squared		0.947584

Source: Authors computation on Eviews

Table 3 above reveals that four of the independent variables in the model are statistically significant. The null hypothesis of no long-run relationship between NMG and LNFDI, LNGDP, LFP and UNE cannot be accepted following their significant probability value at 5% level of significance. Log of FDI, log of GDP and LFP are all negative and statistically significant while UNE is positive and significant. GLB and POP are positive. The coefficient of FDI, and GLB were expected to be positive but only GLB turned out as expected. For every 1% change in FDI, NMG reduced by 3.1%. This could probably be explaining that as FDI increased, fewer persons emigrated because of the improved GDP position as a 1% change in GDP reduced NMG by 7.9%. Adeseye (2021) also found a significant but positive relationship between migration and economic growth. LFP is quite low, negative and significant. A 1% change in LFP impacted NMG by almost 1%. UNE increased NMG by about 0.3%. GLB also increased NMG but not significantly. On the overall model, the variables were able to explain 95.8% of the causes of variation in net migration in Nigeria.

The short run (parsimonious) ECM of the regression model is presented in the table below.

**Table 4 Short run (ECM) regression result**

Dependent Variable is D(NMG)

Method: Least squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(NMG(-1))	0.579814	0.142946	4.056189	0.0007
D(LNFDI)	-0.009976	0.003681	-2.709722	0.0139
D(LNGDP)	-0.050411	0.024474	-2.059806	0.0534
D(LFP)	-0.005883	0.001990	-2.956826	0.0081
D(POP)	2.44E-05	2.05E-05	1.189284	0.2490
D(UNE)	0.002336	0.000855	2.731995	0.0132
D(UNE(-1))	-0.001746	0.000722	-2.417323	0.0259
D(GLB)	0.000109	0.000267	0.409115	0.6870
C	0.002238	0.003620	0.618295	0.5437
ECM(-1)	-0.714017	0.164386	-4.343541	0.0003
R-squared	0.770172	Adjusted R-squared		0.661307

Source: Authors computation on Eviews

The result in table 4 above expresses the desired requirement that the model converges. The convergence rate is at a speed of 71%. That means its returns to equilibrium state after a disturbance at a speed of 71%. This is also statistically significant at the 5% significance level. A one period lag in NMG has a positive and significant relationship with current NMG. Migrants will keep moving out yearly with each succeeding year greater than the previous year ceteris paribus. LNFDI, LFP, UNE and one year lag of UNE are statistically significant and thus have significant short run impact on NMG.

Following the statistical significance of the relationship between NMG and LFP, FDI, UNE and GDP, the direction of causality was done between NMG and each of the other variables. The result is presented in the table below.

**Table 5: Granger causality test**

Null Hypothesis:	Obs	F-Statistic	Prob.
NMG does not Granger Cause GLB	29	0.82712	0.4494
GLB does not Granger Cause NMG		0.24063	0.7880
NMG does not Granger Cause LFP	29	0.85191	0.4391
LFP does not Granger Cause NMG		0.20717	0.8143

NMG does not Granger Cause LNFDI	29	5.54765	0.0105
LNFDI does not Granger Cause NMG		0.26279	0.7711
NMG does not Granger Cause LNGDP	29	2.09091	0.1455
LNGDP does not Granger Cause NMG		1.05951	0.3623
POP does not Granger Cause NMG	29	0.50699	0.6086
NMG does not Granger Cause POP		0.13427	0.8750
UNE does not Granger Cause NMG	29	0.90809	0.4167
NMG does not Granger Cause UNE		0.55069	0.5837

*Source: Authors computation on Eviews*

The Granger causality result in table 5 above reveal that the only the null hypothesis that NMG does not granger cause LNFDI is rejected at the 5% level of significance. This causality is unidirectional. This means that NMG granger causes FDI without a feedback reaction. All others show no causality.

### **Conclusion and Recommendation**

The study explored the impact globalization, unemployment, foreign direct investment, population, labour market and GDP have on net migration in Nigeria. Our findings revealed that there is no significant relationship between net migration and globalization as well as between net migration and population. However there exists a significant relationship between net migration on one hand and FDI, economic growth, unemployment and labour force participation on the other hand. Of all these, it was revealed that only NMG granger causes LNFDI in a unidirectional manner.

Some conclusions drawn from the study include that economic development of Nigeria affects the rate of migration in Nigeria. It can be said that it is the major factor. None availability of jobs (unemployment) is also a determining factor of migration in Nigeria. Labour force participation and unemployment had opposite effects on NMG as expected and significantly too. Both variables move in opposite direction (See appendix B).

Based on the findings from the analysis of the model, we recommend as follow:

- a. Government should help improve labour participation by fighting unemployment through better business environments that will ensure that remittances have a good place for investment in Nigeria.
- b. The benefits other countries derive from globalization can also come to Nigeria if Nigeria des what other countries are doing – better economic growth rates to attract investors (both foreign and full blooded Nigerians who have great investments abroad). Nigeria can truly gain more from globalization.

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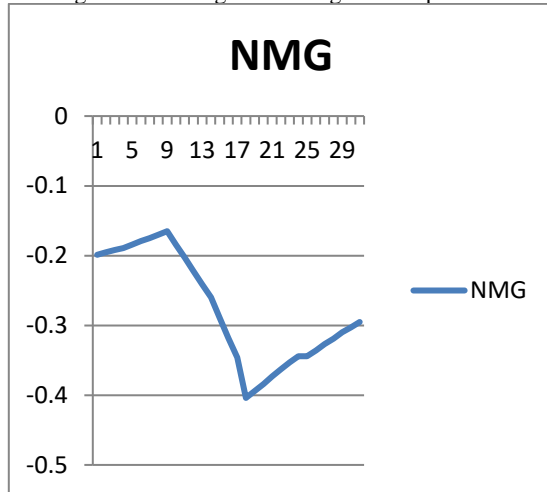
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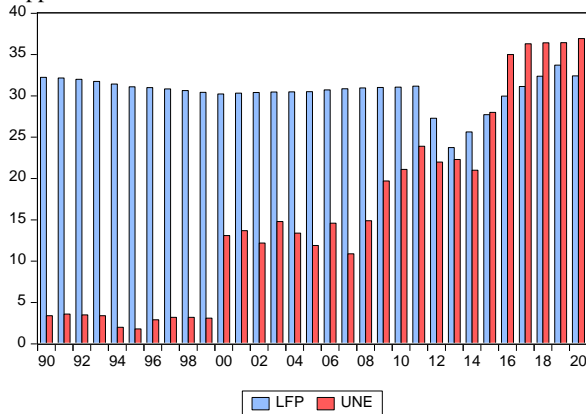
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**Appendix A**

Net migration was negative throughout the period under review



**Appendix B**





## **PLANNING FOR URBAN CEMETRIES IN KADUNA METROPOLIS, KADUNA STATE, NIGERIA.**

**Bako Kozah Kevin,**

Department of Urban and Regional Planning,  
Nuhu Bamalli Polytechnic Zaria,  
Kaduna State, Nigeria.

**Bako Parah Emmanuel,**

Department of Urban and Regional Planning,  
Nuhu Bamalli Polytechnic Zaria,  
Kaduna State, Nigeria.

**Bulus Damina**

Department of Urban and Regional Planning,  
Waziru Umaru Federal Polytechnic, Birnin Kebbi.

**Abdul Husaini**

Department of Urban and Regional Planning,  
Federal University of Technology, Minna,  
Niger State, Nigeria.

### **Abstract**

Strategic planning for cemeteries should be one of the easier tasks for planners. Supply and demand can be estimated with some certainty from death rate. For the dead to rest in peace, Planners need to begin to see reason for planning for the death. The research was conducted via a reconnaissance and physical survey. The existing population of the study area was provided by the National Population Commission and information regarding death people was sourced from Kaduna State Ministry of Health. The inventory of the spatial distribution of cemeteries in Kaduna metropolis was done via physical survey and update of Google images of study area and digitization. The data were presented and analyzed using descriptive statistics techniques. The study identified 25 cemeteries spatially distributed within the metropolis and the facilities within the identified cemeteries were grossly inadequate and unplanned. The result also showed that the cemeteries are over utilized with regards to their capacity as about 70% of the cemeteries were filled beyond capacity with 80% of them totally in poor condition. Major recommendation and design proposal, which include provision of cemeteries within 1.5km radius for better service delivery as well as provision of land by government for additional grave sites.

**Keywords:** Burial grounds, cemeteries, spatial, internment, planning standards, characteristics.

### **Introduction**

Webster's Third International Dictionary defines a cemetery as: an area for burial or entombment...any burial ground, typically a large one: a graveyard. Section 8100 of the Health and Safety Code provides: Six or more human bodies being buried at one place constitute the place a cemetery.

As a popular saying goes, "Death is inevitable" whereas the phenomenon of death and living is, and has been accepted by man as an inescapable index of his existence, he has nevertheless been over owed by its paradoxical presence. Man's preoccupation with death is as old as the history of man himself, people must be born and eventually die. Think of urban cemeteries as the first public parks in America. They enticed city-dwellers into an idyllic country experience with rolling green hills, shady trees and stone benches designed for reflective thought.

Moreover, cemeteries can serve as more than just the resting place of the dead; providing the living with areas for contemplation, seeking solace, and gaining insights into the past.(Kevin, 2017).

Therefore, for the fact that death is inevitable, every human being will eventually die. Cemeteries in towns and cities must be located in the city outskirts which should be above 1km from homes and living areas (Al-jibaly,1998). All public cemeteries must be standardized, designed and accessible with good linkages within an urban space (Chapin, 1970).

With this regard, cemeteries within Kaduna metropolis are not properly located or distributed according to standard base on service radius and hierarchy from neighborhood to regional.

For the fact that death is inevitable, every human being will eventually die, over 2.5 million Nigerians are expected to die this year (WHO, 2016). The vast majority will be buried. Yet a number of communities, especially those more fully developed, are hard pressed to find cemetery space within their borders especially Kaduna metropolis.

Therefore, lack of space and of physical design plan for cemeteries and management resulted to the underutilization of space and misuse of space, which as a result cemeteries are riddled with stumps that stick up from the sandy loam like matchsticks.

In view of the foresaid, this study assessed the characteristics (condition) and spatial distribution of cemeteries with the view to providing appropriate recommendations for improved spatial distribution and effective space use of cemeteries. The paper achieved the foresaid aim through the following sets of objectives: Review of the principles, standards and backdrop of cemeteries in cities; Examining the characteristics (physical condition), and spatial distribution of cemeteries within the study area; and through physical design proposal and recommendations towards improvement of cemeteries condition and spatial distribution in the study area.

## **Types of Cemeteries**

According to M-Gillies (2011) Cemeteries, they are final resting places dedicated to our bodies after death colloquially known as sprawling necropolises; they are adorned with rows of gravestones and columbaria, and reflect the spiritual beliefs and preferences of every culture at every stage of their history. Since the mid-eighteenth century, cemeteries have also served as a city's green space, allowing families and others a place to go for visiting, mourning, reflecting and memorializing the dead. And while many people may only see a cemetery as just a place where the dead are laid to rest, cemeteries can be divided into different types which include:

**1. The Church Cemetery:** Between the Middle Ages and the Victorian era, the dead were often buried on the properties of churches – however with limited space, graves were often used multiple times. But as plagues and disease rose through the soils infecting those who attended mass, new regulations were formed in regards to burials and burial plots, which included making it illegal to bury bodies less than six feet under the soil.

These days, churchyards are still used to house the dead, and while a church cemetery is often found in the churchyard, it can often be separate from the church. These churchyards are owned by the church and are considered private property; however, churchyards are generally open for all to visit.

One such famous churchyard is the Trinity Church Cemetery located in Manhattan, New York, USA, which is the home to many founding US representatives and Revolutionary War soldiers.

**2. The Public Cemetery:** Public Cemeteries are plots of land owned by a governmental unit within a town, city or county and are by law, public cemeteries that must remain open to the public.

**3. The Customary Cemetery:** With no formal or legal status; no sexton or sexton's records, customary cemeteries are simply plots used by neighbors as burying places, which are further cared for by survivors of those buried within. While they are not generally legal, these types of cemeteries are tolerated and can often be found in rural areas.

**4. The Private Cemetery:** Often owned and operated by a corporation, lodge, community organization, military or specific family, these cemeteries are restrictive to the public and will list the owners and/or caretakers at the cemetery entrance.

**5. The Lodge Cemetery:** Similar to the private cemetery, a lodge cemetery is owned and operated by lodges or other fraternal organizations, such as the *Bohemian Grove Club*, *Freemasons* or *Oddfellows*. In many cases, these cemeteries are strictly restricted to members of the organization, but often, others can purchase plots – and because many of these organizations were founded as a means to provide burial or death insurance, costs were generally inexpensive for members.

**6. The Ethnic Cemetery:** These types of cemeteries can either be private or public, but are owned, operated and maintained to support one religious group, such as Russians and the Russian Orthodox Church.

**7. The Family Cemetery:** In most states, these types of cemeteries are still legal, but while there are fewer family cemeteries, at one time there were thousands of them. Consisting of a plot of land, owned by a family, a family cemetery would see the occasional close friend buried on the property along with family members, due to many families owning large amounts of rural land, they could afford to allocate portions of land for this purpose to keep burial costs down.

**8. The Veterans' Cemetery:** As part of their service in the military, veterans who were honorably discharged from service are given the opportunity to be buried in a military cemetery. Currently there are 119 national veterans' cemeteries in the United States, the most famous of all being the Arlington National Cemetery.

**9. The Monumental Cemetery:** Monumental cemeteries are cemeteries in which headstones or other monuments made of marble, granite or similar materials rise vertically above the ground. However, because maintenance of monuments is the responsibility to the family, and further because of the number of graves inside the cemetery, monumental cemeteries have been considered unsightly.

#### **Principles that guide the location of cemeteries.**

The location of cemeteries is based on planning principles; such principle is influenced by the norms and values of the people. These principles also vary from place to place, which may be due to differences in the culture and way of life. (El-Nafaty, 2004).

- I. 0.5 hectares of land is required for cemetery, for population of 1000. This principle is adopted in Egypt. In Nigeria, it is 0.25 hectares for every 1000 population.
- II. Cemeteries are to be located away from the living and working areas. Germany uses a distance of 2km, Italy and Greece use 500m-1km while the distance adopted in Nigeria is 1km away from living areas.
- III. Cemeteries should be provided with an organized space for future expansion. The space reserved is based on the population of the area.
- IV. Cemetery is to be provided in each residential neighborhood, for a certain population.
- V. Cemeteries are to be located in city outskirts. This principle is mostly adopted in Islamic societies like Pakistan, Morocco and Saudi-Arabia.
- VI. Cemetery can also be located in organized tombs, buildings or historic sites. This principle is applicable in places like Egypt, and Israel.
- VII. Burial grounds or cemeteries can also be reserved for special people or royalties, e.g., kings, pharaohs, armed forces, wealthy or influential individuals.
- VIII. An exhausted cemetery is left fallow for about 70-100 years before its reused.

- IX. No cemetery is to be located in any land uses other than public /semipublic land uses or open spaces.
- X. All spaces within a cemetery must be fully utilized before the need for an expansion.

**Table 1:** Planning Standards for Cemeteries.

Catchment	One cemetery per village, town, or urban area (5000 and above)
Site requirement	: Low water table
Location:	Accessible to catchments area
: Site size	Site size will relate to population grouping.
Population of up to 5,000 persons	: 0.5ha to 1ha.
Population 5,000 to 15,000	: 1ha to 1.5ha.
population up to 100,000 persons	: 10 ha

**Source:** Ghana Ministry of Environment Science and Technology Town and Country Planning Department (2000)

<b>Population to be served</b>	<b>: Population of the District (5000 and above)</b>
Location criteria	: Near river, Lake or Sea. Not less than 20m from nearest dwelling house. Not less than 15m from public road. Accessible from catchments area. On site car parking for at least 25 vehicles.
Site size	: 1ha to 2.5 ha (including space for parking and storage facility)

**Source:** Ghana Ministry of Environment Science and Technology Town and Country Planning Department (2000).

#### **Cemetery grave or burial plot sizes.**

- A standard grave is about 8 feet long and 2 1/2 feet wide.
- This size provides room for an upright monument or flat grave marker.
- Some burial plots may be up to 9 feet long or 4 feet wide to accommodate a person of larger size.

**Source:** Ghana Ministry of Environment Science and Technology Town and Country Planning Department (2000).

**Material and Methods.**

A reconnaissance and physical survey were conducted during which the wards, neighborhoods and cemeteries within the boundaries of the four Local Government Areas that make up the metropolis of Kaduna were identified and updated on a base map of the study area. The existing population of the study area was sourced from National Population Commission (NPC), and information regarding death rate was gotten from the Kaduna state Ministry of Health. The spatial distribution of cemeteries in Kaduna metropolis was done by updating through physical survey of Google imageries of study area and digitization. The inventory of the cemeteries was done by physical counting and their conditions noted by physical observation. This was easily carried out by community cemetery attendant prior approval of the village and Ward heads. The information on the conditions of the cemeteries was gotten via physical observation using a checklist of available facilities prepared by the researcher as a guided by standards while descriptive statistics was used to analyze and discuss the data.

**The Study Area.**

Kaduna State is located on the southern edge of the high plains of Northern Nigeria, bounded by parallels 9°03'N and 11°32'N and extends from the upper River Mariga on 605E on the foot slopes of the scarp of Jos Plateau. The state occupies almost the central portion of northern Nigeria and shares borders with Sokoto, Katsina, Niger, Kano, Bauchi and Plateau States (Figure1) with a total land area of 46,053 square kilometers and a population base of 6,066,562 persons (NPC, 2006). It has a density of one hundred and thirty (130) persons per square kilometer and is made up of twenty-three (23) local Government Areas (Figure 1 & 2).

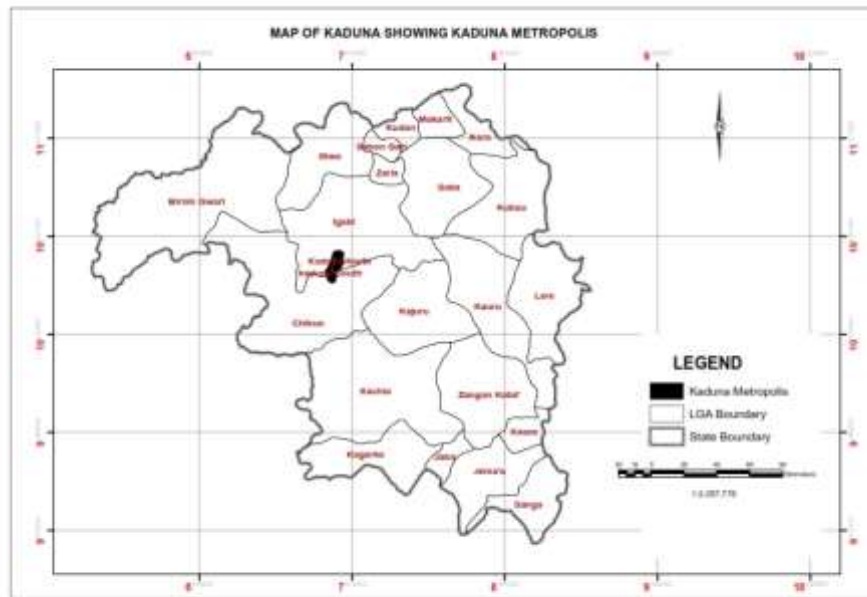
Kaduna metropolitan area is the capital of the state and consists of Kaduna North LGA, Kaduna south LGA, and part of Chikun and Igabi LGAs with existence of distinct local administrators. The metropolis has a projected population of 1,123,581 persons with growth rate of 2.55% and by this projection Kaduna City (metropolis) is the fifth largest city after Lagos (10,578,000), Kano (3,395,000), Ibadan (2,837,000), and Abuja (1,995,000) (Max Lock, 2010). Historically, Kaduna metropolis became prominent as a result of being the administrative capital of Northern Nigeria Protectorate from 1912 to 1917 and headquarters of North Central State from 1967 to 1975 (the North Central State was made of Zaria and Katsina Provinces). In 1975 the name changed from North Central State to Kaduna state but Kaduna metropolis remained the capital and maintained its sphere of influence. Kaduna State, North Central Nigeria, is politically classified as belonging to the now 'Northwest' zone of the current six (6) Geo – political zones of Nigeria. It is populated by about 59 to 63 different ethnic groups if not more with the exactitude of the number requiring further verification through a genuine field work (Max Lock, 2010).

The urban form of Kaduna metropolis: The initial setting of the town was based on the principle of segregation that aimed to prevent the native population from spreading malaria and other disease to the Europeans. The strangers and the indigenous Hausa were also kept apart to prevent the former from being a bad influence on the later who were mainly Muslims. Kaduna has long outgrown the three distinct city sectors described above and the lines of segregation have been blurred with time. As described in the 1967 Kaduna master plan, the historical governmental functions of Kaduna have also strongly influenced its spatial development and form. From the mid-1950s onwards, based on records available in the survey Department, the army drew up series of plans for the rationalization of its land (Max Lock and Partners Consultancy, 1967).



**Figure 1:** Map of Nigeria showing Kaduna State.

**Source:** Max Lock Consultancy limited (2010) and modified by author, 2017



**Figure 2:** Map of Kaduna State showing Kaduna Metropolis.

**Source:** Max Lock Consultancy limited (2010) and modified by author, 2017

## Results and Discussions

**Table 2:** Adequacy of land area for Cemeteries within the metropolis.

S/no	Location	Population	Area in ha	Expected	Short fall	Remark	Hierarchy
1	Kabala Doki	36,244	0.65 Ha	3.6Ha	1.9 Ha	Inadequate	Neighborhood
2	Kabala Doki		1.05 Ha			Inadequate	Community
3	Gabisawa	1211	0.045 Ha			Inadequate	Neighborhood
4	T/Wada	96,302	1.54 Ha	9.6 Ha	6.83 Ha	Inadequate	Community
5	T/Wada		1.23 Ha			Inadequate	Community
6	Kawo	148,405	0.46 Ha	14.8 Ha	13.08 Ha	Inadequate	Neighborhood



7	Kawo		1.26 Ha			Inadequate	Community
8	Hayin Baki	43,128	0.65 Ha	4.3 Ha	3.65 Ha	Inadequate	Neighborhood
9	Kabala west	42,813	0.68 Ha	4.2 Ha	3.5 Ha	Inadequate	Neighborhood
10	Nariya	148,234	1.31 Ha	14.8 Ha	13.5 Ha	Inadequate	Community
11	Unguwan Mu'azu	60,230	0.47 Ha	6.0 Ha	5.5 Ha	Inadequate	Neighborhood
12	Kudenda Zikoriko	4,302	0.49 Ha	0.5 Ha	0.01 Ha	Adequate	Neighborhood
13	Barnawa	60,198	0.56 Ha	6.0 Ha	4.77 Ha	Inadequate	Neighborhood
14	Barnawa		0.67 Ha			Inadequate	Neighborhood
15	Narayi	40,808	0.34 Ha	4.8 Ha	4.46 Ha	Inadequate	Neighborhood
16	Romi	55,129	0.86 Ha	5.5 Ha	4.64 Ha	Inadequate	Neighborhood
17	Unguwan Pama	22,673	0.46 Ha	2.2 Ha	1.74 Ha	Inadequate	Neighborhood
18	Unguwan Sarki	41,395	0.51 Ha	4.1 Ha	3.59 Ha	Inadequate	Neighborhood
19	Unguwan kanawa	45,397	0.48 Ha	4.5 Ha	4.02 Ha	Inadequate	Neighborhood
21	Malali	47,397	1.13 Ha	4.7 Ha	2.7 Ha	Inadequate	Community
22	Malali		0.87 Ha			Inadequate	Neighborhood
23	Kakuri	98,222	0.87 Ha	9.8 Ha	8.93 Ha	Inadequate	Neighborhood
24	Unguwan Maigero	4,231	0.73 Ha	0.5 Ha	+ 0.23 Ha	Surplus	Neighborhood
25	Unguwan Rimi	84,193	0.64 Ha	8.4 Ha	7.76 Ha	Inadequate	Neighborhood

	<b>Total</b>		<b>20.15</b>	<b>107.8 Ha</b>	<b>87.65</b>		
					Ha		

**Source:** Authors field survey 2017

**Table 3:** Adequacy with regards to capacity of Cemeteries within Kaduna metropolis.

S/no	Location	Area in ha	Capacity	Required	Proportion
1	Kabala Doki	0.65 Ha	914	1300 graves	386
2	Kabala Doki	1.05 Ha	567	2100 graves	1533
3	Gabisawa	0.045 Ha	27	90 graves	63
4	Tudu wada	1.54 Ha	1872	3080 graves	1208
5	Tudu Wada	1.23 Ha	2873	2460 graves	+413
6	Kawo	0.46 Ha	498	920 graves	422
7	Kawo	1.26 Ha	2987	2520 graves	+467
8	Hayin Banki	0.65 Ha	1724	1300 graves	+424
9	kabala west	0.68 Ha	1423	1360 graves	+63
10	Nariya	0.31 Ha	687	620 graves	+67
11	Unguwan Mu'azu	0.47 Ha	1123	940 graves	+183
12	Kudenda Zikoriko	0.49 Ha	587	980 graves	393
13	Barnawa	0.56 Ha	2567	1120 graves	+1447
14	Barnawa	0.67 Ha	1874	1340 graves	+534
15	Narayi	0.34 Ha	783	680 graves	+103
16	Romi	0.86 Ha	3167	1720 graves	+1401
17	Unguwan Pama	0.46 Ha	1231	920 gr aves	+401
18	Unguwan Sarki	0.51 Ha	689	1020 graves	331
19	Unguwan kanawa	0.48 Ha	1321	960 graves	+361
21	Malali	1.13 Ha	2142	2260 graves	118
22	Malali	0.87 Ha	1987	1740 graves	+247
23	Kakuri	0.87 Ha	2543	1740 graves	+803
24	Unguwan Maigero	0.73 Ha	627	1460 graves	842
25	Unguwan Rimi	0.64 Ha	1231	1280 graves	49

**Source:** Authors field survey 2017

The table reveals that most of the cemeteries within Kaduna metropolis is full as a result, graves are reused without reaching the period of time needed before it can be reused. Therefore, provision of addition land for burial is required so that facilities within the cemeteries should not be over utilized. This is calculated using 60% land area for grave while

40% is allocated to supporting facilities. It also shows that spaces within the cemeteries are not adequately utilized. It also reveals that, most of the cemeteries are only graves site neglecting other supporting facilities.

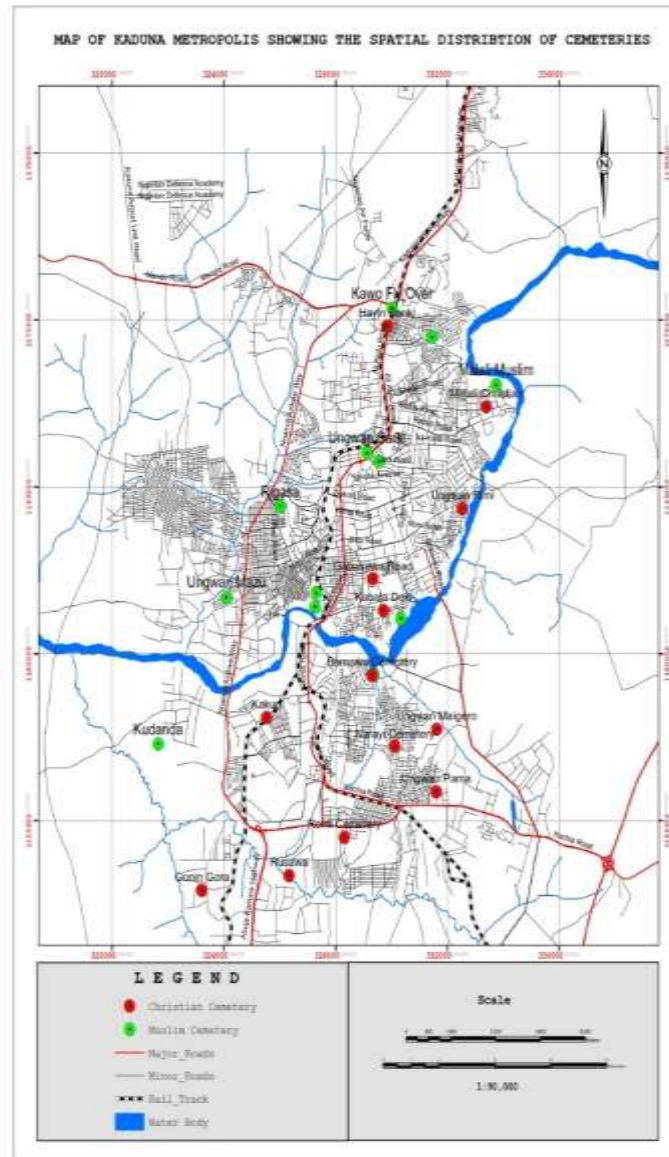
**Table 4:** Cemetery facilities and their condition.

S/N O	LOCATION	FACILITIES				CONDITION		LIGH T
		BOREHOL E WELL	ROAD S	FENCE	MANAGEME NT OFFICE	B.HOLE/ WELL	FENC E	
1	Kabala Doki	1	NILL	✓	•	FUNCTIONIN G	GOOD	GOOD
2	Kabala Doki	2	NILL	✓	•	GOOD	GOOD	NILL
3	Gabisawa	1	NIL	✓ S	•	GOOD	GOOD	GOOD
4	Tudu wada	2	NIL	✓	✓	GOOD	GOOD	GOOD
5	Tudu Wada	NIL	NILL	✓	•	FAIR	GOOD	GOOD
6	Kawo	1	NILL	✓	•	GOOD	GOOD	NILL
7	Kawo fly Over	3	NILL	✓	✓	FAIR	BAD	NILL
8	Hayin Banki	NILL	NILL	✓	NILL	BAD	BAD	NILL
9	Kabala west	1	NILL	•	NILL	FAIR	NILL	NILL
10	Narayi	NILL	NILL	NILL	NILL	NILL	NILL	NILL
11	Unguwan Muazu	1	NILL	NILL	NILL	FAIR	NILL	NILL
12	Kudenda Zikoriko	1	NILL	NILL	NILL	FAIR	NILL	NILL
13	Barnawa	2	NILL	NILL	NILL	FAIR	NILL	NILL
14	Barnawa	2	NILL	NILL	NILL	FAIR	NILL	NILL
15	Narayi	NILL	NILL	NILL	NILL	BAD	NILL	NILL
16	Romi	1	NILL	NILL	NILL	BAD	NILL	NILL
17	Unguwan Pama	1	NILL	NILL	NILL	BAD	NILL	NILL
18	Unguwan Sarki	1	NILL	NILL	✓	GOOD	BAD	GOOD
19	Unguwan kanawa	1	NILL	✓	✓	GOOD	GOOD	GOOD
20	Unguwan Yero	1	NILL	NILL	NILL	FAIR	NILL	NILL
21	Malali	2	NILL	NILL	NILL	FAIR	NILL	NILL
22	Malali	2	NILL	NILL	NILL	FAIR	NILL	NILL
23	Kakuri	1	NILL	✓	✓	FAIR	BAD	NILL
24	Unguwan Maigero	2	NILL	✓	✓	GOOD	GOOD	GOOD

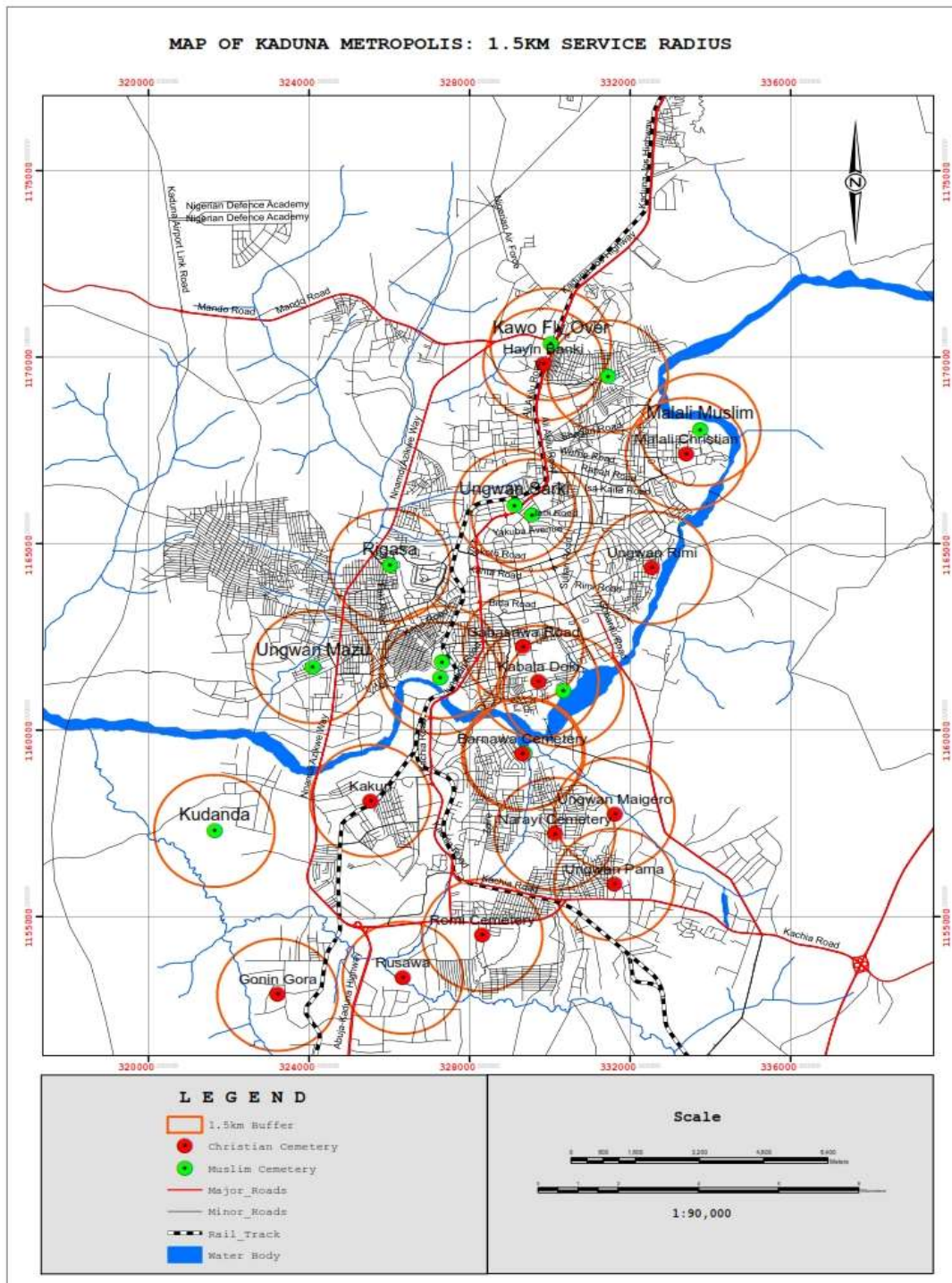
25	Unguwan Rimi	2	NIL L	NILL	NILL	FAIR	NILL	NILL
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**Source:** Authors field survey 2017

From the table above, there are few facilities located within the cemeteries e.g., borehole, and well, fence etc. The conditions of the facilities are bad due to poor management and over stretched of the facilities due to insufficient provision of the facilities. It also shows that less attention is given to cemeteries because they are places for the dead. It also shows that as a result of lack of management staff in most of the cemeteries there is tendency that some facilities like lighten when provided can be stolen. More also because of the absence of good accessibility within most of the cemeteries, there are no drainages within the cemeteries for run-off water, as a result of that, water runs and wash away some graves within the cemeteries. This data also shows that cemeteries without fence around are prone to stealing of some valuables within the cemetery.



**Figure 3:** Spatial Distribution of Cemeteries in Kaduna Metropolis.



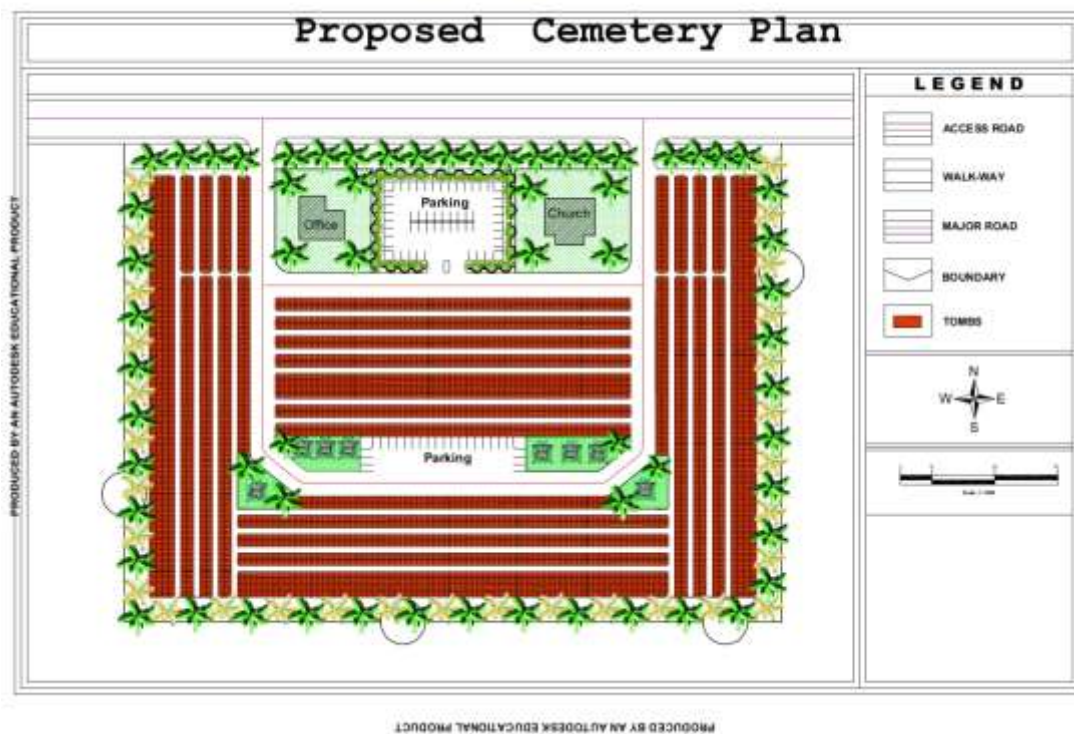
**Figure 4:** Showing 1.5 service radius for cemeteries in Kaduna Metropolis.

**Table 5:** Space projection from 2017 to 2021

S/no.	Year	Population	Death rate	Total death	Area /Ha
1	2017	1,482,339	1.27	18,826	7.9
2	2018	1,572,613	1.27	19,972	8.4
3	2019	1,619,792	1.27	20,571	8.7
4	2020	1,668,386	1.27	21,186	8.9
5	2021	1,718,437	1.27	21,842	9.1
<b>TOTAL</b>		<b>8,061,567</b>		<b>102,397</b>	<b>43.0HA</b>

Source: Author 2017

Result in the table above, illustrates, that from the projected population starting from 2017 to 2021, with death rate of 1.27%, it was estimated in each year the number of persons that are expected with die within the metropolis and also, the estimate land requirement, needed to bury them.

**Figure 5:** Proposed layout plan for cemetery

The layout plan is been design to solve the challenges of planned Cemeteries within the metropolis. This is a prototype to be adopted within the fringes of all the four (4) LGAs within the Metropolis. The design provides for a place for solace and relaxation. The death can never rest in peace without a good resting place.

### **Conclusion and Recommendations.**

The place of cemeteries in land use planning cannot be overemphasized due to the fact that all the living, live to die someday and be buried at the foresaid place. Unfortunately, the study has revealed that cemeteries are unevenly distributed and grossly inadequate with low attention in providing of space for the cemeteries, facilities and overstretching of already filled to capacity cemeteries in Kaduna Metropolis, which is supposed to be a place of meditation, aesthetics and sober reflection. In other to improve the capacity and effectiveness of cemeteries operations in Kaduna Metropolis, the following are suggestions that may help towards improvement.

Cemeteries should be provided within the metropolis using the standard population of 10,000 persons per hectare, by doing so, the shortfalls in the area will be curtailed to the minimum level. A grave layout designed above is a prototype that should be implemented around the fringes of the four LGAs within the Metropolis. This will minimize under and over utilization of space. The legal backing for cemeteries operation should be reviewed to meet up with the current need and challenges of the contemporary. Cemeteries that are full should be stopped in use and allowed to fallow for 70 years before it can be re-used again. The Cemeteries currently in use should be managed by the aid of an employed cemetery superintendent, section and row at a time before moving to another row, so that there will be coordination and well utilized. There should be proper boundary delineation of all cemeteries without fence and fence should be provided in other to stop people from encroaching into cemeteries. Facilities should be adequately provided to reduce over utilization and depletion of the ones available. Drainages should be provided within all the cemeteries for easily flow of water to avoid erosion of graves. Circulation should also be adequately provided within cemeteries for easy access to grave sites and aesthetic view and lighting within the cemeteries. There is need for more provision of public cemeteries within the Metropolis because people prefer using the public cemeteries than the private home or other means.

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