RUGIPO RESEARCH AND TECHNICAL JOURNAL; VOLUME 1, ISSUE 1 (AUGUST, 2022)

TETFUND PROJECTS 2017-2021:
(*TETFUND/DR&D/CE/POLY/OWO/ARJ1*

ISSN: 2714-3643
"**ID**": 7917305; "**RC NO**": 1903473

Rhema Academic Publishers Ltd
Ado-Ekiti, Ekiti Sate, Nigeria
E-mail: rhemaacademicpublishers@gmail.com;
Phone: +234 704 774 2214, +234 805 976 6124

ISSN: 2714-3643

RUGIPO RESEARCH AND TECHNICAL JOURNAL

VOL. 1, ISSUE 1

AUGUST, 2022

Sponsored by:
TETFUND PROJECTS 2017-2021:
(*TETFUND/DR&D/CE/POLY/OWO/ARJ1*

ISSN: 2714-3643

RUGIPO RESEARCH AND TECHNICAL JOURNAL

VOL. 1, ISSUE 1

AUGUST, 2022

Sponsored by:
tetfund
TERTIARY EDUCATION TRUST FUND
TETFUND PROJECTS 2017-2021:
(TETFUND/DR&D/CE/POLY/OWO/ARJ1

RUGIPO Research and Technical Journal,
Rufus Giwa Polytechnic, Owo,
P.M.B 1019, Owo,
Ondo State, Nigeria.

ISSN: 2714-3643

Published by:

RhemAP Rhema Academic Publishers Ltd
Ado-Ekiti. Ekiti Sate. Nigeria
E-mail: rhemaacademicpublishers@gmail.com;
Phone: +234 704 774 2214, +234 805 976 6124

ARJ Project 2022 of:

RUFUS GIWA POLYTECHNIC, OWO, ONDO STATE.
Advancement Through Technology

Sponsored by:

tetfund
TERTIARY EDUCATION TRUST FUND

***TETFUND PROJECT 2017-2021*:**
(*TETFUND/DR&D/CE/POLY/OWO/ARJ1*)

EDITORIAL ADVISORY BOARD COMMITTEE MEMBERS

REVIEWERS/EDITORIAL BOARD MEMBERS

EDITORIAL

Civilization and technology have been, in recent times, growing at a speedy progression. Consequently, efforts are made today, more than ever before, to acquire knowledge. Indeed, knowledge is the product of learning or personal experiences. Apart from the classroom mode of learning, internet serves as an avenue of exchanging information and updating knowledge.

It is against the background of the potency of knowledge that this journal, RUGIPO RESEARCH AND TECHNICAL JOURNAL, was floated. The journal is published by the Research and Technical Journal Committee of Rufus Giwa Polytechnic, Owo. The publication, which is multidisciplinary in nature, is geared towards contributing to the pool of knowledge available for the development of the human society. It features research papers and other scholarly articles on pure sciences, agriculture, social and management sciences, engineering and environmental studies as well as the humanities.

RUGIPO RESEARCH AND TECHNICAL JOURNALhas a standard editorial policy, which is aimed at getting high quality articles published. To this end, much attention is focused on the issue of originality of articles. As a matter of policy, we carry out plagiarism check on all submitted articles.

The journal is published annually. So, we welcome more articles and research papers for publication from members of the academic community and the industry.

At this juncture, the Editorial Board expresses its sincere appreciation to the Management of Rufus Giwa Polytechnic, Owo, for approving and supporting this publication. We are also grateful to the Management of Tertiary Education Trust Fund (TETFund) for sponsoring the publication. In the same vein, we owe much gratitude to all our reviewers and editors as well as authors whose articles are published in this edition of the journal.

It should be noted that the opinions expressed in this journal are entirely those of the authors. Therefore, the Editorial Board accepts no responsibility for any observed misconception or error in the publication.

Dr. Akinniyi, A.J.
Chairman/Editor-in-Chief,
Research and Technical Journal Committee (R&TJC),
Rufus Giwa Polytechnic,
Owo, Ondo State, Nigeria.
Phone: +234 703 900 6863, +234 808 901 0573

EDITORIAL POLICY

About the Journal:
RUGIPO Research and Technical Journal (*RUGIPO-R&TJ*), Rufus Giwa Polytechnic, Owo, Nigeria, is a multidisciplinary journal that publishes original research papers not previously published, that are not being considered elsewhere for publication in the fields of basic sciences, applied sciences, engineering, technology, social sciences and humanities. The Journal seeks to publish high quality papers that describe significant and novel findings and advanced knowledge in the fields of endeavours in the form of original articles, reviews, technical and case studies reports.

Authorship:
An author is an individual who has significantly contributed to the development of a manuscript.***RUGIPO-R&TJ*** recommends that authorship be based on the following four criteria:

i) Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work;
ii) Drafting the work or revising it critically for important intellectual content;
iii) Final approval of the version to be published; and
iv) Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Indexing and Abstracting:
The published articles of ***RUGIPO-R&TJ*** are to be indexed and abstracted in line with internationally accepted standards.

Call for Papers:

i) Articles for publication in the ***RUGIPO-R&TJ*** are usually preceded by placing a call for papers advertisement that are widely circulated via posters and handbills sent to sister institutions, radio jingles, various social media platforms, public announcements in the popular radio stations near and around Ondo State.
ii) Expected time of manuscripts' submission is between 1-2 months. Manuscripts' submission is by online system through the journal website with the institution-domain email address.

Review Process:

i. Articles for publication in the Journal are evaluated on the basis that they present new insight into the investigated topics and are most likely to advance or contribute to research knowledge and progress.
ii. Authors' manuscripts will be initially examined by the Journal's Editorial Unit and those considered to have insufficient ground for publication may be rejected without external or peer-review evaluation, while the authors of those deemed publishable are issued letters of acceptance.
iii. Manuscripts not prepared in compliance with the prescribed requirements and styles of the Journal will be sent back to authors for corrections.
iv. Accepted manuscripts will be sent to 2-4 relevant independent experts (double-blind Peer-review) for evaluation, which commonly takes on the average of 1-2 months.

Permission:
Prospective contributors wishing to include figures, plates, tables or texts that have already been

published elsewhere are required to obtain permission from copyright owner(s) for both print and online format when submitting their papers.

Plagiarism Policy and Disclaimer:
The Editorial Board of *RUGIPO-R&TJ*, in conjunction with the Publisher, has put in place all necessary machinery to ensure genuine authorship, and that no inaccurate or misleading data or statements appear on the Journal. In view of this, all manuscripts submitted to the Journal are subjected to plagiarism checker (Turnitin) with not more than 35% acceptable score. Consequently, it is made categorically clear that the data and opinions appearing in the articles are the responsibility of the authors concerned.

Accordingly, the Publisher and the Editorial Board accept no liability whatsoever for the consequences or inaccurate or misleading data or statements, intentional or not.

Misconduct:
Misconduct constitutes violation of this editorial policy, journal policies, publication ethics, or any applicable guidelines/policies specified by *RUGIPO-R&TJ*. Any other activities that threaten/compromise the integrity of the research/publication process are potential acts of misconduct. Suspected cases of misconduct will be investigated according to*RUGIPO-R&TJ* guidelines.

Information for Authors:
- Submitted article should be in A4 format and should not be more than 12 pages.
- The article should be typed in Time New Romans font style and font size 12 point in double line spacing.
- Abstract should not be more than 250 words, with five keywords or short phrases
- Title should be in title case, followed by authors name(s), affiliation and corresponding author's email address.
- Article should be arranged in the following orders: Introduction, Materials and Methods/Methodology, Results, Discussion (Results and Discussions may be merged as the case may be) and References.
- References should follow the APA 7th edition style.
- Each article should be accompanied with evidence of payment of #3000 for reviewing, paid into RUGIPO Journal, Polaris Bank 1771401460
- All submissions must be through the Journal online submission system on the Journal web page and a copy should be sent to rugipotechjournal@rugipo.edu.ng or rugiporetechjournal@gmail.com .

For Further Enquiries, contact:
The Editor-in-Chief,
Research and Technical Journal Committee,
Rufus Giwa Polytechnic,
Owo,
Ondo State, Nigeria
Or call: +234 703 383 1865

TABLE OF CONTENTS

		PAGES
1.	Globalization and Architectural Profession: Enhancing a Sustainable Environment for Nigerian Architects in the Global Market. **Ilesanmi, O. S. Olowoyo, A. S., Bankole, I. E. and Olanitori, A.**	1
2.	Proximate Composition and Microbiological Quality of Elubo Produced from Water Yam Under Different Treatments. **Jose A. R., Oyetayo, A. M. and Dada, O.**	7
3.	Assessment of Energy Generating Mix in Advanced Economy for 2030. **Aponjolosun, J. K.**	11
4.	Communicating Efe On Stage: Yerima's Techniques in The Lottery Ticket. **Ajimuda, O. S., Adetoro, A.**	18
5.	Globalization of Architecture: Theorizing a new agenda for Nigerian architecture. **Ilesanmi, O. S., Ojo, E. T., Bankole, I. E., Olanitori, A. and Kolade, O. O.**	26
6.	Yardsticks for Effective Maintenance of Public Buildings in Nigeria: A Case Study of Ondo State. **Ogunbode, B. A., Ayodele, E. O., Olofinsawe, M. A., Olowolayemo, O. E. and Obanoyen, A. S.**	34
7.	Comparative Study of Various Wall Finishes in Buildings in Ondo State, Nigeria. **Alejo, A. O., Oyegoke, I. K. and Olotu, F. M.**	47
8.	The Indelibility of the Writer's Instrumentality to A Call to Duty: A Stethoscopic Journey Through Femi Osofisan's Who's Afraid of Tai Solarin? **Egbuwalo, O. L.**	54
9.	Estimation of Elevations of Unobserved Locations Using Simple Kriging Method. **Olomoshola, O., Olanitori, A. and Olawole, S. A.**	60
10.	Ethnomedicinal and Phytochemical Properties of Uvaria Afzelii Sc. Elliot (Puss Finger) and Uvaria chamae P-Beauv (Finger Root) in Ibadan Metropolis. **Osabiya, O. S and Adeduntan, S. A.**	69
11.	Creating Virtual Architectural Education in A Traditional Environment: Prospects and Challenges. **Ilesanmi, O. S., Ojo, E. T., Bankole, I. E. and Kolade, O. O.**	76
12.	Engagement of Health and Safety Practitioners on Construction Sites: Its Effects on Workers' Performance. **Olowolayemo, O. E., Williams, O. S., Ogunbode, B. A., Oyegoke, I. K. and Popoola, O. M.**	83
13.	Strength Performance of Concrete Produced with Crushed Burnt Brick as All-In Aggregate. **Olotu, F. M., Alejo, A. O. and Oyegoke, I. K.**	90
14.	Combination of Electrical Resistivity Tomography (Ert) And Geo-Electric Sounding in Groundwater Detection Within the Basement Rocks of Isuada-Owo, Ondo State, Nigeria. **Olanegan, P. O., Fasunla, O. M. and Olaitan, S. K.**	96
15.	Impact of Substrates and Associated Defects on Paint in Tropical Buildings' Exterior: A Review. **Kehinde, Abiodun**	104
16.	Information and Communication Technology (ICT) in Architectural Education: The Challenges. **Ilesanmi, O. S., Alejo, A. O. and Olowoyo, A. S.**	113
17.	Experimental Investigation and Performance Evaluation of Thermal-Behaviour on Multi Cavity Porous Media.	

	Adepo, S. O., Imoukhuede, K. A. and Ayodele, O. R.	**118**
18.	Efficacy of Eddy Current and Inductive Proximity Sensor: A Critical Review. **Aponjolosun, J. K. and Faweya, J. A.**	**123**
19.	Digital switch-over in Nigeria: An unending Journey? **Ajimuda, O. S.**	**130**
20.	Development and Performance Evaluation of an Electric Frying Machine. **Imoukhuede, K. A., Ayodele, O. R. and Obanoyen, O. N.**	**139**
21.	Antimicrobial and Larvicidal Assay of Cola Milenii Leaf Extracts on Anopheles Stephensi. **Adewumi, B. L., Giwa, O. E., Elehinafe, T. R. and Osaloni, A. R.**	**147**

RUGIPO RESEARCH AND TECHNICAL JOURNAL

GLOBALIZATION AND ARCHITECTURAL PROFESSION: ENHANCING A SUSTAINABLE ENVIRONMENT FOR NIGERIAN ARCHITECTS IN THE GLOBAL MARKET

Authors

O. S. Ilesanmi[1], A. S. Olowoyo[1], I. E. Bankole[1], and A. Olanitori[2]

[1]Department of Architectural Technology, Rufus Giwa Polytechnic, Owo.

[2]Department of Surveying and Geo-informatics, Rufus Giwa Polytechnic, Owo.

Abstract:

Contemporary globalization can be described as the process of increasing the connectivity and interdependence of the world's market and partnership as a result of the recent technological advances. In the global market today, architecture has indeed been largely internationalized and substantially standardized through the unprecedented advances in electronic, communication and transportation technologies. However, in Nigeria it is presently to some extent localized, for Nigerian architects are unable to compete favourably with their foreign competitors due to the demands of globalization, especially on building industry professionals of developing countries. Thus, there is the need for a radical approach towards a qualitative departure from the present traditional management styles and structures of architectural firms in Nigeria, so as to salvage the Nigerian architects' position in the global market. This paper, therefore, discusses ways of enhancing a sustainable environment for the Nigerian architects in the global market with consideration of the concept, demands, benefits and challenges of globalization, as well as sustainable strategies. The paper recommends, among others, outsourcing of core and non-core competencies, international collaborations, specialization, diversification, software development and correct application of world class technologies in design and presentations.

Keywords: *Architecture, Globalization, Nigerian, Sustainable environment*

Introduction

From different perspectives, globalization can be described in several ways as the widening and deepening of international flows of trade, finance and information in a single, integrated global market or as the transformation (shrinking) of the world into a global village, as borders disappear, distances shrink, and time shortens. In other words, globalization enhances transfer of services, goods, labour and capital across the globe with little or no problem. Thus, it serves as a means of development of many developing countries. On the other hand, it aids the formation and flourishing of monopolies which, in the long-run, leads to exploitation of the masses as well as a total disregard of the environment and human rights of poor countries' people. Notwithstanding the aforementioned, the advantages of globalization outweigh its disadvantages, especially when considering Nigerian architects' access to the global market alongside with contemporary globalization.

Contemporary globalization is simply a process of connectivity and interdependence of the world's market and business as a result of the recent technological advances. The advances in transportation, telecommunications infrastructure and the rise of the internet have immensely made it easier for people to travel, communicate and do business internationally. Therefore, for a meaningful and successful international architectural practice to be achieved, it is obvious that majority, if not all, of the opportunities offered by the contemporary globalization need to be seized. Thus, for the Nigerian architects to fully enjoy the benefits offered by contemporary globalization there is urgent need of finding sustainable ways of enhancing our quick and full access to the global market, so as to allow a qualitative departure from our traditional approaches to architectural practice in our country. This paper

will discuss in detail the concept, demands, benefits and challenges of globalization as well as sustainable strategies for easy and quick access of the Nigerian architects to the global market.

Concept of Globalization

Concept of globalization, in general, term means that the whole of the world is increasingly behaving as though it were a part of a single market, with interdependent production, consuming similar goods, and responding to the same impulses (Williamson, 1998). Concept of globalization of business can also be described as the rapid change in the technical, social, political, and territorial organization of investment, production, trade, and aid. It is basically a business restructuring process such as trans-nationalization of communication, commerce, production, ownership, consumption, socio-cultural reproduction and politics. Others include the increased segmentation and volatility of market demand, the organizational decentralization of forms and enhanced flexibility of production (Riggs, 2007). In other words, the concept of globalization from business perspective involves narrowing and widening of income gaps among and within nations. Thus, it is a global process that entails both positive and negative consequences which is as a result of its demands on nations.

Demands of Globalization

Globalization is increasing the complexity and competitiveness of business (Argea, 2007) and so also are its demands. Globalization demands for adequate research into the required strategies of how to be able to compete favourably at the global marketplace, especially across multiple business units and functions available to architects.

Secondly, globalization demands the need for effective logistics in the global market place. According to Russel (2006), “the days of single companies designing a product from scratch, building that product and then selling it in the marketplace themselves are all over”. In today's day and age, this process is simply too expensive for companies to do and stay competitive. It is therefore, pertinent to note that architectural firms are in the era of designing two-dimensional and three-dimensional drawings and outsourcing the remaining different parts (walk and fly through, landscaping, model making, etc) of the presentation and working drawings possibly from within or other parts of the world. In other words, the era of turn-key design has gone. Nigerian architects need to know that the logistics in the global marketplace is far different from what is obtainable in the domestic market. The marketplace is so competitive that outsourcing of correct conditioned materials and experts in different aspects of designs from different locations in the world is highly inevitable. There is the need for change of our orientation if we are very serious about our effective operations in the global marketplace.

Thirdly is the demand for firms to form multinational or joint international venture. Today in the global marketplace, large international firms, including architectural firms, have tried to perfect multinational model by taking full control of fast development of new software, specialized skills and cost effective labour pools, so as to balance the quality and costs for their designs and productions or presentations. On the other hand, the mid-market firms, the Nigerian architectural firms' category in the global market, depend solely on the use of old and somehow outdated software, sole proprietorship and turn-key contract ideas. The aforementioned approaches are common features of the Nigerian architectural firms, which have left us today with less quality and high costs for designs, presentations, supervisions and project management.

Lastly, globalization demands for standardization of professional services. According to Osuntogun (2005), “Clients are increasingly becoming international, and increasingly require the same standards of quality and uniformity from their professional agents that they receive in other parts of the world. Consumer needs are becoming more internationally homogenized through communication technologies and travels”. The demand is actually to ensure higher standard of service to clients across the globe who demand for evenness in professional services regardless of location.

Benefits of Globalization

The Nigerian architectural firms (mid-market firms) need to survive and prosper in the highly competitive global marketplace if they want to be accorded recognition internationally. It is, therefore, very necessary for all the practitioners and the future professional architects to be well informed about the benefits of globalization.

One of the benefits of globalization is increased trade between nations. It is necessary to note that through globalization Nigerian architects can seek to be commissioned in Nigeria and other countries in the world. This opportunity avails any Nigerian architectural firm to be commissioned or seek to be commissioned in other countries beside Nigeria or locate its office in any other country apart from Nigeria.

In addition, through globalization, corporations have greater flexibility to operate across borders. This opportunity can be annexed by Nigerian architectural firms and take advantage of cheaper costs and shift their offices to countries where there are cheaper labour cost and lower taxes. In addition, Nigerian architectural firms can ".....become multinational and thereby develop truly international markets or operations through merger and acquisitions" (Ojo and Bello, 2005).

Rapid improvement and increasing flow of communications also allows vital information to be shared between individuals and corporations around the world. This opportunity can, as well, be seized to reach out to many clients in the world, to make easy contacts offices in different locations in the world and even to advertise themselves and their services to a worldwide audience. It can further be used for outsourcing of experts and cheap labour from wherever they are available in the world. Thus, global operations can be effectively managed, using new technologies and the emergence of virtual architectural team and firms.

Improved transportation system through globalization is another benefit that can be carefully exploited. The opportunity of greater ease and speed of transportation for goods and people, as brought by globalization, can be seized by the Nigerian architectural firms to bring together experts from different locations to a particular site with ease. It can equally be used in movement of office equipment from where they are found cheaper or from one office location to another.

Globalization also enhances better and more widespread of education as it allows trans-border educational activities and operations.

The above enumerated benefits are worthy of note by the Nigerian architects so as to be acquainted with the benefits derivable from globalization, most especially those that may create a sustainable environment for architectural practice to thrive well at the global marketplace.

Challenges of Globalization

The dynamics of globalization are multifaceted, in some aspects; the powers of nation state are undermined. For all the opportunities it creates, globalization has also deepened pre-existing inequalities. The interdependence of globalization is seemingly asymmetric. While some countries prosper glaringly by it, the same cannot be said of other countries (Osuntogun, 2005). For instance, the increased free trade between nations as allowed by globalization equally gives opportunity to developed countries large corporations or firms to take advantage of weak regulatory rules in developing countries. As multinational firms take advantage of this opportunity, at the same time it will amount to disadvantage to firms in developing countries. It will be so unless government of developing countries rise to the situation by reviewing their existing laws and promulgating new ones, so as to allow fair competition among the firms. In addition, the presence and influence of the multinational firms from developed countries will kill or affect the growth of the small firms in the developing countries.

Eradication of geographical boundaries and identities is one of the factors of globalization. This factor has a great influence on thriving of developing countries' architectural firms at local and global marketplace. There will be no more room for monopoly of knowledge with respect to cultural identities of developing countries, whereas the multinational firm will have room for such about developed countries due to their financial capability to get information fast from any country in the whole world, a global village.

Sustainable Strategies for Creating an Enabling Environment

The concern is increasing among the Nigerian architects about creation of an enabling environment for their full access to the international market, but the question about the strategies is yet unanswered. Thus, the need to discuss the sustainable strategies for creating an enabling environment is paramount to the sustainability of Nigerian architects in the global marketplace. At this point, emphasis needs to be laid on some of the following.

1. There is the need to encourage specialized and appropriate training for the new generation architects as a sure strategy for creating an enabling environment for architectural practice to thrive well at the global marketplace in the near future.

2. Architects Registration Council (ARCON) and the Nigerian Institute of Architects (NIA) need to intensify their efforts in the training of the new generation architects and retraining of the practising architects by organizing conferences, workshops and seminars on the current global demands on architectural consultancy services as well as the benefits of globalization with respect to architectural practice at the global marketplace. In addition, there is need for training of the Nigerian practising architects with the use of AutoCAD and internet facilities as against the traditional way of architectural design, presentation and firm management.

3. Architects Registration Council (ARCON) and the Nigerian Institute of Architects (NIA) equally need to act on behalf of Nigerian architects with clear, short-range and sharp actions to steer through other developed countries and look out for the next in line big wave techno-change in designs and presentation techniques. This may be helpful to the sustenance of Nigerian architectural firms in the global marketplace.

4. There should be formation of multinational architectural firm through merger of the existing architectural firms in Nigeria with one another as a group or to form partnership with foreign architectural firms. Nigerian architects needs to avail themselves of the benefits associated with international collaborations on project designs, presentation, supervision and management.

5. Architects Registration Council (ARCON) and the Nigerian Institute of Architects (NIA) need to participate fully in the global politics so as to promote and protect growth and survival of the Nigerian architectural firms in the global marketplace.

6. There should be outsourcing of core and non-core competencies internally to identify processes and functions that can be sourced from experienced service providers at lower cost and better quality. Outsourcing of experts from within and outside the country in areas such as presentation drawings, detailed working drawings, model making, landscaping designs, project supervisions and project management with different software packages is of paramount importance in this era of high quality demands on consultancy services. The idea of running architectural firm alone with one's family members needs to be shelved and instead face the reality of the day.

7. Environmental friendly software packages' development is also essential. It is a tool that makes design delivery faster with easier designs presentation. Encouragement of architectural design software

in Nigeria is a sure strategy for growth of Nigerian architectural firms' packaging of designs, presentations and even model making.

8. Priority needs to be given to adequate publicity of the Nigerian architects' consultancy services worth on international network media. Through this, numerous world audiences can be reached whereby business negotiations in respect of the advertising firms' area of specialization may commence.

Recommendations

1. Financial institutions reform – Financial institutional reform by the Nigerian government can be a sure and easy way to make fund available to the Nigerian architectural firms. Easy access to fund to will put in place basics of an architectural firm such as opening of offices in different locations in the world, hiring and retaining of excellent staff, satisfying clients and improving processes.

2. Review of the Nigerian foreign policy and promulgation of new laws - Review of Nigerian foreign policy and promulgation of new laws are necessitated as a result of the need to protect and encourage indigenous firms against their foreign competitors who may seize opportunity of our country's weak foreign policies and laws. There is need for government to have ceiling cost of project that may not be compete-able for by any foreign firm. This paper is of the opinion that governments of developing countries need to rise to the situation by reviewing their existing laws and promulgating new ones so as to allow fair competition among the firms. In addition, the presence and influence of the multinational firms from developed countries, if care is not taken, will kill or affect the growth of the small firms in the developing countries.

3. Review of Schools Curriculum – Sumaila (2006), Zubairu (2002) and Amole (2000) suggest inclusion of a new course in our schools curriculum to prepare architects for new emerging roles. Adeyemi (2000) suggested a structural view of the schools curriculum. Olagunju et al (2006) also saw the need for curriculum planning that can meet the need of an individual, community and the nation at large. With the numerous benefits and demands of globalization on architectural practice at the global marketplace, there is every need for Nigerian schools of architecture to review their curricular in favour of specialized training in line with the new design and presentation technology techniques and global clients taste or demands. The new generation architects' future depends largely on the range of their exposure to global demands on architecture while on training.

4. Review of Professional Code of Conduct – The Nigerian Institute of Architects code of professional conduct should be reviewed with consideration for the benefits and demands of globalization. For instance, article 3, item 3.9 states that “A member may make his availability and experience known by means of **direct approaches to individuals and organisations** provided that the information given is in substance and in presentation factual, relevant and neither misleading nor unfair to others nor otherwise discreditable to the profession. A member **shall not advertise consulting services** by the public means, nor shall be given monetary consideration for the publication or exhibition of his work”. It is in the opinion of this paper that for Nigerian architects to fully be availed of the benefits of globalization and gain a sustainable access to the global marketplace, all rules and regulations of our land towards business globalization and that of the Nigerian architects' professional body must be to encourage free trade and architectural practice internationally. Otherwise, architectural practice will remain and continue to remain as localized professional practice.

Conclusion

If the available opportunities from contemporary globalization are well embraced by Nigerian architects, it will not only affect the size of architectural firms in Nigeria, it will also allow architectural firms to be set up in other countries and at the same time function as a single business operation. In other words, it will enhance Nigerian architectural firms to go corporate rather than the obtainable individual

and ethnic based operating firms. It will further encourage Nigerian governments (that is, all levels of government) and other countries' government to patronize Nigerian architectural firms in the award of future contracts.

References

Adeyemi, E. A. (2000). Lest we forget, In Sumaila, S. A. (2006). Increasing the academic and research content of architectural curriculum of Nigerian universities: Panacea for meeting contemporary challenges*, AARCHES journal,* Vol. 5, No. 1, p. 49 – 54.

Amole, O. O. (2000). Completing the sphere of architect's education through building and environmental education, In Sumaila, S. A. (2006). Increasing the academic and research content of architectural curriculum of Nigerian universities: panacea for meeting contemporary challenges, *AARCHES journal,* Vol. 5, No. 1, p. 49 – 54.

Argea; New demands of globalization, Mid-market outsourcing solutions, Online document.Retrieved – September 01, 2007, from http://www.argea.com/mm_globalization.

Ojo, B. & Bello, M. O. (2005). Globalization and real estate market in Nigeria, The Faculty of Environmental Design and Management, Obafemi Awolowo University, Ile-Ife, Nigeria, *Conference proceedings*, p. 52 – 58.

Olagunju, R. E., Akande, O. K. & Ayuba, P. (2006). Towards a new curriculum plan and development for architectural education in Nigeria, *AARCHES journal*, Vol. 5, No. 1, p. 64 – 70.

Osuntogun, A. (2005). The challenges of globalization on the Nigerian built environment and its culture, key note address, The Faculty of Environmental Design and Management, Obafemi Awolowo University, Ile-Ife, Nigeria, conference proceedings, p. 1 – 6. Riggs, F. W. (2007). Globalization: the key concepts, Online document. Retrieved – September 03, 2007, from http://www2.hawaii.edu.

Russel, M. (2006). Logistics in the global marketplace, online document. Retrieved–September 03,2007, from http://www.logistics-guide-to.com/a/337327/logistics.

Sumaila, S. A. (2006). Increasing the academic and research content of architectural curriculum of Nigerian universities: Panacea for meeting contemporary challenges, *AARCHES journal*, Vol. 5, No. 1, p. 49 – 54.

Wiliiamson. J. (1998). Globalization: The concept, causes and consequences, Key note address to the congress of the Sri Lankan association for the advancement of science, Colombo, Sri Lanka/ The World Bank, Online document. Retrieved – September 01, 2007, from http://www.iie.com/publication.

Zubairu, S. N. (2002). Post occupancy evaluation and facilities management – course for the new millennium, *AARCHES journal,* Vol. 2, No. 1, p. 17 – 20.

RUGIPO RESEARCH AND TECHNICAL JOURNAL

PROXIMATE COMPOSITION AND MICROBIOLOGICAL QUALITY OF *ELUBO* PRODUCED FROM WATER YAM UNDER DIFFERENT TREATMENTS

Authors
Jose, A.R., Oyetayo, A.M,* and Dada, O.
Department of Science Laboratory Technology, Rufus Giwa Polytechnic, Owo

*Corresponding author's E-mail: michaelococcus@gmail.com

Abstract:
In this study, water yam was subjected to cold water and hot water soaking, thereafter; they were oven- dried at 60 °C for 72 h and ground to fine powder as elubo which was then subjected to proximate and microbiological analysis using conventional techniques. The results show that control sample had the highest moisture (8.79 %), protein (10.16 %), ash (1.66 %) and fibre (2.00 %) contents while hot water treated water yam flour had the lowest values of 6.72 , 9.89 , 1.49 and 1.87 % respectively for moisture, protein, ash and fibre content respectively. Although, the lipid and carbohydrate content were higher in the hot water treated sample which had 1.82 and 78.73 compared with the control which had 1.53 % and 75.86 % respectively for lipid and carbohydrate.. The microbial count on the three samples of elubo revealed that there was no significant (p, 0.05) difference in both the total bacterial and total fungal count of elubo made from both hot water and cold water treatments. However, the total bacterial and fungal count in the untreated sample (control) were significantly higher than the other samples. Three bacterial species (Staphylococcus aureus, Bacillus subtilis, Pseudomonas aeruginosa) and five fungal species (Saccharomyces cerevisiae, Rhizopus stolonifer, Penicillium italicum, Aspergillus niger and Geotrichum candidum) were isolated from the prepared elubo samples. This indicate that soaking treatment have no detrimental effect of the nutritional profile and microbiological quality of water yam flour and may be used in the preparation of elubo.

Keywords: Elubo, Water yam, Quality, Proximate, Microbiology

Introduction

Dioscorea species is a major staple food in Nigeria where it is cultivated in large quantity. It is a very popular food among Nigerians across all the social strata. Although, the crop is found throughout the tropics, most of the yams are produced in Africa (Udensi et al., 2010). Nigeria is the major producer of yam accounting for over 80% of the worldwide production, other countries where yam is produced on a large scale are Ivory coast, Ghana, Benin Republic and Togo, all in West Afrca (Abara et al., 2011).

Several yam species have been described from different part of the world; however, the major varieties with economic importance in Nigeria are *Dioscorea rotundata, Dioscorea cayenensis* and *Dioscorea alata*. *Dioscorea alata (water yam)* is one of the neglected crops according to Arinathan et al. (2009). Since it is highly perishable, its tubers may not be kept for more than a few months after harvesting. Moreover, the high level of water in *D. alata* as well as its fragile nature contributes to its low market value and acceptability in world market (Udensi et al., 2010).

Of a necessity, yam needs to be coverted into a more stable and easy to manage form which will improve its shelf-life thereby increaing its market value with attendant enhancement of food security. Yams are highly perishable and once harvested deteriorates quickly leading to loss of upto 50 % of the production (Udensi et al., 2010). This necessitates the development of strtegies to conserve this important source of food to make it available throughout the year. Various products are thefore produced from yam and yam flour popularly called *elubo* among the people of south west Nigeria is one of such

products. It is a flour made from the processed yam which is then made into thick paste whenever needed with minimal processing.

The production of *elubo* from fresh water yam after harvest is an efficient antidote against loss both in quality and quantity of yams. During the processing, the yam tubers are peeled and washed to prevent enzymatic browning and then cut into slices for drying. The dried yam is then pulverized into powder form (flour) followed by sieving using a mesh (Ekwu et al., 2005). The flour (*elubo*) is a stable material that can be stored for several months before use. *Elubo* is very popular among the Yorubas of the Southwestern Nigeria and it is prepared using various methods ranging from cold water treatment to high temperature treatment and fermentration. This study was therefore designed to assess the proximate composition and microbiological quality of *elubo* made from water yam using different processing methods.

Materials and Methods

Source of materials

The water yam was bought from Oja Oba in Owo, Owo Local Government Area, Ondo state, Nigeria. They were moved to the Biology Laboratory, Department of Science Laboratory Technology, Rufus Giwa Polytechnic, Owo for further experimental procedures.

Treatment of the yam sample

The water yam was peeled with a knife and then cut into small sizes and subjected to three different treatments.

A. 1 kg was soaked in cold water for 24 hrs
B. 1 kg was soaked in hot water (100 ^{o}C) and allowed to cool and left for 24 hrs
C. 1 kg was not soaked at all to serve as control

Thereafter, all the samples were oven-dried at 60 ^{o}C for 72 h until they reached a constant weight.

Determination of Proximate Composition

The moisture, ash, lipid, fibre, protein and carbohydrate content of the samples were determined using the method described by AOAC (2005).

Microbiological Assay

Isolation of bacterial species elubo sample

Nine milliliters of distilled water was pipetted into 6 clean test tubes each, covered with cotton wool and aluminum foil, and then autoclaved at 121 ^{0}C for 20 minutes. The sample was macerated in a beaker containing 10 ml of distilled water to make 1:9 of sample water ratio i.e. 10^{-1}. The mixture was shaken well to suspend the propagules then a sterile pipette was used to measure 1 ml from the supernatant into another test tube containing 9ml sterile distilled water. The mixture was shaken to homogenize this making 10^{-2}. This was done in sequential order until the last test tube 10^{-6}. About 0.1 ml of suitable dilutions was transferred aseptically in to Petri dishes and molten sterile agar (at 45 ^{0}C) was aseptically poured and the mixture was swirled gently to ensure even distribution of the inocula. The medium was allowed to set after which plates were inverted and incubated at appropriate temperatures.

Characterization and identification of isolates

To identify the isolates from pure cultures, plate characteristics as well as various biochemical tests were carried out. This was done according to the scheme of APHA (1998).

Statistical Analysis

The results are expressed as means ± SEM of three replicates. Data were subjected to one-way analysis of variance (ANOVA) using SPSS version 25.0. The Duncan's Multiple Range test was used to separate the means at the 5% level of probability

Results and Discussion

The results of the proximate composition of the three flours obtained from water yam is shown in Table1. The control sample had the highest moisture (8.79 %), protein (10.16 %), ash (1.66 %) and fibre (2.00 %) contents while hot water treated water yam flour had the lowest values of 6.72 , 9.89, 1.49 and 1.87 % respectively for moisture, protein, ash and fibre content respectively. Although, the lipid and carbohydrate content were higher in the hot water treated sample which had 1.82 and 78.73% compared with the control which had 1.53 and 75.86 % respectively for lipid and carbohydrate.

Table 1: Proximate composition of water yam flour (elubo) produced from three different treatments

Proximate	Cold water	Hot water	Control
Moisture	7.28±0.00^{c}	6.72±0.01^{d}	8.79±0.02^{b}
Protein	10.02±0.01^{a}	9.89±0.07^{a}	10.16±0.05^{a}
Lipid	1.59±0.10^{c}	1.82±0.00^{a}	1.53±0.00^{a}
Ash	1.58±0.02^{b}	1.49±0.00^{d}	1.66±0.00^{b}
Fibre	1.98±0.00^{a}	1.87±0.01^{b}	2.00±0.01^{a}
Carbohydrate	77.55±2.10^{a}	78.73±0.25^{a}	75.86±0.15^{a}

This study showed that the fat and ash contents for all the flours tested were higher than those that have been reported in the literature. i.e.: ash and fat contents in different varieties of *D. alata* 0.19 - 0.51 and 0.5- 0.73% respectively (Okorie et al., 2011). However, these differences can be expected due to varietal and geographical differences. High amounts of fat can be one of the reasons for the feeling of satiety once the flour of this cultivar is compared to other root and tuber crops such as cassava, potato and sweet potatoes. The high level of carbohydrate may be probably due to the presence of mucilaginous material in the starch of the yam. The higher ash content in the control sample suggests that soaking treatment may affect the mineral content of the yam flour. Ash content is the measure of the mineral content of food material. Literature reveals very low levels of minerals in Nigerian varieties of *D. alata* species (Udensi et al., 2008). Comparatively, there were no significant differences in the nutritional composition of water yam flour subjected to different soaking methods and the non soaked one.

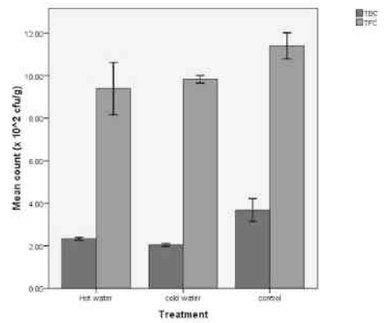


Figure 1: Microbial count on *elubo* produced from water yam under three different treatments

The microbial count on the three samples of *elubo* is shown in figure 1. The figure reveals that there was no significant (p, 0.05) difference in both the total bacterial and total fungal count of *elubo* made from both hot water and cold water treatments. However, the total bacterial and fungal counts in the untreated sample (control) were significantly higher than the other samples. This higher count in the untreated sample may be due to the better water activity in the untreated sample which made it a better growing medium for microbial species. Moisture content is directly linked with the survival of microbial agents in food (Achi and Akubor, 2000). Higher moisture content has been linked to quick deterioration leading to spoilage. Therefore, the untreated sample may be prone to fast spoilage due to the activities of microorganisms.

Table 2: Microbial distribution on *elubo* produced from water yam under three different treatments

Organism	Cold water	Hot water	Control
Staphylococcus aureus	+	+	+
Bacillus subtilis	+	+	+
Pseudomonas aeruginosa	-	-	+
Saccharomyces cerevisiae	-	-	+
Rhizopus stolonifer	+	-	+
Penicillium italicum	+	+	+
Aspergillus niger	+	+	+
Geotrichum candidum	+	-	+

Key: + = present, - = absent

Three bacterial species (*Staphylococcus aureus, Bacillus subtilis, Pseudomonas aeruginosa*) and five fungal species (*Saccharomyces cerevisiae, Rhizopus stolonifer, Penicillium italicum, Aspergillus niger* and *Geotrichum candidum*) were isolated from the prepared *elubo* samples. All these were found on the untreated sample whereas, only four were found in the sample treated with hot water while six were found in the sample treated with cold water.

The presence of *S. aureus* and *B. subtilis* on all the samples may be from environmental contamination as these organisms are ubiquitous in the environment and are normal flora of the human skin and soil respectively. *P. italicum* and *A. niger* were found on all the samples which suggests that they may be the major organisms responsible for the spoilage of the *elubo*. These two fungi have been implicated in the spoilage of several dry products such as cereals, flours, tubers and their products (Adeniran et al., 2013).

Overall, the three *elubo* samples were of high microbiological standard as the microbial counts were within the permissible range set by National Food and Drug Administration Commission (NAFDAC) for the type of food. Also, the absence of pathogens and toxigenic strains of organisms is a clear indication that the *elubo* samples are safe for consumption.

Conclusion

Based on the results obtained from this study, it can be concluded that different soaking methods had no detrimental effect on the nutritional profile and microbiological quality of water yam flour. However, hot water treatment seems to increase the lipid and carbohydrate content of the water yam flour as well as its microbial quality. But further studies concerning the phytochemicals and mineral constituents of these flours is needed to come to a more conclusive study

References

Abara, A.E., Tawo, E.N., Obi-Abang, M.E. & and Obochi, G.O. (2011). Dietary fibre components. of four common Nigerian Dioscorea Species. *Pakistan Journal of Nutrition,* 10: 383-387

Achi, O.K and & Akubor, P.I. (2000). Microbiological characterization of yam fermentation for `Elubo' (yam flour) production. *World Journal of Microbiology & Biotechnology,* 16: 3-7.

Adeniran, L.A., Makun, H.A. and & Muhammad, H.L. (2013). Survey of Mycotoxigenic Fungi in Concentrated Poultry Feed in Niger State, *Nigeria Journal of Food Research*. 2: 2.

APHA (1998). *Standard Methods for the Enumeration of Water and Waste water.* (20th ed., pp 38). Washington DC., United States.

Arinathan, V., Mohan, V.R. and & Maruthupandian, A. (2009). Nutritional and antinutritional attributes of some underutilised tubers. *Tropical and Subtropical Agroecosystems,* 10: 273-278.

Association of Official Analytical Chemist (2005). Official methods of analysis, 18th ed. Washington DC.

Ekwu, F.C., Ozo, N.O. and & Ikegwu, O.J. (2005). Quality of fufu flour from white yam varieties (*Dioscorea spp*). *Nigerian Food Journal,* 23: 107-113.

Udensi, E.A., Oselebe, H.O. and & Iweala, O.O. (2008). The investigation of chemical composition and functional properties of water yam (*Dioscorea alata*): Effect of varietal differences. *Pakistan Journal of Nutrition,* 7: 342-344.

Udensi, E.A., Oselebe, H.O. and & Onuoha, A.U. (2010). Antinutritional assessment of *D. alata* varieties. *Pakistan Journal of Nutrition,* 9: 179-181.

RUGIPO RESEARCH AND TECHNICAL JOURNAL

ASSESSMENT OF ENERGY GENERATING MIX IN ADVANCED ECONOMY FOR 2030

Author

Aponjolosun, J.K

Department of Electrical/Electronic Engineering Technology
Rufus Giwa Polytechnic,Owo, Nigeria.
Email: johnsonkay1@yahoo.com

Abstract:

The future energy mix scenarios seem unclear as there is continual rise in demand all year round. Couple with this, the UK is poised to cut down its dependence on fossil fuel for energy production and concentrate more on renewable in its stead. The country is under legal obligation to reduce its greenhouse gas (GHG) by no less than 80% from the 1990 benchmark by the year 2050. This work focuses on the UK generation mix by year 2030. It dwells upon how the renewable technologies would constitute minimum of 30%, average emission brought down to maximum of 50gCO2/kWh. The entire research was centered on three major issues of interest to the UK; vis-à-vis security of supply, affordability and reduction of greenhouse (GHG) gas. This is done by using an excel-based Energy Optimisation Calculator, which captures the interaction of various inputs to produce a least-cost generation mix. The result shows that a carbon neutral electricity sector is feasible if low-carbon technologies are deployed on a large scale.

Keywords: Generation mix, Greenhouse gas, National grid, Optimization, Renewable energy.

Introduction

It has become a common knowledge in recent times that the issues of climate change, energy supplies and affordable energy are three major challenges that are connected together with regard to issues of availability and utilization of electrical energy. A holistic approach to encompassing the entire issues needs to be accorded a great consideration. According to the National grid, published on the UK future energy scenarios (UK FES, 2014) document, the future energy scenarios of UK were based around energy trilemma of security of supply, sustainability and affordability.

In the light of the aforementioned, many developed countries like UK, have been stepping up efforts to ensure robust strategies which are deployed to address the issues of climate change with the encouragement and development of sustainable energy system. The energy market is a dynamic system changing annually with many pieces of legislation and goals set by the UK and EU (**The UK renewable energy strategy,** 2009). The UK is under obligation to abide by these regulations as climate change and dwindling fossil fuel reserves are global issues in UK future energy scenarios (UK FES, 2014) and **the UK low carbon transitional plan; national strategy for climate and energy** report (2009)

The UK energy supply in the last three decades has been characterised by huge amount of coal and oil. To reverse the trend, the experts in the field of energy now adopts different scenarios among which is the gone green scenario that the usage of more of renewable energies to reduce drastically the greenhouse gases **(Progress report to parliament meeting,** 2014). In the light of this, all hands are now on deck to generate energy mix for the future of UK. It is based on this, among other laudable reasons, that this paper is designed to generate energy mix for 2030 to meet energy and climatic change goals without compromising the cost.

The figure below shows the current energy generation mix in the UK.

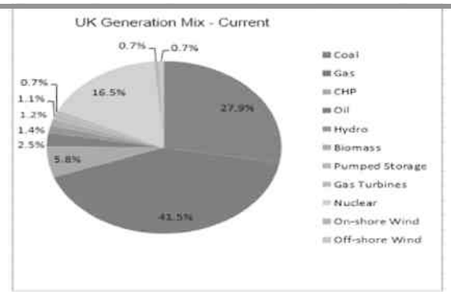


Figure : Current UK Generation Mix

Energy Generation Mix in UK

With the focus on reduction of green gas emission by at least 80%, the committee on climate change suggested the decarbonisation of UK electricity sector by 2030 (with average emissions of $50C0_2$/kwh) by the report of committee on Climate Change in 2016,(Ekins*et al*, 2011). The advice put forward by the committee shows clearly a reduction in the use of fossil fuel to generate electricity and in order to meet the electricity demand. As at May 2019, the generation mix is dominated by the fossil fuel with coal leading the supply with 30% of the total generation and gas taking up 29% and other energy used. It was observed from the prediction made by the National Grid Gone Green scenario that in the future generation mix for 2030, the renewable energy will take up the large percentage of the generation mix and lower percentage of the fossil fuel due to the reduction in the use of coal.

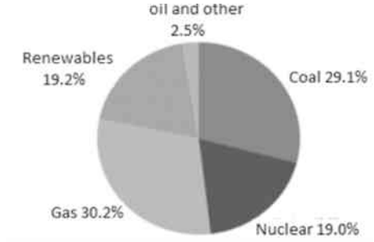


Figure 2: UK shares of electricity generation

The UK has started a 4-year research and development programme worth £125m to ensure the rapid development of the CCS technology (Ekins *et al,* 2013) because of its potential to reduce $C0_2$ emissions by 90% of the fossil fuel combustion.

Renewable electricity will play a key role in the future generation mix of the UK in order to meet the reduction of CO_2 emissions target. As at 2013, the renewable share of UK electricity generation was 14.9% and this is to rise to 19.2% by 2014 ((Ekins *et al,* 2011). The increase in the renewable electricity generation is expected to continue as renewable will play a significant role in the future UK electricity generation mix. Other renewables include tidal, wave etc. as reported by the UK holds 56GW out of which only 8.6GW can be exploited (Kannan, 2009).

Other generation mix include combined heat and power (CHP), micro generation (MG), oil, pumped storage (PS) and CAES.

Methodology

The objective of the optimisation problem is to obtain a generation mix for 2030 with the lowest cost, in p/kWh, provided that the following targets are met:

Table 1: Targets for 2030 Optimal Scenario

Total Capacity	Total output	Average emission	Renewable resources	Low carbon	Max non-dispatchable
130GW	366TWh/yr	50g/kWh	At least 30%	At least 29%	40%

Different scenarios are used by National grid to forecast the electricity demand in 2030 (Hughes and Strachan, 2013) and National Grid **UK future energy scenarios** (2013), such as "Low carbon life", "Gone green", "No progression", "Slow progression". For this paper, "Low carbon life" scenario is chosen to indicate the total capacity and total output in 2030. The fraction of renewable resources and low carbon generators would increase to 30% and 29% respectively in order to reduce the average CO_2 emission to 50g/kWh.

The power plants that are considered to contribute to UK generation in 2030 are coal, gas, combined heat and power plant, hydro, biomass, nuclear, onshore wind, off shore wind, wave, tidal and solar PV.

Coal

Coal plants do not only have a large CO_2 emission, but also creates other kinds of pollution such as SO_2, NOx, and PM2.5. Although carbon capture storage technology could reduce the emission significantly, it would have a large amount of extra cost. In the meantime, fuel cost is expected to keep rising in the future.

Table 2: Various Coal Technologies Cost

Type	Capital (£/kW)	Fixed £/kW/yr	Variable £/MWh	Fuel £/MWh
ASC	1642.47	42.6	1.0	19.3
ASC+CCS	3584.0	66.7	2.5	23.1
IGCC	2366.8	59.8	1.0	20.5
IGCC+CCS	3953.4	77.1	2.4	22.5

The constraint of capacitor factor is introduced based on the highest scenario for coal generation.

Table 3: Coals Capacity Factor Range

Type	ASC	ASC+CCS	IGCC	IGCC+CCS
Max CF	85	85	85	85
Min CF	30	30	40	40

Nuclear

Nuclear is a type of power that extremely lacks flexibility. But at the same time, it is extremely clean and has no emission. Although due to the limit of speed of developing, the maximum capacity that can be reached in 2030 is 16 GW.

Table 4: Nuclear Power Generation Total Cost

Capital (£/kW)	Fixed £/kW/yr	Variable £/MWh	Fuel £/MWh
4148.8	84	2.5	5.0

Gas: Gas power station has less pollution than its counterpart in coal, and UK has a large amount of storage in gas at present.Thus, it would play a more important role in UK generation mix in 2030. The data for cost is obtained from Department of Energy and Climate Change **Electricity generation costs (2013)** and as listed below.

Table 5: Various Gas Technologies Cost

Type	Capital £/kW	Fixed £/kW/yr	Variable £/MWh	Fuel £/MWh
CCGS	670.0	17.0	2.4	49.6
CCGS+CCS	1408.0	21.4	4.6	49.6

Renewable and Low Carbon Techniques

The data for the expenses for renewable energies and low carbon techniques are collected from the report published by Department of Energy & Climate Change (2013).

Table 6: Low Carbon and Renewable Energy Sources Cost

Type	Capital (£/kW)	Fixed £/kW/yr	Variable £/MWh	Fuel £/MWh
CHP (renewable)	3500	150	20.0	49.0
CHP (other)	600	46.3	0.1	119.0
Hydro	3400	24.8	6.0	0
Biomass	2500	160	5.0	0
Wind-onshore	1513	41.3	6.9	0
Wind-offshore	2210	125.4	16.4	0
Wind-offshore(R3)	2273	125.4	12.3	0
Wave	3500	202.0	0	0
Tidal	3125	77.5	0	0
Solar PV	2011	25.0	0	0

CHP technology and biomass both have same emission with that of fossil fuel (DECC**UK,**2012). However, they either burn the fuel in such a way that is more efficient, or they use recycled resources that are from the waste of kitchens or agriculture. That makes them more like a low-carbon technology, which can also reduce both the emission and cost.

The constraints for the capacity of these energies are set according to either the limit of installing speed, such as wind agrees with Department of Energy and Climate Change **Electricity Generation Costs (2013)**, wave, tidal, and solar PV, or the maximum potential that can be reach in 2030, such as hydro and biomass, IEA **Projected costs of generating electricity** (2005)

Operating Life of Power Plants

Varies studies has summarized the operating life of different types of power plants. The data used in this study is listed as below.

Table 7: Expected Operating Life of all Energy Sources

Coal ASC	29	Hydro	150
Coal ASC+CCS	25	Biomass	22
Coal IGCC	29	Nuclear	60
Coal IGCC+CCS	25	Wind onshore	20
GAS	25	Wind Offshore	24
Gas with CCS	25	Wind Offshore (R3)	22
CHP renewables	20	Wave	20
CHP (other)	20	Solar PV	30
Tidal	25		

It can be seen that the operating life of most types of power plants distribute from 20 to 30 years. However hydro stations and nuclear stations could operate much longer than the others.

Emissions

Coal driven power plants have a large amount of CO_2 emission, and gas driven power plants have relative lower emission than coal. Installation of carbon capture storage devices could reduce the emission significantly(DECC**UK, 2012)**

Table 8: Power Sources Emissions

Technique	Emission	Technique	Emission
Coal ASC	786	GAS	350
Coal ASC+CCS	220	Gas with CCS	56
Coal IGCC	786	CHP renewables	180
Coal IGCC+CCS	220	CHP (other)	440
Biomass	165		

Results

Efforts to reach the emissions target of 50gCO_2/kWh wind power generation had a dominant role. Even though the majority 49.79% of the optimised scenario incorporates wind power, nevertheless it is an expected scenario due to wind power huge growth.

The total cost of the system is expected to be relatively higher since wind power and especially offshore wind power is an expensive form of energy. Therefore, combining the entire factors above, total cost of this scenario reached **£50,473.9**£bn/year, when at the same time emission target was not only reached but overcame reaching 49.5gCO_2/kWh. Figure 1 shows the results obtained from the optimization solver.

Comparing both Figures 2 & 6, it is noticeable that wind power enjoys the biggest increase in comparison with other power sources. Both onshore and offshore rise dramatically from 1.4 % to a stunning 49.79% of total generation mix.Comparing both charts, it is noticeable that wind power enjoys the biggest increase in comparison with other power sources. Both onshore and offshore rose dramatically from 1.4 % to a stunning 49.79% of total generation mix. Offshore wind power seems to provide the biggest portion in whole optimised model with 31.33% of power generation by 2030.The only drawbackcould be the installation period and the capital cost.

Nuclear power on the other hand, seems to have reduced mainly due to the replacement of old facilities and growing***opposition*** to ***nuclear power, especially*** after Fukushima disaster, National Grid **Future energy scenarios** (2015). Nevertheless, the percentage of 12.3% classifies nuclear power as one of the most essential power sources in 2030 with zero emissions.

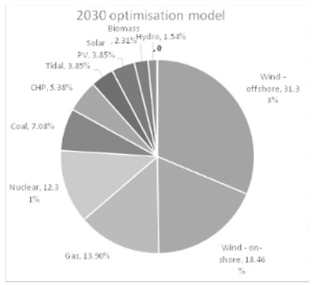


Figure 3: 2030 Optimised model

At the same time gas and coal shrinkage which are currently the vast power providers offering together more than 69.4 % are proposed to get reduced to 20.98% of total contribution, projecting this as the most

important outcome of the whole study. It is worth mentioning though, that the small portion of 20.98% from gas and coal is mainly combined with CCS technology, reducing further the total emissions.

Also, large percentages offered by solar PV contribution to the proposed energy mix seems a very surprising result. Their 3.85% growth considering their long operational life combined with the short development period classifies Photovoltaic technology among the most promising ones.
Tidal power, like PV technology, accounts for 3.85% of the overall energy mix. Although this technology is not proven yet, in UK it is expected to contribute at least 5GW of power.

Conclusion
It is more than clear that the UK power sector is about to face large changes and rearrangements over the next two decades in order to accommodate the 130 GW in **The UK Low Carbon Transitional Plan** (2009) of total capacity with 366 TWh/year total output as resulted from excel optimiser solver for 2030 energy optimisation mix.

Combined heat and power schemes as well as hydro power generation enjoy further raise in 2030 in comparison with today power generation contribution. Though the percentages are the same,the total power capacity in 2030 is expected to reach 130 GW meaning 40 GW raise in comparison with 2013. CHP raise is mainly due to biomass schemes that are expected to be deployed in UK the years to come and also due to their flexibility and high efficiency Barnacle, Robertson, Galloway and Barton (2013). Hydro power is also expected to rise but not in significant rates mainly due to the refurbishment of existing schemes and some micro sites. According to these results in excel optimiser, it is expected that the total cost will reach 13.8p/kWh when today it ranges between 9.39gCO2/kWh to 11.1gCO2/kWh.

References
Barnacle, M, E. Robertson, S. Galloway & J. Barton, G. (2013). Ault Modelling generation and infrastructure requirements for transition pathways.*Energy Policy*, 52, pp. 60-75.

Committee on Climate Change Carbon budgets – 2014 progress report to parliament meeting (2014) [Online]. Available from: http://www.theccc.org.uk/wp-content/uploads/2014/07/CCC-Progress-Report-2014_web_2.pdf. [accessed 24-Apr-2021].

Committee on Climate Change The fourth carbon budget: Reducing emissions through the 1990s (2016) [Online]. Available from: http://archive.theccc.org.uk/aws2/4th Budget/CCC_4th-Budget_interactive.pdf. [accessed 10-June-2021].

DECCUK renewable energy roadmap update 2012[Online]. Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/80246/11-02-13_UK_Renewable_Energy_Roadmap_Update_FINAL_DRAFT.pdf [accessed 17-Aug-2021].

Department of Energy and Climate Change Electricity generation costs 2013 [Online]. Available from: https://www.gov.uk/government/publications/decc-electricity-generation-costs-2013[accessed 25-Jul-2021].

Ekins. P, G. &Anandarajah, N.(2011).Towards a low-carbon economy: scenarios and policies for the UK [Online]. Available from: http://discovery.ucl.ac.uk/1302352/. [accessed 20-Mar-2021].

Ekins. P, N., Strachan, I.,Keppo, W., Usher, J.,Skea, G., A. (2013).The UK energy system in 2050: comparing low-carbon, resilient scenarios [Online]. Available from: www.ukerc.ac.uk[accessed 15-Apr-2021].

HM Government: The UK low carbon transitional plan; national strategy for climate and energy (2009) [Online]. Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/228752/9780108508394.pdf [accessed 10-June-2021].

HM Government:The UK renewable energy strategy (2009) [Online]. Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/228866/7686.p

df. [accessed 24-Apr-2021].

Hughes. N, N. & Strachan, R. G. (2013).The structure of uncertainty in future low carbon pathwaysEnergy Policy, 52 pp. 45-54.

IEA Project costs of generating electricity (2005) [Online]. Available from: http://www.oeedilibrary.iorg/oeed/content/book/9789264008274-en\http://www.oeed-ilibrary.org/energy/projected-costs-of-generating-electricity-2010_9789264084315-en\http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Projected+Costs+of+Generati[accessed 26-Aug-2020].

Kannan., R. (2009). Uncertainties in key low carbon power generation technologies – implication for UK decarbonisation targetsAppl Energy, 86 (10) pp. 1873-1886.

National Grid UK future energy scenarios (2013) [Online]. Available from: http://www.nationalgrid.com/NR/rdonlyres/2450AADD-FBA3-49C1-8D63-7160A081C1F2/61591/UKFES2013FINAL3.pdf. [accessed 20-Jul-2020].

National Grid Future energy scenarios (2015) [Online]. Available from: http://www2.nationalgrid.com/uk/industry-information/future-of-energy/future-energy-scenarios/[accessed 22-Sept-2021].

Renewable UK News- new government figures show Cameron was wrong to attack onshore wind (2014). [Online]. Available from: http://www.renewableuk.com/en/news/renewableuk-news.cfm/2014-12-18-new-government-figures-show-cameron-was-wrong-to-attack-onshore-wind. [accessed 20-Sept-2021].

RUGIPO RESEARCH AND TECHNICAL JOURNAL

COMMUNICATING *EFE* ON STAGE: YERIMA'S TECHNIQUES IN THE LOTTERY TICKET

Authors
Ajimuda, Olufunso Stephen
&
Adetoro, Abiodun
Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria.
ajistephen68@gmail.com

Abstract:

In the development of drama, right from the Classical Period, poets (playwrights) have deplored comedy as a sub-genre. Ahmed Parker Yerima, a Nigerian teacher, theatre practitioner, playwright and critic explored this sub-genre in The Lottery Ticket. The type of comedy Yerima used in this play is the 'New Comedy' popularised by Menander, which deals with aspects of daily life and a more realistic representation of human life; and the sub-strata called humour or efe or awada. Efe is a Yoruba word meaning joke or humour in its broad sense. This type of humour was made popular by the late Nigerian theatre practitioner, Moses Olaiya, popularly known as Baba Sala. The paper examined how Yerima communicates efe in the play. It started by taking a look at the word 'communication'; definition of comedy and the sub-strata known as humour or efe; the techniques Yerima explored in communicating efe, such as the use of Pidgin - English, use of local images, fast paced actions flowing into each other, allusion, innuendo, and incongruity. The theory which drives the work is the Play Theory. The theory, which was popularized by the British psychologist, William Stephenson, sees communication more as play than as work; more for pleasure and entertainment than for information and improvement.

Keywords: Drama, Comedy, Humour, 'Efe', 'Awada'

Introduction

Communication is a dynamic process that takes place around human beings all the time. In fact, we spend 70% of our time receiving and sending messages. Communication is one aspect of human life that many people have taken for granted, yet it is at the heart of all social intercourse. This is so because, many-a-time, we engage in communication without even knowing we are doing so. For instance, a student who is just meeting his colleague on resumption for the semester might first welcome her with a smile (which is a form of communication); then, the verbal communication might follow. Even when they are no longer talking, communication might still continue in the form of holding hands. The smiles and the holding of hands are things some people engage in without knowing they are communicating. Even, at times, human beings communicate while alone, talking to oneself, called intrapersonal communication. This now brings us to the question, what is communication?

Many communication scholars have come out to define communication in different ways. Davies (1967) defines communication as "the process of passing information and understanding from one person to another." *Roger and Shoemaker* (1971) define it as "the process by which messages are transferred from a source to a receiver" while t*he International Commission for the Study of Communication Problems (1977) defines it as "*the broad field of human interaction which takes place through symbols. The symbols may be gestural, pictorial, plastic, verbal, or any other symbols which operate as stimuli to behavior, which would be evoked by the symbol itself in the absence of special conditions of the person who responds."

Defining communication further, *O'Connor* (1981) sees it "as the process of sending and receiving messages to achieve understanding…anytime you speak a sentence, make a gesture, or merely grunt,

you are 'saying' you have some idea in your mind that you wish to transfer to another person." *Little* (1983), defines it as "the process by which information is transferred between individuals and, or organisations by means of previously agreed symbols."
All these definitions can be summarised as the act of exchanging information between the source and the receiver. It is indisputable that it is an essential tool for creating regular relation among people; it maintains and animates life. It can also be said to be the motor and expression of social activities and civilization. It is what gives life a meaning as its absence can ground the world.

Communication is a two-way process involving: a sender, a message, a medium, a channel, a receiver, a response and feedback. However, communication cannot be said to be effective by having just all these elements. There should be understanding and cooperation between the parties involved. Essentially, communication involves the sender/communicator and the receiver who should both share a mutually accepted code. The 'code' is not restricted to only language as it may involve colours, gestures, signs, costumes, among others.

There are various levels in communication such as intrapersonal, interpersonal, Group and Mass Communication. Intrapersonal communication is a type of communication which happens within a single person. For example, a person can communicate interpersonally through pain, thinking, emotion and feelings. Interpersonal communication involves two persons while Group communication involves more than two persons or a small group. As for Mass Communication, this involves the use of interpersonal as well as tools and technology in passing information to a large number of audience. Media like newspaper, radio, television and internet are used for this type of communication.

Theoretical Framework
The theory for driving this work is the Play Theory of Communication. The theory was proposed by the British psychologist, William Stephenson in 1967. The theory explains that people use communication more as play than as work; more for pleasure and entertainment than for information and improvement. This paper explores Yerima's techniques in his quest of using communication for entertainment and pleasure in *The Lottery Ticket.*

Synopsis

Ahmed Parker Yerima, teacher, theatre practitioner, playwright and critic, was once a lecturer in the Department of English and Drama, Ahmadu Bello University, Zaria, Nigeria, the Director of the National Troupe of Nigeria and currently a lecturer at Redeemers University, Ede, Osun State, Nigeria. Since Yerima's foray into the art of play writing, he has published about two score plays. He had been listed in Ogunbiyi (1981: 36) as part of the second generation of playwrights along with Wale Ogunyemi, Zulu Sofola, Femi Osofisan, Bode Osanyin, but it was not until the 1990's that he started becoming popular as an established playwright. Some of his published plays are: *The Silent Gods (1996), Kaffir's Last Game (1998), The Trials of Oba Ovonramwen (1998), The Bishop and the Soul (1998), Thank You Lord (1998), Attahiru (1999), The Sisters (2001), Erelu Kuti (2001), Dry Leaves on Ukan Tree (2001), Tafida (2001), Yemoja (2002), Mojagbe (2002), The Lottery Ticket (2002), Otaelo (2003), The Limam (2004), Ade Ire (2004), Idemili (2006), Ameh Oboni (2006), Hard Ground (2006), The Wives (2007), Akuabata (2008), Tuti (2008), The Asylum (2009), The Movement (2009), The Flood (2009), An Inspector Calls (2009), Orisa Ibeji (2011), Abobaku (2015), among others.*

A comprehensive reading of Yerima's plays will reveal that they provide an insight into the politics, ideology, culture, myths and the socio-economic life of his people - Nigerians . According to Adeoti (2007: xi) in his introductory note to *Critical Perspectives on Yerima*, "Yerima's plays can be critically analyzed from diverse perspective of ideology, history, psychology and pragmatics." Adeoti opines further, "Yerima draws broadly from generic elements of tragedy, comedy, tragic-comedy and satire; freely experimenting, in sometimes eclectic manner with the theoretical forms known in theatre history."

Ahmed Yerima's *The Lottery Ticket* (2002) explores greed, especially among Nigerians. In the author's note, he states: "My idea was to write a comedy and exploit that element of man which negates all other religious doctrines, and human relationship – greed."(6) Yerima has placed this theme within the context of the social reality in the Nigerian society where almost every brand name has a lottery attached to it. When this happens, according to Yerima, "there exists a clash with men's dreams and desires against the slim chances of ever winning. It is greed's ability to transform the human in us into the animal we become that fascinates me." (2002:6) The play is "focused on individual survival strategies rather than an elusive utopian society as the one that is presented in the plays of the radical dramatists." (Julius-Adeoye, 2013:145) "It is expected by the playwright that this play might help the reader-audience to come to terms with their everyday reality and also in their realization of the daily struggle for survival." (Acheoah & Ayodapo, 2014:34)

In espousing this theme, Yerima, unlike in most of his plays, explores the comedy sub-genre. Comedy, according to Yerima (2003:54), "is derived from the Greek word 'komos', meaning "a revel, an occasion of merry making which shows that drama was not only made of tragedy but also had a dimension of entertainment to it." He adds that "the playwright must be aware that writing a comedy depends mainly on characterization and dialogue. Acting in comic style, which is usually exaggerated, helps to add humour to a comedy." (2003:55)

Also writing on comedy, Adeyemi (2007) states that

> While evoking laughter in the audience, the writer of comedy examines the social worlds, social values and people as social entities. Characteristically, therefore, as comedy seeks to ridicule human vice, folly and socio-political moral problems, comic pleasure is derived from what Martin Grotjahn (1966:17) describes as a conscious and subtle juxtaposition of the character's obvious imperfection and the audience's perfection. (185)

Osundare (2008) also describes comedy thus:

> From Aristotle, Aristophane, from Freud through Bergson to Koestler, we have learnt that that creative and intriguing absurdity which touches off the bomb of laughter is a function of the shared wit and sensibility of laugh-merchant and buyers. The joke is cracked on trust that it will elicit the expected responses, and a good jokester operates by hints and innuendoes; what he hides is often greater than what he reveals. The audience is then left (or forced) to work out the rest, take the jokesters hint to its logical conclusion and respond accordingly… (6-7)

The type of comedy Yerima used in this play is the 'New Comedy' popularized by Menander (Menandros c.342 – c. 291 BCE). "Rather than mythical plots or political commentary, Menander used aspects of daily life for his plays… he did much to move comedy towards a more realistic representation of human life. (https://www.ancient.literature.com. Retrieved on May, 26, 2020)

Various terminologies have been created for the understanding of the context and structure of varying kinds of comedy, such as farce, jest, wit, absurdity as they evince laughter or subtle humour. Humour or *Efe* or *Awada* which can be classified as a sub-strata of comedy, is explored by Yerima in *The Lottery Ticket*. "Palmer (1994) notes that humour is difficult to describe as

> it is multidimensional, it is part of personality and part of our cognitive and emotional process. It is subject to social rules governing appropriate behaviour, on different occasions. It is part of literary and audio-visual narrative, it is subject

> to moral and
> aesthetic judgement, and it is a rhetorical instrument. (ii)

"Humour is manifest in situations, characters, language, or a combination of these factors to varying degrees" (Olusegun, 2015) and it is usually a cultural affair situated in the culture that produces it. Putting humour in context in the Nigeria environment, Olusegun (2015) opines that:

> …the cultural relatively of humour and language shows that the culture elements, structure, and relationship factors that generate humour differ from culture to culture. Humour belongs to the mix of cultural referents that we use to contextualize art forms. That is, the art of humour is sometimes context-dependent for its meaning to be clear... The theoretical concept of humour has mostly been Western in their origins; the practice, however, is culturally relative and different. The humaneness of humour is expressed in music, songs, arts, theatre, and the culture of derision to correct and express laughter all the folly of humans. The motives of humour is the discovery of the 'not-so-serious' in human nature by means of observation. While the audience is the sympathetic individuals who find such folly a part of themselves, there is a blend of satire in humour to show that the literary artist is not only interested in evoking laughter at the object of derision but also to point out the foolishness of man's actions.(120)
> .

Efe or *Awada* is a Yoruba word meaning joke or humour in its broad sense. This type of humour was popularized by the late Moses Olaiya popularly known with the stage name *Baba Sala* in the Nigerian Theatre industry (Haynes, 1994). Moses Olaiya is described as the father of comedy on the Nigerian stage and his objective was "to arouse laughter and excite interest in the people." (Julius-Adeoye, 2013)

Olusegun (2015:121) opines that "the term humour may cover the various shades of what *Awada* (*Efe*) may mean in Yoruba Language. It encompasses not just literary or conversational discourse but also other aspects such as the demeanour of the participants, mode of dressing, speech patterns, and every design which may elicit either subtle or farcical laughter in the audience." Adeleke (2005) identifies three major characteristics of jokes, humour, and laughter:

> the teller, the victim and the audience allow the performer to have a field day in the willing suspension of disbelief as the audience allow the performer to have a field day in the knowledge that he is acting out the basic human desire for psychological and emotional release. Within a social ambience, a*wada (efe)* is said to occur when the actions of the participants (teller, victim, and audience) are interpreted within the situational assumptions of the moral, cultural, and social circumstances that they share. The victim "may be an individual, an institution or a set of beliefs" while the audience lends support to the humourist by guffawing.(44-45).

This paper intends to explore the techniques used by Yerima in successfully putting *efe* on stage in *The Lottery Ticket*.

Techniques Used in Putting *Efe on* Stage in the *Lottery Ticket.*

The play, *The Lottery Ticket*, as in most Yerima's plays, has one Act and all the actions take place in one location – Mama Lizi's 'Buka'. Yerima is to be praised with the pace at which the actions flow into each other such that one has to wait to catch one's breath. Towards the end of the play, there is a little twist as Baba Tailor wakes up and one tries to figure out what happens at the end.

The play is written in Pidgin-English which has become the Lingua Franca amongst the uneducated and semi literate ones in the Nigeria society due to the multi- lingual nature of the country. The use of Pidgin-

English is apt to the play because most of the characters are illiterates in society. Even Sajent, a policeman, shows that he is not literate enough when he says " if not say book don spoil we country, I for don be ASP or DSP..."(46). For comic effect, Yerima spices the Pidgin spoken by the characters with the local flavour of Nigerian languages. An example can be seen in Baba Tailor's description of how Lasisi was beaten by Danger's boys. In his words, "Dem panel beat dat boy no be small"(25). A technique greatly used in the play is humour. In Yerima's use of humour, he captures and recreates the stereotype vices and foibles of Nigerians. He tries to create laughter through the use of extended language and the pre-fabricated roles of the characters. Acting in comic style, which is usually exaggerated, helps to add humour to a comedy. An example of the use of humour can be seen in the exposure of the greed of Nigerians and their trait of looking for quick avenues to get rich. An instance can be seen in this conversation:

> MAMA LIZI: Dis Tuba Cola people no go kill us. Every where wey person go na Tuba Cola. Dey wise well well for the thing.
> LIZI: See how people drink all the one wey we buy finish. People nodey even chop again. Once you ask wetin they want, one ponmo and Tuba Cola.
> MAMA LIZI:One man come here yesterday say he want one spoon of beans and two bottles of Tuba Cola (10).

Lizi's description of the church scene is also an example of wit and humour. It exposes the hypocrisy of some so-called Christians. According to Lizi:

> For Sunday wey I go church. Na him spirit carry one girl as we dey sing *"Me I no go suffer. I no go beg for food. God of miracle, Na my papa o. God of plentiful Na my papa o.* " As we begin sing, na him dis girl fall for ground. Her eyes white. One kind cold con dey for church. She begin call number. I think say na the lottery number. Even including the Pastor, we all think say na the lottery number. Everybody hold him Bible, open with pencil for hand, ready to write. Church just quiet. No body breathe. Pin self fit drop you go hear am. Then she come say the number finish, say who get the moto, make he be careful accident dey come (20).

The humorous effect of this story is heightened by the reactions of Landlord, Baba Tailor and Mama Lizi:

> LANDLORD:Nonsense!
> BABA TAILOR:Wetin na do am?
> LIZI: One prayer warrior just carry de whole bowl wey Holy Water dey troway for him body de spirit commot him body straight (20).

Yerima also makes use of local images, most of which have to do with Lagos, the spatial setting. Examples are "Agege bread"(a type of bread popular in the Agege area of Lagos); "Agbada (free flowing gown commonly associated with the Yoruba ethnic group in Nigeria); "Koboko" (horse-whip); "Bonga fish" (dried fish); "gbajue" (swindler); "akara" (bean cake); etc. These images give the play some kind of 'local colouring'.

There is the use of a lot of allusions in the play – both spatial and temporal. In the spatial allusions, one can comprehend that the setting is Lagos with the allusion to places like Ajegunle, Iponri bridge, Obalende, Ebute-Meta. The temporal allusion shows vividly that the actions in the play took place during the military era, especially between 1996 and 1998 when Brigadier Buba Marwa was the governor of Lagos State. Instances of such allusions can be seen in Mama Lizi's statement :

> The water clean well well. Since new Governor come everything done dey work for Lagos. Him and PTF just dey pach our jagajaga road. Dem don carry all our dirty wey full Lagos finish. Even dem Landlord don suffer for him hand. He don cut all dem longer throat. Na God go bless him

> Mama womb. And the man fine well well for him Soja uniform. Na proper action Governor, make he just no go tire (15).

Another one can be seen in the reference to 'Operation Sweep', the security outfit set up to combat crime in Lagos state when Brigadier Marwa was at the helm of affairs. This can be seen in Danger's statement that, "…gbajue. If not for operation sweep and de way wey I hear say dem kill de boys I for don join" (26). There is also the issue of killer beans which filled the rumour mill in Lagos during this period, hence Governor Marwa had to eat bean cake in public to restore the confidence of the people of the State in beans. Mama Lizi alludes to this when she says: "Oga sajent I don dey cook beans since Governor chop *akara* for television and he no die. I no poison am with beans "(45).

Yerima also alludes to the spate of ritual killing which is rampant in the country, especially Lagos, when Danger orders Mama Lizi thus:

> Mama Lizi, give me the ticket or I go cut your neck. Take your head do spare part for the person wey dey take person head do business (41).

This malaise is captured by Christopher Oji. He writes:

> Recent statistics indicate that no fewer than 60 persons were declared missing between last August and October. A breakdown of the figure shows that an average of 15 – 20 persons get missing in Lagos every month. According to the State Police Command, Ikeja, the number of missing persons has sky-rocketed . . . Most people are kidnapped in buses . . . which are notorious avenues of operation of ritualists. (Sunday Sun, February 4, 2007. p.30)

This wave of human sacrifice in Nigeria got to a head in August 2004. Nigerians were shocked to the marrow when many corpses were discovered in a shrine in Okija, a rustic town in Anambra State: This incident is described thus by Stan Okeke:

> In the beginning, Okija was just another rustic, agrarian town in Ihiala local government area of Anambra State . . . But in August 2004, a sudden storm burst in the town as the police invaded the grooves of the dreaded Ogwugwu Akpu and Ogwugwu Isi Ura shrines and exposed gory spectacles that can only match the type you see in Hammer House of Horror, a classic horror box office buster shown in the 1970's and 1980's. At virtually every nook and crany of the groove, police discovered corpses in different stages of decomposition, either lying in ant-infested coffins or funeral shrouds on hare top-soil . . . This discovery put Nigeria once again on the front burner and subsequent investigations were to open a can of worms. Few days later, Tafa Balogun, the then Inspector General of Police, IGP, stormed the shrine, again with his crack team from Abuja, and made more horrible discoveries. Investigations were ordered to determine if human sacrifices were being carried out in the shrines as rumoured . . . (*Sunday Sun,* March 4, 2007. p.33).

Despite the promise of an investigation into this gory discovery in Okija by the Federal Government, nothing has been heard of it since then. Rather, the shrine is now back in operation. According to Okeke, "While the Ogwugwu Usi Ura has suspended its activities, Ogwugwu Akpu still holds court" (*Sunday Sun,* March 4, 2007. p.33).

Another technique explored by Yerima is the use of innuendo to indirectly attack characters and the society. In his quest to say that the artificial life and high taste of the well-to-do is a major cause of

hypertension, Landlord says, “The wealthy man chop woman leg, wash am with odeku” (17). 'Chop woman leg' is a sexual innuendo while 'odeku' is a reference to a big bottle of Guiness Stout. Mama Lizi also makes use of sexual innuendo in assessing herself:

> MAMA LIZI: I say I no be old woman. See my chasis, see better for my body. Na only one pikin I born. I no be old woman you hear? (12).

Here, Mama Lizi is promoting her youthfulness and sexuality and that having a child does not rob her of this. This use of sexual innuendo by Yerima is to guard against what can be described as obscene words but their meaning is not lost on the audience or the reader. The use of humour in subtly passing a message is decribed thus by Olusegun (2015):

> *Awada* (*efe*) in the Nigerian context significantly serves as a veritable source of facts/truth in situations where it is difficult to speak the truth gravely. Very serious situations are rendered in a jocular manner in order to minimize frictions. For example, the socio-cultural awareness of truth-telling in joke situations is couched in the proverb; *idi awada ni ati' n mo otito* 'it is from jokes that we derive the facts/truth'.Through subtle reference, and the presuppositions among the participants, the *alawada* (the humourist) can aim a dig at the folly of anyone including those in authority. Though the mutual understanding of the referents and occasions may elicit laughter, the participants usually realize the truth in humorous situations for their own edification. (121)

Yerima also made use of a comic device known as incongruity, which is one of the characteristics of comedy, in the play. Adeyemi (2007: 194) describes incongruity as “the discrepancy between what is normally expected and what the writer gives his audience”. An example of this technique can be found in Baba Tailor's reversal of fortune from the poorest out of the characters, to the winner of the raffle. He is the last to get a lottery ticket as he cannot even afford ten naira to buy a bottle of Tuba Cola until Landlord assists him. While those who have more than one ticket did not win, Baba Tailor is declared the winner. The unexpected also happens at the end when Baba Tailor, who is presumed to have died, 'resurrects' to the consternation of the other characters as well as the audience.

Conclusion

This paper looks at how, in the development of drama from the Classical Period, poets (playwrights) have deplored the sub-genre of comedy. Ahmed Parker Yerima, a Nigerian playwright and critic, explores this sub-genre in *The Lottery Ticket.* The type of comedy Yerima used in this play is the 'New Comedy' popularised by Menander, which deals with aspects of daily life and a more realistic representation of human life; and the sub- strata called humour or *efe* or *awada*. The paper also examines how Yerima communicates *efe* in the play through techniques such as the use of Pidgin-English, use of local images, fast paced actions flowing into each other, allusion, innuendo, incongruity.

While entertaining in *The Lottery Ticket*, Yerima takes a swipe at the greedy nature of Nigerians and their inordinate desire to get rich at all cost. He also brings into focus some of the malaise in the Nigerian society such as thuggery, greed, hypocrisy, lack of trust, advanced fee fraud, corruption, armed robbery and bad leadership; which have turned Nigeria to a dystopian society.

References

Adeleke, D. (2005). Ethos of laughter among the Yoruba. *Ihafa: Journal of African Studies*, 5(2), 43-63.

Adeoti, G. (2007). *Muse and Mimesis; Critical Perspectives on Ahmed Yerima's Plays*. Spectrum Books.

Adeyemi, T. (2007). Yerima's comic dramaturgy in *The Lottery Ticket.* In G. Adeoti (Ed.) *Muse and*

mimesis: A critical perspective on Ahmed Yerima's drama. (pp.185 – 196) . Spectrum Books.

Daramola, I. (1997). *Mass communication: Theory and practice*. Alabi Eyo Publishers..

Emike, A.J. & Ayodabo, S..J. (2014). Communicative strategies in contemporary Nigerian drama: A stylistic analysis of Ahmed Yerima's *The Lottery Ticket.* In *Scholars Journal of Arts, Humanities and Social Sciences*, 2 (1), 32-36.

Folarin, B. (2002). *Theories of mass communication*: *An introductory text*. Stirling. Horden.

Haynes, J. (1994). Structural adjustment of Nigerian comedy: Baba Sala. *Passages 8,*

Julius-Adeoye, R. J. (2013). *The drama of Ahmed Yerima: Studies in Nigeria theatre*. (Unpublished Ph. D Thesis). Leiden University.

Little, P. (1983). *Communication in business*. Petler Book Ltd.

Menander-AncientGreece- Classical Literature. https://www.ancient.literature.com.

Palmer, J. (1994). *Taking humour seriously*. Routledge.

O'Connor, J. R. (1981). *Speech: Exploring communication*. Prentice-Hall.

Oji, C. (2007, February 4). Missing and counting. *The Sunday Sun*, 30.

Okeke, S. (2007, March 4). Okija bounces back. *The Sunday Sun*, 33.

Olusegun, A.E. (2015). The awada phenomenon: Exploring humour in Wole Soyinka's *Alapata Apata* . *European Journal of Humour Research*, 6 (4), 118-132.

Sarbaugh, L. E. (1987). *Intercultural communication.* New Brunswick Press.

Stephenson, W. (1988). *The play theory of mass communication*. University of Chicago Press (First published in 1967).

Osundare, N. (2008). Style *and literary communication in African prose fiction in English.* Hope Publication.

Yerima, A. (2002). *The lottery ticket*. Kraft Books …… (2003) *Fragmented Thoughts and Specifics: Essays in Dramatic Literature.* Lagos: Books Plus.

RUGIPO RESEARCH AND TECHNICAL JOURNAL

GLOBALIZATION OF ARCHITECTURE:THEORIZING A NEW AGENDA FOR NIGERIAN ARCHITECTURE

Authors

O. S. Ilesanmi[1], E. T. Ojo[1], I. E. Bankole[1],

A. Olanitori[2]andOlusegunOlaiya Kolade[3]

[1]Department of Architectural Technology, Rufus Giwa Polytechnic, Owo.

[2]Department of Surveying and Geo-informatics, Rufus Giwa Polytechnic, Owo.

[3]Department of Art and Industrial Design, Rufus Giwa Polytechnic, Owo.

Abstract:

This paper begins with a review of the opinions of some leading scholars about the positioning of Africa (and by implication, Nigeria) within "the new world order", globalization. The summary of these opinions is that Africa has not yet been advantageously positioned in globalization, even within its natural sphere, the continent of Africa. The paper further discusses the effect of globalization on architecture, a scenario that is described, by some, as the "globalization of architecture". Options have been discussed, on the theoretical basis, on the subject of projecting Nigerian Architecture, within the current scenarios of "globalization of architecture", firstly within Africa and also within "the new world order". The emphasis on a "theoretical agenda" is informed by the belief that, in the absence of a well-articulated and predetermined "theoretical agenda", it may be difficult to compete with other major role-players, who have already become better entrenched in globalization. The paper therefore recommends the formulation of a "theoretical agenda", which must cover all the major facets of Nigerian Architecture, namely: architecture faculties, works of Nigerian architects and practices, and also projecting the talents of younger architects.

Keywords: Agenda, Architecture, Globalization, New, Theoretical.

Introduction

This paper is an advocacy for a timely development of a new theoretical agenda to guide the teaching and practice of architecture in Nigeria in the face of an inevitable global phenomenon - globalization. Two concepts that are contained in this preliminary or introductory statement of the intent of this paper deserve further elucidation; they are advocacy and theory. The paper dwells only on the premise of advocacy because the subject-matter of positioning of Nigerian Architecture within the sphere of globalization is too vast to be covered in one article or to be addressed by only a few persons. It will demand collective efforts within the whole spectrum of Nigerian Architecture itself. The advocacy is for a theoretical agenda because the forces that propel globalization in the world today are sometimes so immense that wherever and whenever they are unleashed within a specific sphere, the principal actors within that specific sphere may find out that it is already too late to develop suitable theoretical agenda to meet the realities after they would have already ensued in practice.

Longworth has attempted to explain this specific scenario, with specific reference to the case of the "Asian Tigers" beginning from the late 20th century, in the article, "The New Global Economic Order". According to him, for as long as the funds (from globalization) were flowing into Asia, "the nations had no interest in adopting those safeguards". Although the safeguards mentioned above refer to financial and banking policies, the general interpretation that may be deduced is that nations may find it too late to develop safeguards (including safeguards in professional practice) once the funds begin to flow in from globalization. In his discussion on the peculiarity of the experience of the "Asian Tigers" (as compared to long-established Western capitalist nations) Longworth offered the following explanation: "…many Western nations learned that uncontrolled capitalism can destroy as surely as it builds. Over the years,

they put in place a web of rules and regulations to prevent excesses, enforce accountability, and ensure safety nets …" (Longworth, 2005). The relevance of all this to Nigerian Architecture may be explained in the following ways.

Architecture is about development, and development demands and attracts funds. One aspect of globalization involves the flow of funds and investments into nations, in a scenario in which "the control of national governments over economic activity" is seriously weakened (Longworth, 2005; Beinart, 2005; Mazrui, 2005). In this scenario of weakened "control of national governments" only the concerted efforts, appropriate interpretations of the evolving scenarios and timely interventions by the professional class can save the professionals themselves; and that is the premise of the theoretical agenda.

Globalization and Africa

According to the definition of globalization credited to British economist, Anthony Giddens, (from his work: 'The Third Way: The Renewal of Social Democracy'), "Globalization can be defined as the intensification of worldwide social relations which link distant realities in such a way that local happenings are shaped by events occurring many miles away and vice versa". It has further been described, by Longworth, as a "new global economic order". According to him, it is "a catchall term for many processes that are at the heart of the global economy". The operation of this new global scenario is described as one that "enables any entrepreneur to raise money anywhere in the world, and with that money, use technology, communications, management, and labour located anywhere the entrepreneur finds them, to produce goods and services" – the new "global corporation" (Longworth, 2005). Global trends that have led the world to globalization have been analyzed by scholars. Two of these trends, relate directly with the subject-matter of this paper:

- Global communications, which have been made possible by "technological breakthroughs such as the semiconductor and the communications satellite". Mazrui refers to this as a "new network of the information superhighway" (Longworth, 2005; Beinart, 2005; Mazrui, 2005).
- A new scenario that has affected the controls previously exercised by governments over economic activities within their domains. This has been described as "the wave of deregulation, which began in the late 1970s and weakened the control of national governments over economic activity". Beinart attributes this scenario to "the devotion to unregulated capitalism" (Longworth, 2005; Beinart, 2005; Mazrui, 2005).

The posture of Africa within this globalization scenario has been further analyzed by other scholars. On the issue of the weakening of government control over economic activities within its domain, Beinart further describes globalization as a global integration, which "diminishes government's freedom of action, forcing them towards neoliberal economic policies". He has observed that while the Cold War lasted the United States and the USSR continually extended aid to Africa for the purposes of furthering their respective ideological dogmas. According to him, the advent of globalization, which (in time) coincided with the collapse of communism in Eastern Europe, has created a new scenario in world affairs. His opinion is that "since the United States no longer sees Africa as part of a global struggle that threatens its security, the anticommunist rhetoric that used to elicit aid no longer exists". He further elucidates on the position of Africa within the age of globalization in the following words: "It is the devotion to unregulated capitalism, more than either democracy or strategic advantage, that determines the treatment of African countries in the age of globalization" (Beinart, 2005).

From Beinart's perspective, we see Africa (in the age of globalization) as a continent that must create its own means of survival (in the absence of substantial foreign aid) within a scenario of globalization, which is accompanied by the diminishing of the freedom of action of national governments. Africa's respected scholar, Mazrui, has in what he describes as the narrower sense defined globalization as "the maturation of global capitalism and its interdependencies, alongside a new network of the information superhighway". Elucidating further on Africa's posturing within the "age of globalization", he has

described a paradoxical scenario in which "the African people have been moving closer to the national center" (of political, business and economic affairs), "but at a time when the African governments have been losing their influence in world affairs". According to him, in the "age of globalization", the "African state has seemed to be moving deeper into the global periphery" (Mazrui, 2005). In general, Mazrui has summarized these scenarios with the following words: "Africa has been experiencing in the 1990s internal democratization and external marginalization at the same time. The African state has been receding into the shadows; the African people have been emerging into the national light". In short, as a result of her internal problems (mostly self-inflicted), that had spanned several decades since the era of national independence in Africa (i.e. throughout the second half of the 20th century), Africa is now saddled with the problem of belatedly charting its course into real democracy, while the rest of the world is securing positions in the "age of globalization". Mazrui has, however, also suggested that it may be the destiny of Nigeria and South Africa to chart Africa's preliminary course within the "age of globalization". According to him:

'

- When Nigeria does succeed in putting its house in order, and when South Africa consolidates its new system under majority rule without having to lean on the stature of Nelson Mandela, Africa as a whole will have two clear leaders on the world stage. Sometimes a continent needs some of its members to be "more equal than others" if leadership is to be sustained'.

"The African Condition in the Shadow of Globalization": Mazrui, 2005.

One point becomes very clear from these discourses: to view globalization only in the context of the new and immense opportunities offered by advances in communication technology is "to look at only one side of the coin". The impacts of globalization on local businesses are also very relevant; this includes the impacts of globalization on Nigerian Architecture as a local business (as defined by the ARCON Decree No 10 of 1969). The Wikipedia article on globalization has described a scenario in which globalization has so far resulted in the decline in local businesses and the rise of poverty in Sub-Saharan Africa, while it has, at the same time, resulted in the reduction of poverty in other sub-regions such as: Latin America; and East Asia and Pacific [Globalization. (2007, September 22).].

In his work, "Globalization and its Discontents", Stiglitz has argued that the "neoliberal assumptions" that form the fundamental bases of globalization are "fundamentally unsound". He has thus traced the low levels of development in Sub-Saharan Africa, in the "age of globalization" to the unsoundness of these "neoliberal assumptions" [Globalization and Its Discontents. (2007, September 16)]. Furthermore, in his work "Making Globalization Work". Stiglitz has observed that the "neoliberal assumptions" of globalization have affected the developing nations adversely, by depriving local businesses, commerce and industry, and also the poor in general, of access to credit [Making Globalization Work. (2007, September 18)].

Globalization of Architecture

The phrase, "globalization of architecture", appears in the article, "1991: Architecture" of the Collier's Year Book for the year 1991 (reproduced in **Microsoft ® Encarta ® Reference Library 2005**). In the said article, it is reported that "globalization of architecture continues to increase, as North American, European and Asian – mostly Japanese – architects increasingly took on major projects outside their home countries" (1991: Architecture. In **Microsoft ® Encarta ® Reference Library 2005.**). Although the very fact of architects taking on projects outside their countries may not be strange, the emphasis is on the increases in the trends in the current "age of globalization". It would appear that these noticeable increases must have warranted or justified the coinage of the phrase: "globalization of architecture".

The foregoing leads us to the point of attempting to examine the possible impacts of all the above scenarios on Nigerian Architecture, as we know it today. We proceed from the basic understanding that since the 19th century, architecture and the entire building industry have been involved in the business of

creating the environments for big businesses; and in the course of this, they have also evolved into very significant businesses in themselves. The definition of globalization (by Anthony Giddens), applied to Nigerian Architecture, appears to suggest that, in the "age of globalization", there is the possibility that issues pertaining to Nigerian Architecture and substantial aspects of building developments and construction in Nigeria, may be "shaped by events occurring many miles away". Consequently, a few preliminary questions instantly arise pertaining to the posturing of Nigerian Architecture within the "age of globalization", namely:

- Is the Nigerian government or political structure going to be willing or capable to stand by the prescriptions of the ARCON Act No. 10 of1969 (and amendments) and protect Nigerian Architecture in the face of a globalization scenario in which an entrepreneur from a "global corporation" in planning to invest huge funds in a business venture (that involves substantial architectural inputs) in Nigeria?
- Is there a possibility that a Nigeria business concern that is operating in partnership with a "global corporation" will prefer to exploit the weakened "control of national governments over economic activity" and conduct architectural and construction business, to the total disregard of the provisions of the ARCON Act No. 10 of 1969?
- Is there a chance that the weakening of "control of national governments over economic activity" could also result in the weakening of the applicability of the ARCON Act No. 10 of 1969 within the "age of globalization" in Nigeria? ARCON Act No. 10 of 1969 is a government act or regulation that is supposed to operate in a scenario in which the "control of national governments over economic activity" is being weakened in the "age of globalization".
- Is there a possibility that scenarios, such as these, are already unfolding in Nigeria? If so, then the case of a new theoretical agenda deserves utmost urgency.

The questions above apply to the entire building industry in Nigeria, but it may the duty of Nigerian Architecture to take the lead. They are, however, issues that may place Nigerian Architecture (and certainly the entire professional class in the Nigerian building industry) in contention with three very powerful blocks, namely: the Nigerian political class, the Nigerian business class and the "global corporation".

When the position of Mazrui is interpreted in the context of Nigerian Architecture, it would appear that it is the expectation of some African scholars and perhaps other valuable opinions that when Nigeria puts "its house in order" it will begin to take a leadership role in the conduct of African business within the "age of globalization". The fulfillment of such roles, which has now begun to be expectations of respected African opinions (Mazrui, for example), will not be a product of "chance encounters by individual Nigerian architects"; it establishes the premise for the advocacy for a "theoretical new agenda" to meet the demands of an equally new era – the "age of globalization".

Theorizing a New Agenda

In discussing the issue of theorizing a new agenda for Nigerian Architecture, we are certainly not going to deal with solutions but posers, which hopefully, may lead to answers, in the end. These posers refer to two principal aspects of Nigerian Architecture, namely: the situation of the Nigerian architectural student, scholar or researcher in the "age of globalization", on the one hand, and the situation of Nigerian architectural practice in the "age of globalization", on the other hand.

Internet Studio and Nigerian Architecture: In the "age of globalization", the internet-studio has become an indispensable tool in diverse aspects of architectural studies and research. Persons who are engaged in the study of architecture (architectural theory and history, architectural design, urban planning, modern building and constructional systems and techniques etc), in the absence of internet-studios, are already clearly disadvantaged.

One must praise the ingenuity of the current Nigerian architectural students, who continually spend their

money in internet-cafes, to make up for the deficiencies encountered in some Nigerian architectural faculties that lack internet-studio facilities. However, such "unguided self-help efforts" (of students at public internet-cafes) do not totally make up for formal instructions of students in the internet-studio. The suggestion being made here is that the time has come, when the collective body of Nigerian Architecture should make the internet-studio a pre-requisite for accreditation at every level of formal architectural education. The internet-studio, as it is presently constituted, gives cause for some sorts of sober reflections, on the part of the Nigerian (or African) architectural student, researcher or scholar.

There are, presently, hardly any web-sites that present contemporary architectural works (of Nigeria or Africa). For example, one of the leading architectural web-sites (GreatBuildings.com) has currently (in September, 2007) about 32 entries on Africa, out of a total of more than 5,500 entries around the world; predictably, nearly 50 percent of these entries refer to Ancient Egypt. At the moment, there is no entry labeled directly as pertaining to Nigeria, but one of the entries is exceptionally curious. It is: "Ibibio Village"; location – Cameron; style – African vernacular architecture. There is probably something wrong with that entry, but it portrays the dangers of passive participation in the "age of globalization" propelled by what Mazrui has described as the "new network of the information superhighway".

On the whole, under the present positioning of Nigeria and Africa in the era of communication technology and the age of globalization, a Nigerian architectural student, scholar or researcher (studying or researching on a subject that pertains more to architecture in Nigeria or Africa) is likely going to have more materials and references to cite from abroad than from Nigeria or Africa (the study-area). This is a disservice to Nigerian architecture; it establishes the need for the establishment of the authentic identity of contemporary Nigerian (and also contemporary Africa) Architecture within the premise of the communication technology (internet) of the "age of globalization". Presently a "wide gap in internet" waiting to be filled by a web-site on contemporary Nigerian (and African) Architecture.

Our curricula for architectural education will also be affected by these developments. For example, the curriculum for photography will have to be reviewed in order to give our students adequate exposure in the current techniques in digital photography and the associated computer software for photography.

Nigerian Architecture - Awards, Competitions and Reviews: In the "age of globalization" we will be confronted with the problems of creating the means of projecting Nigerian Architecture and Nigerian architects. Projecting Nigerian Architecture, in the present era, will require websites in internet (as has already been discussed). It will involve the coverage of at least three aspects of Nigerian Architecture, namely:

- Projecting the works of already established and mature Nigerian architects.
- Projecting the talents of young Nigerian architects.
- Projecting the Nigerian faculties of architecture.

Firstly, we must examine the constraints. The environment of architectural practice is one in which self-advertisements of the architect and his/her works are abhorred. We also practice in an industrially handicapped environment. In the industrialized world, manufactures of diverse building components and materials are usually anxious to advertise, on their web-sites, architectural works in which their products have been applied. In doing so, they end up also projecting the architectural works and also the architects. The Nigerian architect is unable, at the present state of our nation's industrialization, to benefit from this aspect of projection.

Awards of Distinctions: Awards of distinctions have proven to constitute a very useful medium of projecting architects. It may be earned in two principal ways, namely: through professional reviews of works of architecture, and also through participation in competitions. With the Nigerian Institute of Architects poised to celebrate its golden jubilee in the next three years, we already have a body of professional Nigerian architects capable of assessing completed works of architecture and also outstanding competition entries for awards of distinctions.

Competitions: Competitions have often also provided the means for projecting architects and architecture into limelight. The principal essence of the competition is not the cash prize; it is by far more fulfilling to reward leading competition entries by awards of distinctions than by cash prizes. It would probably be incorrect to generalize that all architects, who so far excelled in international competitions, have always had records of awards of distinctions from their respective places of practice. However, most of the architects, who have often been invited to participate in limited international competitions, have often had some records of awards of distinctions from their permanent places of practice. The Nigerian architect, who enters international competitions, without awards of distinctions earned in his/her seat of professional practice, may be doing so from the point of disadvantage. It will certainly be to the greater advantage of Nigerian Architecture to institute diverse awards of distinctions that may be won through national competitions or through reviews of completed works.

Experimental Projects: The experience from other lands shows that competitions may be established on the basis of real projects or on the basis of experimental projects. In some countries (for instance, the former USSR), experimental projects have sometimes been used as a method of developing the architectural parameters for the resolution of emerging sociological problems before such issues become topical in the political consciousness of the nation. A foremost example of such use of experimental projects (in the former USSR) was in the development of facilities for tourism.
USSR relied extensively on the concept of experimental projects for the development of its parameters for the architecture for resort development (in the 1970s and 1980s), at a time when there was a general lack of scholarly materials on this aspect of architecture. The results have been a phenomenal success, leading to advancements in resort developments on the Black Sea coasts of Russia, Abkhazia, and Ukraine etc.

One instance, that would probably demand experimental projects in Nigeria, is the Universal Basic Education (UBE), which has become one of the topical sociological issues, since the rise of democracy in Nigeria. This has involved the transformation of primary schools to meet the requirements of the UBE programme, but what we have observed, in practice, has been the addition (sometimes purely at random) of some new classroom blocks to existing schools, often with little or no attention being paid to layout planning. The following questions do arise:

- Is the architecture of the UBE supposed to be as simplistic as that?
- Is layout planning not relevant in the UBE scheme?
- Would it not be to the greater benefit of Nigerian Architecture to develop the architectural parameters of the UBE scheme (by experimental projects) involving young Nigerian architects in national competitions?

Such national architectural competitions, based on experimental projects are rewarded through various categories of awards of distinctions, would create avenues for the recognition, elevation and exposure of the talents of young Nigerian architects, in a depressed economy where architectural commissions have been very scanty for a couple of decades now.

The application of the concept of experimental projects towards the development of architectural parameters for the resolution of emerging sociological issues is not, by any means, unfamiliar particularly since the advent of modernism in architecture. Traces of this trend are recognizable in the following scenarios:

- Metabolism, the Japanese movement in modern architecture that was led in the 1960s by KenzoTange and later by Fumiko Maki.
- Archigram, which emerged in England also about the same time (in the 1960s) and was led by Peter Cook, Ron Herron and others.
- The visions of the ideal city plan and the “city of tomorrow” proposed by Le Corbusier's (the Swiss-born French architect Charles Jeanneret).
- The *Futurist Manifesto* of 1914, proposed by Italian architect Antonio Sant'Elia, towards a

modern architecture that is characterized by glass, steel and concrete etc. (Ghirardo, 2005).

Nigerian Architectural Faculties: Projecting the Nigerian faculties of architecture is also a matter that demands significant and urgent attention. We may begin at the point that over several decades now, research works at master's degree, PhD and post-doctoral levels have been proceeding at the Nigerian faculties of architecture. It may be preposterous to presume that the political body of Nigeria will reach out to the libraries of these faculties to assemble useful information for nation building. The first step is probably for Nigerian Architecture to establish a central medium for assembling and categorizing such research works, and granting awards of distinctions for outstanding research works. Assembling and categorizing research works in a central medium provides the following advantages:

- Firstly, it provides a good resource pool for future research activities.
- Secondly, it provides a central resource data bank for the national political body, in the circumstances that the nation may wish to apply such research efforts towards nation building.
- Thirdly, it projects outstanding research works and their authors, and also the works of Nigerian architecture cited, nationally and internationally.

Such resource pools of local research works (probably published or listed on our web-site) will have two principal effects, namely:

- Appropriate projections of local research activities could lead to international co-operations, and eventually the uplift of the international statures of the Nigerian architectural faculties themselves.
- Projection of Nigerian architectural works that have been reviewed in such research activities.

Reviews and Listing of Notable Nigerian Architectural Works: Finally, another reliable method of projecting contemporary works of Nigeria Architecture and also Nigerian architects (the authors of such works) will be through reviews published on web-sites. It must first be observed that reviews, conducted by the authors of the works themselves, fall far short of the international standards or criteria for reviews. This will require a collaboration between two principal arms of Nigerian Architecture, namely: Nigerian architects in practice; and Nigerian architects in the academia. To foster this objective, it will become necessary for Nigerian architects in practice to open up opportunities for Nigerian Architects in the academia to spend their sabbatical leaves or their research vacations in their respective practices. Needless to say that there are already many outstanding works of contemporary Nigeria Architecture that have not yet been probably projected to international limelight, because their reviews have not yet been published (in the “age of globalization”, that certainly means on internet). Listing of notable Nigerian architectural works may not have to be confined to contemporary architectural works only. Other architectural works that have significant relevance with the history of Nigeria as a nation, and also with various aspects of the cultures of the people of Nigeria in general, may also deserve to be listed.

Conclusion

In this paper, the subject of theorizing a new agenda for the projection of Nigerian Architecture in its totality (the mature architects and their practices, the talents of young Nigeria architects, Nigerian architectural faculties etc.) within the “age of globalization” has been discussed. The conclusion is that it may be difficult to project Nigerian Architecture within the “age of globalization”, without a website that has been collectively created, by Nigerian architecture, for the purpose. Some websites have been listed for reference, namely: about.architecture.com, GreatBuildings.com, www.archipedia.org, www.architecture.com (the web-site of the Royal Institute of British Architects - RIBA). In establishing a website for Nigerian Architecture, the strategy adopted in the case of about.architecture.com and GreatBuildings.com may have to be explored. The web-sites about.architecture.com and GreatBuildings.com are a web-sites sponsored and hosted by the New York Times Company (of USA).

In Nigeria today, we have a good number of newspapers published daily on the internet. Perhaps, if we take a cue from this, we could work out collaborations with some newspaper houses in Nigeria towards the hosting of a special website for Nigerian Architecture (probably, Nigerian Architecture.com).

In pursuit of these objectives, we will create immense opportunities for interactions between Nigerian architects in the academia, and other Nigerian architects in practice, to the greater glory of Nigerian Architecture.

References

Architects' Registration Council (ARCON) Act No 10 of 1969. Federal Government of Nigeria.

Beinart, P., 2005. Globalization and Africa: An Interpretation. In Microsoft ® Encarta ® Reference Library 2005. © 1993-2004 Microsoft Corporation. All rights reserved

Ghirardo, D. (2005). "Modern Architecture". Microsoft Encarta Reference Library 2005". © 1993-2004 Microsoft Corporation.

Globalization. (2007, September 22). In *Wikipedia, The Free Encyclopedia*. Retrieved 16:01, September22,2007,fromhttp://en.wikipedia.org/w/index.php?title=Globalization&oldid=159556237.

Globalization and Its Discontents. (2007, September 16). In *Wikipedia, The Free Encyclopedia*. Retrieved 15:47, September 22, 2007, from http://en.wikipedia.org/w/index.php?title=Globalization_and_Its_Discontents&oldid=158319312.

Longworth, R. C.(2005). The New Global Economic Order. In Microsoft ® Encarta ® Reference Library 2005. © 1993-2004 Microsoft Corporation.

Making Globalization Work. (2007). In *Wikipedia, The Free Encyclopedia*. Retrieved16:16,September22,2007,fromhttp://en.wikipedia.org/w/index.php?title=Making_Globalization_Work&oldid=158809433.

Mazrui, A. A.(2005). The African Condition in the Shadow of Globalization. In All rights reservedMicrosoft ® Encarta ® Reference Library 2005. © 1993-2004 Microsoft Corporation.

Tabb, W. K.(2005). Globalization. In Microsoft ® Encarta ® Reference Library 2005.© 1993-2004 Microsoft Corporation.

1991: Architecture. In Microsoft ® Encarta ® Reference Library 2005. © 1993-2004 Microsoft Corporation.

Electronic Resources

GreatBuildings.com

www.archipedia.org

about.architecture.com (about.com:architecture)

www.architecture.com (The web-site of the Royal Institute of British Architects - RIBA)

Further Reading

Stiglitz, J. E.(2002). Globalization and Its Discontents. W. W. Norton & Company, New York, USA. ISBN 0-393-32439-7.

Stiglitz, J. E.(2006). Making Globalization Work. W. W. Norton & Company, New York, USA. ISBN 0-393-06122-1.

RUGIPO RESEARCH AND TECHNICAL JOURNAL

YARDSTICKS FOR EFFECTIVE MAINTENANCE OF PUBLIC BUILDINGS IN NIGERIA: A CASE STUDY OF ONDO STATE

Authors

Ogunbode, B. A.,[1*] Ayodele, E. O.,[2] Olofinsawe, M. A.,[3] Olowolayemo, O. E.,[4] and Obanoyen, A. S.[5]

[1, 2, 3,4&5] Department of Quantity Surveying, Faculty of Environmental Studies, Rufus Giwa Polytechnic, Owo, Ondo State Nigeria.

[1]*Corresponding Author E-mail: bensonogunbode@gmail.com.*

Abstract:

Building maintenance has until recently been a neglected issue in most of our government policy formulation and execution. The sustainability of such maintenance demands serious attention. However, the study is aimed at developing yardsticks for effective maintenance of public buildings in Nigeria, with due consideration given to identifying noticeable defects and causes associated with public buildings. The study was carried out in selected public buildings of the three Senatorial Areas of Ondo State, wish are Post Offices, Libraries and Schools.In achieving the aim of the study, seventy-eight (78) retrieved questionnaires were analyzed using Relative Significance Index (RSI). The findings showed that users attitude to staining of paintwork at wall surfaces, peeling of plastered/rendered surfaces; leakages of waste/water pipes causing dampness: amongst other were the types of defects in the building facilities, while it was equally revealed that care free attitude of the users/occupants of the buildings, use of inferior materials, lack of regular check-up of the building for early detective for effective maintenance, Poor workmanship due to lack of control and proper monitoring, availability of fund to quickly effect remedy when the need arises were among major causes of the defects in the building facilities. The paper, therefore, recommends that there should be awareness for users/occupants in the usage of the buildings, regular check-up of the building for early detective and prompt response to provision of fund for maintenance work, early engagement of professionals, strict compliance to specifications and good workmanship to enhancing effective maintenance of the buildings.

Keywords: Buildings, Public Buildings, Maintenance, Yardsticks for Maintenance, Ondo State.

Introduction

Building maintenance is an important programme for the sustainability of infrastructural development (Baba &Buba, 2013). While Adenuga (1996) observed maintenance as an issue that is concerned with the planning and control of contribution resource to ensure that necessary repair and renewal are carried out with maximum efficiency and economy, Eti et al. (2006) &Ajibola (2009) submitted that maintenance is the work that is done regularly to keep a building in good conditions, and as near as possible in their original state. According to Igiri (2003), buildings are crucially to man existence and survival. It plays an important role in the actualization of the goals and objectives by satisfying the physical and emotional needs of the occupiers and users (Zulkarnain*et al.,* 2011, Asabiaka, 2008). According to Ogunmakinwa, Akinola&Siyanbola,(2013), maintenance of building received little attention from the users, designers and contractors. The users do not always make use of the property and the services in good condition. Often, users do not obey the information contained in the maintenance manual of the building if at all it exists. Most property owners sometimes

endeavour to keep maintenance expenditure to the least, eliminating the consequences of the long-term effect of such action.

The condition in most of the publicbuildings in Ondo state consequently reveals a pathetic picture of neglect, deterioration, decay, dilapidation and threatening collapse (Ogundipe, 2005). Corroborating this, Adenuga, Odusanmi&Faremi, (2007), opined that, culture generally in public sector in Nigeria suffered from lack of funds for a considerable time. In Adenuga and Iyagba (2003) as mentioned by Adenuga, Odusanmi&Faremi (2007), it is impossible to produce buildings which are maintenance free, but maintenance work can be minimized by good design and proper workmanship carried out by skilled experts or competent craftsmen using suitable codes of installation, requisite building materials and methods. Therefore as the components of a building begins to deteriorate, it becomes necessary to take measures to ensure that the desired characteristics of that facility, which provides safety and convenience are retained. Thus, their production is accorded huge financial budget. All these reveal the need for a critical look at our building maintenance culture in our national life (Akingbohungbe, 2000).

What is Public Building?

Public buildings are any type of building that is accessible to the public and is founded from public sources. All types of governmental offices are considered public buildings. Examples are: post offices, libraries, courthouses and public schools. (VanBaren, 2017, Designing Buildings, 2017). While Designing Buildings (2017) opined that only those public schools that are also used for daily community functions are regarded as public schools. VanBaren, (2017) was of the opinion that any school that is funded through governmentare regarded as public school.

MATERIALS AND METHODOLOGY

Overview of Maintenance Culture in Nigeria

Most public and private buildings in Nigeria are faced with maintenance challenges resulting in deteriorations and ultimate defects of various degrees (**nairaproject.com, Online 2017; Mbamali 2003;**Olanrewaju&Anifowose, 2015). Maintenance according to BS 3811 (1984) is the combination of all technical and associated actions intended to retain an item or restore it to a state in which it can perform its required function.

It is a well-known fact that the primary objective of building maintenance is to preserve buildings in their initial functional, structural and aesthetic states (Adejimi, 2005). This is to ensure that such facility continues to remain in such state and retain their investment value over a long period of existence, and provide safe and conducive environment for the performance of various human activities (Baba &Buba 2014). Yet, Mbamali (2003) opined that poor maintenance culture has become a widely recognized problem in Nigeria which has poorly affected the quality of public properties. Corroborating this, Nairaproject (Online, 2017) said that maintenance culture in Nigeria is one of the lowest around the world, especially, in our principal towns and cities where the majority of public properties are located.

Moreover,Akingbonhungbe (2000) said that maintenance attitude remain low at individual and government level. Maintenance culture in Nigeria is one of the lowest around the world, especially, in our principal towns and cities where the majority of public properties are located. The physical buildings (except new one and a few others) wear blistering and fade look with many door key window screen (glasses) already disused.

What is Maintenance Culture?

The Oxford Advanced Learner's Dictionary (2005) in this context defined maintenance as the act of keeping something in good condition by checking or repairing it regularly. While BS 3811(1984) defined maintenance as the combination of all technical and associated administrative actions intended to retain an item in or restore it to a state in which it can perform its required function, BS 3811 (1974) defined building maintenance as work done to keep a building in, or restore it to its initial state, or to a currently acceptable standard. To retain implies that defects are prevented from developing by carrying out work in anticipation of failure, and to restore means that minor defects had already occurred before they are corrected; in order for an item or facility to continue to perform its required function, some degrees of improvement are needed over the life span of the building as standards of comfort and amenity arise where there are statutory requirements for maintenance (Olanrewaju and Anifowose, 2015). Whereas, Olagunju (2012) opined that maintenance of buildings therefore needs cure so as to enhance durability, improve quality of life, protection of human health and the environment.

Ahmed (2000) and Odediran et al. (2012) were of the opinion that maintenance program in Nigeria has not received much attention in the past as the emphasis is on the development of new properties. This is also in line with the statement of Kunya et al.(2007) who observed that there is an apparent lack of maintenance culture in Nigeria, and that emphasis is placed on the construction of new buildings for public sector and neglecting the aspect of maintenance which commences immediately the builder leaves the site. Zubairu (1998) stated that the country does not have a maintenance policy which resulted in the persistent problems of building maintenance. Execution for maintenance work is mostly left for the maintenance department to handle on direct labour basis or contract. Jobs of higher amounts, according to Kunya et al. (2007), are given out in form of maintenance contracts to mostly unqualified maintenance contractors.

Types of Maintenance in Building

Maintenance, according to BS 3811 (1984), is subdivided into planned and unplanned maintenance. While planned maintenance is subdivided into preventive maintenance, corrective maintenance, predictable maintenance and schedule maintenance. Unplanned maintenance also, is subdivided into unpredictable maintenance, avoidable maintenance and emergency maintenance.

Purpose of Maintenance Culture

Ajibola (2009) was of the opinion that we must imbibe maintenance culture in order to enjoy the best value for our money, for us to enjoy the best of life, for how well we use and enjoy our buildings, household equipment, furniture etc, dependent on how well we have imbibed the culture of maintenance. The purpose of carrying out maintenance work on buildings according to Adejimi (2005), is to preserve the building in its initial state as far as practicable in order to effectively serveits desired purpose.

Al-Zabaidi (1997) identified some of the main purposes of maintaining building as follows:
i. To preserve a building in its initial state as long as practicable so that it serve effectively the purpose for which it is built.
ii. To maintain an acceptable quality standard in term of structural stability to meet the current taste and demand.
iii. To attract higher rental value whenever such buildings are to be placed on commercial use.
iv. To assist in the minimization of production cost
v. To keep down time and maintenance costs themselves to a minimum.
vi. To maintain and retain aesthetic value
vii. To improve the general condition of such buildings.
viii. It must also be stressed that in as much as it is hardly feasible to produce building that are maintenance free, the amount of necessary building maintenance work could still be kept to a minimum through improved method of design, specification and construction as well as feedback of maintenance data to the designer (Akingbohungbe, 2002).

The Need for Maintenance in Building

Previous studies revealed the effects of numerous factors affecting building for necessary maintenance. Assaf (1996) opined that design and construction faults that affect maintenance of buildings are defects in structural design, defects in architectural design, defects due to consultants firm's administration and staff, defects due to construction drawings, defects due to construction inspections, defects due to construction, defects due to contractual administration, defects of construction materials, defects due to construction equipment, defects arising from specifications and design defects in maintenance practicability and adequacy.

Adejimi (2005) asserted that to a large extent, building maintenance problems can be attributed to problems originating from poor design. Adejimi (2005) in his study identified twelve relevant factors affecting the maintenance strength of buildings as design resolution, structural strength, specified material strength, maintenance manual, safety measures, skill maintenance personnel, maintenance plants, environmental factors, usage factors, quality control factors and post construction prevention strength. Kiong and Akasah (2012) analyzed the maintenance factors for IBS precast structural system in Malaysia in order to produce a better quality of the IBS precast building. They identify design aspect as an important factor of the building quality.

Zulkarnain et al.(2011) reviewed the critical success factor in building maintenance management practice for University sector under four perspectives; customer (customer satisfaction, service quality, customer complaint, reaction to customer needs), internal processes (service excellence, technology capability, customer employee, competence, process efficiency, e.t.c.), financial perspective (management expectations, financial growth, cost reduction, productivity improvement, e.t.c.) and learning and growth perspective (technology leadership, continuous service improvement, upgrading staff competence, e.t.c.). They concluded that critical success factors can help in providing a successful competitive performance for the university sector in the area of maintenance management. Olagunju (2012) identified factors that influence the level of maintenance of building standard. In the study, eight factors were identified to be significant to physical condition of building in Niger State, Nigeria. The variables are structural components condition, roof components, toilet facilities, discharge of waste water component, exterior wall condition, condition of walkway within the building premises, electrical wire and switches conditions, interior walls surface condition.

The Study Area

The Study was carried out in three senatorial areas of Ondo State. That is The Southern, The Central and The Northern Senatorial Areas of Ondo State.Ondo State was carved out of the old Western State as one of the seven states created on February 3, 1976 (Ondo State, 2010 and myondostate.com, online, 2015). The State is dominated by Yorubas who speak various dialects in the Yoruba language. Education is accorded higher priority by the state government with the state reputed as the education factory of Nigeria as a result of emphasis in the sector over the years with more than 2,000 Public buildings, ranging from primary, secondary, technical schools and tertiary institutions; some, which are owned by the federal government, some by the state government and the rest by private corporations/individuals. Other public institutions arehospitals, event centers, markets buildings, government offices, post offices, libraries, etc.

Research aim and objectives

The aim of the study is to determineyardsticks for theeffective maintenance of public buildings in Ondo State with a view to proffering solutionsfor effective maintenance of public buildings. The objectives are:

(1) To assess thenoticeable defects associated with public buildings in Ondo State.
(2) To assess major causes of defects associated with public buildings in Ondo State.
(3) To determine yardsticks for the effective maintenance of public buildings in Ondo State

Methodology

In an attempt to achieve these objectives, data were obtained from both primary and secondary sources. Primary data were collected through the administration of a well-structured questionnaires administered to organization heads, technical staff of public buildings,users of the public buildings andpofessionals in the building industry as well as oral interview. Seventy eight (78) questionnaires were returned out of the

one hundred (100) administered. Secondary data comprised information which was derived from textbook, paper presentation, journal and information from the internet which were relevant to the study. The method adopted for this are the major tools used to validate the project research question. The study areas are the three senatorial areas of Ondo State. The research adopted both quantitative and qualitative frame work with a case study design approach adopted to identify the concept yardsticks for effective maintenancewith particular reference to some selected public buildingsin Ondo State. They are: Post Offices; Libraries and Schools.

The Likert scale involving rating on interval scale of 5 and 1 developed for application in social sciences and management researches for quantification of qualitative variables was used. "Extremely Important" (EI) were scored 5, "Very Important" (VI) were scored 4, "Somewhat Important" (SI) were scored 3, "Not very Important" (NVI) were scored 2 and "Not Important" (NI) were scored 1. Bakhary (2005), Olanrewaju and Anifowose (2015) gave an equation that could be useful for determining the:

Relative Significance Index (RSI) in prevalence data as:

$$\mathbf{RSI} = \frac{\sum \mu}{AN}$$

Where μ is the weighting given to each factor by respondents;
A is the highest weight (i.e. 5 in this case);
N is the total number of respondents

But for this type of research work where a 5-point scale was used, the RSI shall be calculated via the equation:

$$\mathbf{RSI} = \frac{5a + 4b + 3c + 2d + 1e}{jN} \qquad (0 < \text{index} < 1)$$

And

$$\mathbf{TWV} = \sum (5a + 4b + 3c + 2d + 1e)$$

Where: a = number of respondents "extremely important and perfectly known",
b = number of respondents "very important and partially known"
c = number of respondents "somewhat important and known"
d = number of respondents "not very important and partially unknown"
e = number of respondents "not important and perfectly unknown"
N = sample size, i.e. total number of respondents = 78
j = number of response categories = 5

2. RESULT AND DISCUSSIOON.

The data were presented using tables for clarification and better interpretation. The analysis tools included both descriptive and inferential statistics.

Table 1: Type of Respondents in order of its frequency

S/N	Respondents	Frequency	%
1	Users of the Public Buildings	30	38.46
2	Professionals in the Building industry	23	29.49
3	Technical Staff of Public Buildings	15	19.23
4	Maintenance organization Head	10	12.82
	Total	**78**	**100.00**

Table 2: Types ofPublic Building Surveyed in the three Senatorial Areas of Ondo State.

S/N	Respondents	Frequency	%
1	Post Offices	19	43.18
2	Libraries	15	34.09
3	Schools (Post Secondary Institutions)	10	22.73
	Total	**44**	**100.00**

Table 3: Number of the type of Public Buildings Surveyed from the three Senatorial Areas of Ondo State. (A= Number of building; B= Percentage; C= Rank).

S/N		POST OFFICES			LIBRARIES			SCHOOLS		
		A	B	C	A	B	C	A	B	C
1	SOUTHERN SENATORIAL AREA	5	26.32	3rd	4	26.67	3rd	2	20.00	3rd
2	CENTRAL SENATORIAL AREA	7	36.84	1st	6	40.00	1st	4	40.00	1st
3	NORTHERN SENATORIAL AREA	7	36.84	1st	5	33.33	2nd	4	40.00	1st
	Total	**19**	**100.00**		**15**	**100.00**		**10**	**100.00**	

Table 1 shows the type of respondents in the order of its frequency. It shows that the highest number of respondents, 38 (38.46%),are users/occupants of the public buildings. The second with 25 (29.49%) are professionals in the building industry, followed by Technical Staff of Public Buildings with 15 (19.23%), and the last with 10 (10.82) are the maintenance organization heads.

Table 2 shows the types of building surveyed in the three Senatorial Areas of Ondo State. 19 (43.18%) are respondents' on Post Offices, 15 (34.09%) are respondents' on Libraries and the remaining 10 (22.73%) are respondents' on School Buildings.

Table 3 shows the type of public buildings surveyed from the three senatorial areas of Ondo State.From the Southern Senatorial Area, 26.32% are Post Offices; 26.67% are libraries while 20.00% are school buildings. From the Central Senatorial Area, 36.84% are Post Offices; 40.00% are libraries while 40.00% are school buildings. And from the Northern Senatorial Area, 36.84% are Post Offices; 33.33% are libraries while 40.00% are school buildings.

Table 4: Respondents' Ranking of Noticeable Defects Associated with Public Buildings in in the Studied Areasof Ondo State

Noticeable Defects	1	2	3	4	5	Total	TWV	RSI	Rank
Staining/Peeling of paintwork at wall surface	0	0	5	30	43	78	350	0.897	1st
Peeling of plastered/rendered surfaces.	0	2	8	29	39	78	339	0.869	2nd
Leakages of waste/water pipes causing dampness.	2	2	16	26	32	78	318	0.815	3rd
Doors/Window defects – broken blades/glass, damaged/stiff louvre carrier, decay in door/window frames, etc.	4	8	11	25	30	78	292	0.749	4th
Crack in the wall	6	10	34	16	12	78	252	0.646	5th
Leaking Roof	13	14	15	15	21	78	220	0.564	6th
Sagging of carcassing members	18	20	20	10	10	78	208	0.533	7th
Blockages of sanitary/water pipes	22	27	10	9	10	78	192	0.492	8th
Weak foundation/foundation failure	29	28	10	5	6	78	165	0.423	9th

Table 5: Respondents' Ranking of Major Causes of Defects Associated with Public Buildings in the Studied Areasof Ondo State

Identified Major Causes	1	2	3	4	5	Total	TWV	RSI	Rank
Care free attitude of the users/occupants of the buildings.	7	16	12	18	25	78	278	0.713	1st
Use of inferior materials	8	20	10	22	18	78	256	0.656	2nd
Lack of regular check-up of the building for early detective for maintenance	10	22	15	16	15	78	235	0.603	3rd
Poor workmanship due to lack of control and proper monitoring	13	25	20	8	12	78	215	0.551	4th
Insufficient fund to quickly effect remedy when the need arises	15	25	15	12	10	78	208	0.533	5th
Slow responsiveness of the authority to request of remedy of any affected area	22	20	18	10	8	78	196	0.503	6th
Non compliance with specifications as contained in the designed documents and the bill of quantities	22	24	18	8	6	78	186	0.477	7th
Non consultation with/involvement of qualified professionals	23	23	20	6	6	78	183	0.469	8th

Table 6: Respondents' Ranking of Yardsticks for Effective Maintenance of PublicBuildings in Ondo State.

Identified Yardsticks	1	2	3	4	5	Total	TWV	RSI	Rank
Awareness for users/occupants towards strict compliance to enhance effective maintenance culture of the buildings	8	12	19	20	30	78	317	0.813	1st
Periodic/regular check-up of the building for early detective for maintenance work	9	10	16	18	25	78	274	0.703	2nd
Prompt response to provision of fund for maintenance work to effect remedy when the need arises	8	15	15	16	20	78	256	0.656	3rd
Involvement of professionals from inception to completion and at every stage of maintenance for the use of standard materials and for proper management of the building facilities	16	16	16	12	18	78	234	0.600	4th
Strict compliance to specifications as contained in the design documents, Bill of Quantities and construction documentations in the usage of approved materials	20	18	16	10	14	78	210	0.539	5th
Quick response of the department concerns to request of remedy when the need arises	25	24	10	8	10	78	185	0.474	6th
Optimization of design process to enhance good workmanship, labour, equipment and plant to									

Table 4 shows the relative significance index (RSI) of the type of the defects of building facilities in the study areas.The first ranked defect with RSI value of 0.897 is the Staining/Peeling of paintwork at wall surface, as was corroborated by the respondents. Peeling of plastered/rendered surfacesranked second

Table 4 shows the relative significance index (RSI) of the type of the defects of building facilities in the study areas.The first ranked defect with RSI value of 0.897 is the Staining/Peeling of paintwork at wall surface, as was corroborated by the respondents. Peeling of plastered/rendered surfacesranked second with RSI value of 0.869.Leakages of waste/water pipes causing dampness is ranked third with RSI value of 0.815. Doors/Window defects – broken louvre blades/glass, damaged/stiff louvre carrier, decays in door/window frames, etc. ranked forth with RSI value of 0.749. Crack in the wall ranked fifth with RSI value of 0.646. Leaking Roof ranked sixth with RSI value of 0.564. Sagging of carcassing membersranked seventh with RSI value of 0.533. Blockages of sanitary/water pipes ranked eighth with RSI value of 0.492.

While the least defect of weak foundation/foundation failure, ranked ninth with RSI of 0.423, as reflected in table 4.

Table 5 shows the causes of defects in facilities in the study area. Care free attitude of the users/occupants of the buildings is ranked the most major cause of defects with RSI value of 0.713. The second is Use of inferior materials with RSI value of 0.656. The third cause is Lack of regular check-up of the buildings for early detective for maintenancewith RSI value of 0.603 The forth cause is poor workmanship due to lack of control and proper monitoring with RSI value of 0.551. The fifth cause is insufficient fund to quickly effect remedy when the need ariseswith RSI value of 0.533. Thesixth cause is slow responsiveness of the authority to request of remedy of any affected areawith RSI value of 0.503. The seventh cause is non compliance with specifications as contained in the designed documents and the bill of quantitieswith RSI value of 0.477. While the last cause, is non consultation with/involvement of qualified professionals with RSI value of 0.469.

Table 6 shows the yardsticks that are recommended in order to give room for effective maintenance culture in tertiary institutions in Nigeria. The first recommended yardstick with RSI value of 0.813 is that there should be awareness for users/occupants towards strict compliance to enhance effective maintenance culture of the buildings. The second recommendation with RS value of 0.703 is that there should be periodic/regular check-up of the building for early detective for maintenance work. The third with RSI with the value of 0.656 is that there should be prompt response to provision of fund for maintenance work to effect remedy when the need arises. The forth recommended yardstick with RSI value of 0.600 is that there should involvement of professionals from inception to completion and at every stage of maintenance for the use of standard materials and for proper management of the building facilitiesThe fifth recommendation with RS value of 0.539 is that there should be strict compliance to specifications as contained in the design documents, bill of Quantities and construction documentations in the usage of approved materials. The sixthwith RSI with the value of 0.474 is that there should be quick response of the department concerned to requestsfor remedy when the need arises, and the last with RSI value of 0.431 is that there should be optimization of the design process to enhance good workmanship, labour, equipment and plant to reduce maintenance problems

CONCLUSION

Even though this research work may not have thoroughly discussed full causes of the whole scenario of

public buildings in respect of the defects and their major causes in the stated Senatorial Areas, it tries to give an overview on the common problems facing the building facilities. The paper therefore had identified that staining/Peeling of paintwork at wall surface, peeling of plastered/rendered surfaces, leakages of waste/water pipes causing dampness, doors/Window defects – broken louvre blades/glass, damaged/stiff louvre carrier, decays in door/window frames, etc, crack in the wall, leaking Roof, sagging of carcassing members, blockages of sanitary/water pipes and weak foundation/foundation failure were the noticeable defects associated with public buildings in the studied areas. The causes of the defects in facilities in the research are identified as slow responsiveness of the authority to request for remedy of any affected area; lack of regular check-up of the building for early detection for maintenance; improper management of the building facility; insufficient fund to quickly effect remedy when the need arises; use of inferior materials; bad workmanship due to poor control and supervision; non compliance with specifications as contained in the designed documents and the bill of quantities, while the last factor is non consultation with/involvement of qualified professionals in the building industry.

Recommendations

As a result of the issues discussedabove, the followings are, therefore, recommendedas solutions*towards developing a model for the maintenance of public buildings in Nigeria,*:

(i). There should be awareness for users/occupants on strict compliance towards enhancement of effective maintenance culture of public buildings.

(ii). There should be periodic/regular check-up of the building for early detection for maintenance work.

(iii). There should be prompt response to the provision of fund for maintenance work to effect remedy when the need arises.

(iv). There shouldinvolvement of professionals from inception to completion and at every stage of maintenance for the use of standard materials and for proper management of the building facilities.

(v). The strict compliance with specifications as contained in the design documents, bill of Quantities and construction documentations in the usage of approved materials.

(vi). There should be quick response from the department concerns to request of remedy when the need arises.

(vii). There should be optimization of design process to enhance good workmanship, labour, equipment and plant to reduce maintenance problems.

References

Adenuga, O.A. (1996) Building Maintenance in Nigeria: structural Deterioration, Recognition and Diagnosis of cause and remedies.;shelterwatch:vol 001 No 001 Lagos..

Adenuga, O, A & Iyagba, R. O. A (2005). Srategic approach for maintenance practices for public building in Lagos State. Journals of Environmetal Studies, Faculty of Science , University of Lagos 5 (1).

Adenuga, O. A, Odusanmi, K. T &Faremi, J. O. (2007). Assessment of Factors affecting Maintenance Management of Public Hospital Buildings in Lagos State, Nigeria. Journals of Construction and

Building Research Conference of RICS. Retrieved On-line 2014 from the https://wwwresearchgate.net.

Ajibola, J. K. (2009). Maintenance Culture in Nigeria: Problems and Challenges. A Paper presented at the Sensitization Campaign on Maintenance Culture, Organised by National Orientation Agency, Oyo State, Ibadan. Retrieved On-line 2014 from the http//www.core.ac.uk.

Akingbohungbe. D.O (2000): Housing and environmental for sustainable Development a paper presentation at the first ondo state polytechnic owo national conference on technology and sustainable development in the 21st century 6th-9th November.

Ahmed, A. (2000). Management System in maintenance of Infrastructure. Fahimta Publishing Company, Kaduna, Nigeria.

Al-zabaidi,H.(1997). Assessing demand for building maintenance in major hospital complex project management 15(3), 173-183.

Asabiaka, I. P. (2008). The need for Effective Facility management in school in Nigeria. New York Science Journal, 1 (2): 10-21

Assaf, S. (1996). Effects of Faulty Design and Construction in Building Maintenance. Journal of Performance of Constructed Facilities. 1996 (171).

Baba, S. W &Buba, A. V, (2013) Evaluation of Factors Affecting Residential Building Maintenance in Nigeria: Users' Perspective. Civil and Environmental Research ISSN 2224-5790 (Paper) ISSN 2225 - 0514 . Vol.3, No.8, Retrieved On-line 2014 from the http://www.iiste,org

Baba S. W. &Buba A. V. (2014). Evaluation of Factors Affecting Residential Building Maintenance in Nigeria: Users' Perspective. Journal of Civil and Environmental Research. ISSN 2224-5790 (Paper) ISSN 2225-0514, Vol.3, No.8, 2013, available Online in www.iiste.org.

Bakhary, N. (2005): "Arbitration in Malaysia Construction Industry" Retrieved 12th January, 2008 from http://www.efka.utm.my/thesis/images/4MASTER/2005/2JSBP/Part1/CHOOTZERCHI

NG MA011138D03TT1.doc

British Standard Institution, BSI (1974): Glossary of General Term Used in Maintenance Organisation, BSI, London.

British Standard Institution, BSI (1984): British Standard Glossary of Management Term in Terotechnology, BSI Hemel Hempstead.

Designing Buildings. (2017). Public Building Definition. Retrieved on 30-12-2018 from the World Wide Web https://www.designingbuildings.co.uk.

Igiri, S.N (2003) maintenance of government office building in Nigeria: A post Occupancy evaluation approach unpublished Ph.D These ,department Building university of Lagos ,Lagos, Nigeria.

Kiong, N.B. &Akasah, Z.B. (2012). Analysis of Building Maintenance Factors for IBS Precast Concrete system: A Review. International Journal of Engineering Research and Applications.2(6):878-883

Kunya, S.U., Achuenu, E.A. and Kolawale, J.O. (2007). Evaluation of Factors Affecting Maintenance Expenditures of Federal Tertiary Institution in Nigeria. Construction Focus. 1(1):98-105.

MyOndoState.Com. (2015). My Ondo State. Com. Retrieved on 9th of June, 2015, from the World Wide Web: http://ipinleondo.com/myondostate/aboutondo.php

Nairaproject (2017). Improving Maintenance Culture and Quality of Public Properties in Nigeria (A Case Study of AkwaIbom International Stadium). Retrieved on 30-10-2017 from the Word Wide Web http://nairaproject.com/projects/1019.html

Odediran, S.J., Opatunji, O.Y. andEghnure, F. O. (2012). Maintenance of Residential Buildings: Users'Practices in Nigeria. Journal of Emerging Trends in Economics and Management Sciences3(3):261-265

Ogundipe , T.L.(2005) An Investigation in to the maintenance culture of building in Nigeria. (A case study of Ondo state). Bsc final year project, Quantity surveying department,ObafemiAwolowo University.

Ogunmakinde, O. E., Akinola, A. A, &Siyanbola, A. B. (2013). ”Analysis of the Factors Affecting Building Maintenance in Government Residential Estate in Akure, Ondo State, Nigeria” journals of Environmental Science and Resources Management. Vol. 5 (2).

Olagunju, R. E. (2012). Predictive Modelling for Sustainable Residential Building Maintenance in Developing Countries: A Nigerian Case. Interdisciplinary Journal of Contemporary Research in Business. 4(6): 1237-1283.

Olanrewaju, S. B. O &Anifowose, O. S. (2015). The Challenges of Building Maintenance in Nigeria: A Case Study of Ekiti State. European Journal of Educational and Development Psychology, Published by European Centre for Research Training and Development UK Vol.3, No.2, pp.30-39, June 2015. Available online in www.eajournals.org.

Ondo State (2010). Facts & Figures on Ondo State by The Department of Research and Statistics, Ministry of Economic Planning and Budget, Akure, Ondo State. 2010 Edn.

Oxford Advanced Learner's Dictionary (2005). Oxford University Press, 7thEdn.

VanBaren, Jennifer. (2017). Types of Public Building. Retrieved on 30-12-2017 from the World Wide Web https://bizfluent.com.

Zulkarnain, S.H., Zawani, E.M.A., Rahman, M.Y.A & Mustafa, N.K.F. (2011). A Review of Critical Success factor in Building Maintenance Management Practice for University Sector. World Academy of Science, Engineering and Technology.53:195-199.

RUGIPO RESEARCH AND TECHNICAL JOURNAL

COMPARATIVE STUDY OF VARIOUS WALL FINISHES IN BUILDINGS IN ONDO STATE, NIGERIA.

Authors
Alejo, A.O., Oyegoke, I.K. and Olotu, F.M.
Department of Building Technology
Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria
Email: ayourlejo@yahoo.com

Abstract:

Wall finishes is the term to describe an application over a wall surface to provide a suitable surface. Wall finishes are smelt, touched and seen by building occupiers even colour and design affects the user psychology and the atmosphere of our building. Building users/owners seem not to recognize the function of various wall finishes in building and factors to be considered in selecting them suitable for the type and purpose of proposed buildings. Therefore, defects such as deterioration, dampness and stain may occur when comparison of wall finishes are not made before the selection of appropriate materials at the design stage with knowledge of the various factors that may hinder the performance or maintenance culture of proposed building of a particular location. The primary objective of this study is to identify the factors considered in the selection of various types of wall finishes and to compare the various wall finishes used in building in terms of defect, durability, maintainability and cost.This research work investigates and compares various wall finishes in building. Buildings in Ondo state, Nigeria were used as the target area to conduct the research works. The factors bearing on various wall finishes were analyzed to find out their individual and collective impact using suitable analytical tools. The findings revealed that paint with high percentage score was the most preferred wall finishes whereas wall paper was ranked the least by the respondent findings, Factors considered most in the selection of wall finishes include durability with the highest ranking percentage and the least was the cost. The study recommends that skilled worker should carry out operations, quality product should be used and all of wall finishes and materials should be considered before selection.

Keywords: Building, Construction, Design, Finishes, Wall

Introduction

Finishing can be considered as either exterior or interior finishing, using materials that may include cladding, doors, exterior trims, windows and paint. Exterior finishing may be extended to include external works like pedestrian way, lawns, fences and hedges while interior finishing will include ceilings, flooring, walls and stairs, it will also include casing, cabinets and fixtures that meet the owner's requirements and those of the building occupants.

Partitions and walls function is to divide a building into different areas of usage according to its occupancy and to hide electrical and mechanical equipment that may run through the cavity. Many types of finishes can be applied to the surface and that may be finished with another more decorative finish.

Finishing can be defined as the final layer which fixes and protects the surface of the building elements. Buildings were usually produced with traditional materials such as adobe, stone and wood at the period

whentraditional building techniques were in use. They were usually plastered or sometimes uncoated. The building section got thinner and new layers had to be added in order to provide comfort requirements after the transition to modern building techniques. The main purpose of finishing layers is to fix and protect the surface. It is also important to coat wall to protect the construction from abrasion, heat, moisture, effects of water and in order to create a suitable appearance (Giilru,2017).

Literature Review

Wall section can be analyzed in three layers; Interior coating, core and exterior coating. Some walls can be formed by one layer while some of them are formed by three layers. For instance, exposed concrete is formed by one layer but bricks walls are formed by three layers (Toydemir et al., 2000). A large variety of wall finishes can be used for renovations or any new construction. Functions of the finishes can change depending on their position on the wall. Exterior finishes play a significant role in forming the architectural character of the building. Also, it has to be resistant to atmospheric, chemical and mechanic effects and easy to clean. Interior finishes does not have direct contact with water and also does not encounter great temperature changes; therefore it does not have heat and water problems. In addition, interior finishing has to be compatible with the function of the space by appearance, color and texture (Toydemir et al, 2000).

The external building finishes therefore may not perform as expected and may fail to provide the desired functions for the intended time possible due to poor workmanship, exposure to adverse environmentalcondition, bacteria, inadequate quality of finish materials, erosion and wind. The coefficient of thermal expansion also affects finishes durability in tropical temperature, especially with high diurnal ranges (Evelyn et al., 2005).Ramanauskas and Stankevicius (2000) maintained that the durability of external finishes is determined by the following: Frost resistant, Moisture resistance and Corrosion resistance.

In essence, finishing materials have to be resistant to mechanical effects and the selection has to be done according to the material's strength properties. In order to protect surface properties and user's safety, finishing materials must have a sufficient compressive strength, impact resistance and walking safety (Toydemir et al., 2000; Binggeli, 2008).

Wall finishes may affect several measures of quality, including; - Relative Humidity of a room (Mortensem et al.,2005), - Indoor Air Quality (Holyson et al., 2000) and Transmission of harmful bacteria (Lanford et al., 2006). Thus, it is seen that moisture control using wall finishes is vital to preventing the growth of mildews and molds (Clausen, 2000). In order to keep wall finishes from transmitting harmful bacteria, they should be easy to clean and able to withstand repetitive wear and frequent germicidal decontamination and have the ability to repel moisture (Lankford et al., 2006).

Paint and wall coverings should be washable, durable and able to resist accidental impacts of trolleys and other objects. Wall finishes such as paint, sprayed plastic skins and plastics sheets with welded joints have been found to satisfy these requirements (O' Connell and Humphreys, 2000). Lam and Goodsall

(1994) studied 83 commercial building developments completed in Hong kong from 1982 to 1992. Tile cladding dominated in terms of the number of buildings. About (59 percent) were clad with tiles. However, in terms of the gross floor area involved, tile cladding ranked third (23 percent) among overcladding (45 percent), Curtain walling (29 percent) and precast concrete panel (2.9 percent). The author concluded that tile cladding is most commonly used for smaller and less expensive commercial developments.

Methodology

The primary objective of this study is to identify the factors considered in the selection of various types of wall finishes and to compare the various wall finishes used in building in terms of defect, durability, maintainability and cost. Eighty (80) questionnaires were administered targeting skilled and very experienced project professionals in the middle and top hierarchies of Ministry of Infrastructure, Works and Housing, Akureand tertiary institutions in Ondo State and marketers of wall finishing materials within the population limit. Seventy (70) questionnaires were returned and were subsequently analyzed. The questionnaire was structured in the Likert -5 point scale of response format. This has the advantage of flexibility for several choice responses.

The responses could be one of:

Never Used	Not Significant	Very Severe Defect	Very Poor
Rarely Used	Slightly Significant	Severe Defect	Poor
Sometimes Used	Moderately Significant	Fair Defect	Fair
Often Used	Highly Significant	Mild Defect	Good
Always Used.	Extremely Significant	No Defect	Excellent

Any of the above responses could apply to each of the statements made in the questionnaire.

Findings

Table 1.0: Various Wall Finishes in Building

Wall finishes	Types of wall finishes	NU	RU	SU	OU	AU	NO	% Score	Mean Score	Rank
Paint	Oil based paint	17	10	17	14	22	70	34.9	4.99	1st
	Water based paint	5	4	9	18	34	70	28.2	4.03	4th
Tile	Ceramic tile	4	0	10	20	36	70	29.4	4.20	3rd
	Clay tile	13	15	21	10	11	70	20.1	2.87	7th
	Quarry stone tile	13	8	22	16	11	70	21.4	3.03	5th
Plaster	Cement plaster	4	5	2	15	44	70	30.0	4.29	2nd
	Finish plaster	25	15	13	7	10	70	17.2	2.46	11th
	Casting plaster	25	18	14	10	3	70	15.8	2.26	14th

	Lime plaster	32	17	12	7	2	70	14.0	2.00	17th
Plaster of paris (POP)	Plaster of paris	12	6	12	15	25	70	24.5	3.50	6th
Brick	Engineering brick	20	10	11	21	8	70	19.7	2.81	8th
	Facing brick	16	14	19	10	11	70	19.6	2.80	9th
	Handmade brick	21	9	21	9	10	70	18.8	2.69	10th
	Fletton brick	30	16	15	7	2	70	14.5	2.07	16th
Wall paper	Vinyl wallpaper	24	20	16	6	4	70	16.8	2.40	12th
	Fabric wallpaper	26	15	16	9	4	70	16.0	2.29	13th
	Hand printed block wallpaper	27	14	19	6	4	70	15.6	2.23	15th

Source: **Author Field Survey, 2019**

Table 1.0 shows that majority of respondents strongly agree that all wall finishes in this research are mostly used but rank running on paint with a mean score of (4.99) always used wall finishes in building. Lime plaster which the percentage mean score of (2.00) was rarely used,

Table 1 .1: **Factors to be considered in Selection of wall Finishes.**

Wall Finishes	Factors	NS 1	SS 2	MS	HS	ES	NO	% SCORE	MEAN SCORE	RANK
Tile	Durability	0	3	5	24	38	70	30.7	4.39	1st
Paint	Durability	1	1	4	31	33	70	30.4	4.34	2nd
	Maintainability	0	3	8	22	37	70	30.3	4.33	3rd
Plaster of Paris	Durability	1	3	10	17	37	70	30.0	4.29	4th
Tile	Maintainability	2	3	5	24	36	70	29.9	4.27	5th
Brick	Durability	0	4	10	21	35	70	29.7	4.24	6th
Plaster	Durability	3	1	6	27	33	70	29.6	4.23	7th
Plaster of Paris	Maintainability	1	5	8	20	36	70	29.5	4.21	8th
	Appearance	2	4	10	17	37	70	29.3	4.19	9th
Brick	Maintainability	0	5	12	20	33	70	29.1	4.16	10th
Paint	Appearance	0	4	10	28	28	70	29.0	4.14	11th
Brick	Appearance	0	7	10	19	34	70	29.0	4.14	11th
Tile	Degree of comfort	3	2	12	26	27	70	28.2	4.03	13th
Plaster of Paris	Cost	0	10	11	22	27	70	28.0	4.00	14th

Wall paper	Maintainability	3	4	13	21	29	70	27.9	3.99	15th
Plaster	Appearance	1	5	19	15	30	70	27.8	3.97	16th
	Maintainability	1	8	9	28	24	70	27.6	3.94	17th
Paint	Degree of comfort	5	2	8	33	22	70	27.5	3.93	18th
Plaster of Paris	Installation	3	4	10	24	29	70	27,5	3.93	18th
Paint	Cost	1	9	13	22	25	70	27.1	3.87	20th
	Durability	3	3	18	22	24	70	27.1	3.87	20th
Brick	Installation	3	6	20	17	24	70	26.3	3.75	22nd
Wall paper	Effect of lightening	4	7	17	21	21	70	25.8	3.69	23rd
Tile	Installation	3	7	20	20	20	70	25.7	3.67	24th
Plaster	Cost	0	14	17	21	18	70	25.3	36.1	25nth
Wall	Cost	2	13	17	19	19	70	25.0	3.57	26th

Source: **Author Field Survey, 2019.**

Table 1.1 above Indicates that respondentw strongly agree that Tiles have a good durability with a percentage score of (30.7%), Paint durability with percentage of (30.4%) and paint maintainability (30.3%) are extremely significant while cost is ranked with (27.1) when selecting them as wall finishes.

Table 1.2Occurrences / Severity of Defects in Wall Finishes

Wall Finishes	Types of wall finishes	Defect of Finishes	ND 1	MD 2	FD 3	SD 4	VSD 5	% Score	Mean Score	Rank
Paint	Water based/Oil based paint	Sagging	4	20	14	21	11	22	3.21	1st
		Crawling	4	17	16	31	2	22	3.14	2nd
		Bleeding	4	18	20	23	5	21	3.1	3rd
Tile	Ceramic/ Quarry Stone/Clay tile	Fading	10	10	25	17	8	21	3.04	4th
		Buckling	15	14	14	14	13	20	2.94	5th
Paint	Water based/ Oil based/paint	Saponification	13	13	18	17	7	20	2.89	6th
Tile	Ceramic/ Quarry Stone/Clay tile	Chipped	15	17	15	14	10	19	2.81	7th
Plaster	Gypsum/Lime/Finish/Cement/Casting plaster.	Bond failure	10	21	14	15	5	19	2.77	8th
Wall paper	Vinyl/Fabric/Woodchip/Hand printed wallpaper	Abrasion	6	25	14	12	4	19	2.76	9th
Paint	Water based/ Oil based/paint	Prolonged drying time	17	11	23	15	4	18.8	2.69	10th
		Yellowing	13	19	20	20	1	18.7	2.67	11th
Tile	Ceramic/ Quarry Stone/Clay tile	Rust stain	15	15	19	10	5	18.5	2.64	12th
Brick	Facing/ Handmade/ Fletton/ Engineering Brick	Iron stain	20	15	10	13	8	18.4	2.63	13th
Paint	Water based/ Oil based/paint	Chalking	13	22	18	10	6	18.2	2.6	14th
Wall paper	Vinyl/Fabric/Woodchip/Hand printed wallpaper	Fading	10	28	23	7	5	17.5	2.56	15th
Brick	Facing/ Handmade/ Fletton/ Engineering Brick	Efflorescence	17	20	14	9	5	17	2.5	16th
		Insoluble deposit	15	25	14	12	4	17	2..5	16th
Tile	Ceramic/ Quarry Stone/Clay tile	Cracking	18	20	25	15	2	17.2	2.47	18th
Plaster	Gypsum/Lime/Finish/Cement/Casting plaster.	Cracking	19	20	26	12	1	16	2.37	19th
		Dampness	20	15	19	18	1	16.5	2.36	20th
Paint	Water based/ Oil based/paint	Deterioration	21	21	17	11	2	16.2	2.31	21st
Wall paper	Vinyl/Fabric/Woodchip/Hand printed wallpaper	Dampness	25	19	20	9	3	15.6	2.23	22nd
Plaster of Paris	Plaster of Paris (POP)	Cracking	25	20	15	7	3	15.3	2.19	23rd
		Dampness	35	15	15	8	2	13.7	1.96	24th

Source: **Author Field Survey, 2019.**

Table. 1.2: Shows that majority of the respondents strongly agree that paint as wall finishing is affected by sagging with a mean score of (3.21) as a very severe defect while dampness (wall paper) with a percentage mean score of (2.23) was ranked lowest. Clients should engage professionals at the early stage of the project so as to help in early cost feasibility and to reduce cost of overrun.

Table 1.3:Performance of Wall Finishes

Wall Finishes	Types of wall finishes	VP 1	P 2	F 3	G 4	E 5	NO	% Score	Mean Score	Rank
Tile	Ceramic tile			4	27	39	70	31.5	4.5	1st
Plaster	Casting plaster		2	3	30	35	70	30.8	4.4	2nd
Plaster of Paris	Plaster of Paris		3	6	24	37	70	30.5	4.36	3rd
Brick	Engineering brick		1	9	28	32	70	30.1	4.3	4th
Tile	Quarry stone tile		2	11	26	31	70	29.6	4.23	5th
Plaster	Cement plaster		1	10	32	27	70	29.5	4.21	6th
Tile	Clay tile		2	18	25	25	70	28.3	4.04	7th
Paint	Oil based paint	2	10		40	18	70	27.2	3.89	8th
Plaster	Finish plaster	1	1	17	37	14	70	27.2	3.89	8th
Brick	Handmade	1	2	25	22	20	70	26.8	3.83	10th
	Facing	1	3	20	33	13	70	26.4	3.77	11th
	Fletton	1	5	26	30	8	70	24.9	3.55	12th
Wall paper	Fabric	2	6	26	29	7	70	24.3	3.47	13th
	Woodchip	3	2	32	29	4	70	23.9	3.41	14th
Plaster	Lime	3	6	30	27	4	70	23.3	3.33	15th
Wall paper	Hand printed	5	10	23	27	5	70	22.7	3.24	16th
Paint	Water based	2	3	23	31	11	70	21.7	3.1	17th
Plaster	Gypsum	2	4	18	33	13	70	21.4	3.06	18th

Source:Author Field Survey, 2019.

Table. 1.3: shows that the performance of ceramic tiles is excellent with a score of (31.5%), Casting plaster is good with % score of (3.08%) and Gypsum plaster is fair with % score of (21.4%).

Conclusion

Assessing the use of various wall finishes in buildings; preferences of wall finishes showed that paint is most preferred followed by tiles and plaster of Paris while bricks and wall paper are the least preferred. Evaluating the factors to be considered in selection of wall finishes in buildings revealed durability has the highest factor considered in the selection of wall finishes followed by appearance, maintainability, cost, degree of comfort and installation.Effect of lightening was rank the least. Occurrence of defects in wall finishes after comparison revealed defects in paint (sagging of paint) as most occurring while dampness in wall paper is the least occurring defect in buildings in the study area. Ceramic tile, plaster and blaster of Paris were ranked highest in performance and excellent when used in buildings.

References

Binggeli, C. (2008). Materials for Interior Environments, John Wiley & Sons, 338 pp., New Jersey.

Clausen, C. A. (2000). "Recognize, remove, and remediate mold and mildew", Proceedings of the 2nd Annual Conference on Durability and Disaster Mitigation in Wood-Frame Housing, Madison,WI, USA, Forest Products Society, November 6-8, 2000, 231-234.

Evelyn. T, Chew M. &Harikrishna, N. (2005). An Assessment of Factors Affecting the Service Life of External Paint Finish on Plastered Facades. International Conference On Durability of Building Materials and Components. LYON, France. Retrieved from http://www.irbdirekt.de/daten/iconda/06059020437.

Gülru KOCA: Interior Finishing Materials: Uploaded by GülruKoca on 02 November, 2017.https://www.researchgate.net/publication/320800578_Interior_Finishing_Materials?enrichId=rgreq-68bf9fb2598748007d96583128147005.

Hodgson, A. T., Rudd, A. F., Beal, D.&Chandra, S. (2000). "Volatile organic compound concentrations and emission rates in new manufactured and site-built houses", Indoor Air, 10: 178-192.

Lankford, G M, Collins, S., Youngberg, L., Rooney, D. M., Warren, J. R.&Noskin, G. A. (2006)."Assessment of materials commonly utilized in health care: Implications for bacterial survival and transmission", American Journal of Infection Control, 34(5): 258-263.

Lam, J.C.&Goodsall, C.J. (1994). A survey of Building Envelope Design for Commercial Buildings in Hong Kong. Building Research and Information 22:2, 79-86.

Mortensen, L. H., Rode, C.&Peuhkuri, R. (2005). "Full scale tests of moisture buffer capacity of wall materials", Proceedings of the 7th Symposium on Building Physics in the Nordic Countries,Reykjavik, Iceland, June 13-15, 2005, 662-669.

Ramanauskas, J., Stankevičius, V. (2000). Weathering Resistance of Thermal Insulating Systems for Walls of Buildings Kaunas. 142.

Toydemir, N., Gürdal E., Tanaçan, L. (2000). YapıElemanıTasarımındaMalzeme, Literatür Yayınevi, 393 s., İstanbul.

RUGIPO RESEARCH AND TECHNICAL JOURNAL

THE INDELIBILITY OF WRITER'S INSTRUMENTALITY TO A CALL TO DUTY: A STETHOSCOPIC JOURNEY THROUGH FEMI OSOFISAN'S *WHO'S AFRAID OF TAI SOLARIN?*

Author

Egbuwalo, O. L.
Languages Department,
Rufus Giwa PolytechnicOwo Ondo State, Nigeria.
oegbuwalo@yahoo.com

Abstract:

Writers all over the globe are literary visionaries who place their stethoscope, as it were,on human nature and societal complexities. A writer is able to see the minutest conduct of man with reference to the ethic of neighbourliness.Most humans are selfish, while very few show empathies. The instrumentality of a writer transcends the ordinary in heralding the nature of human behaviour on the planet; also a writer projects the future through the present.This paper aimed to bring into limelight, through Osofisan's Who's Afraid of Solarin?the peculiarities of public office holders and their conduct as far as service to humanity is concerned.A plot analysis of the play was carried out. Critical textual survey revealed the ingenuity of the author in exposing the dirt in the public servants' linen, asfar as discipline and accountability are concerned. It is also an exposure of how and whymost public officeholders swindle the public they swear to serve.

Keywords: Visionaries, Endowments, Neighbourliness, Instrumentality, Accountability.

Introduction

Writers contribute to the social, economic, political, cultural and religious well-being of the society. This is done through literary presentations in the genres of drama, prose and poetry. Ideas presented in any of these genres remain indelible in the minds of readers and society in general.Egbuwalo(2017) states that talented literary artists emerge within the society and shed light on their people's genealogy through their medium of expression. The historical antecedents of the environments also play significant roles in the writer's inclination in writing.

Objective of the Paper

This paper intends to investigate public office holders' dispositions towards their duty and the implications to the (contemporary) society.

Theoretical Framework

No one is an island, entire of his or her own. A writer is in constant relationship with the environment and his themes are usually the products of his milieu. Environmental Determinismtheory has a part to play in the development of the text, *Who's Afraid of Solarin*?Environmental Determinism is the effect of the interplay between human and the environment. The theory was developed in the fields of Anthropology, Sociology and Geography. Its preoccupation is how local, regional and global environmental factors affect and determine a particular society's cultural, economic, political development and evolution. It explains how the physical and behavioral characteristics of people or races are determined by the physical environment in which they live. It encompasses climate, culture, economy and geography.The Chinese philosopher and politician,Guan Zhong is said to have written, in the 7th century, that the nature of major river systems determined the cultural and behavioral characteristics of people living nearby.

Environmental Determinism theory evolved from application of Darwinian evolutionary biology to sociological and cultural development. The 19th century English philosopher, Herbert Spencer, referred to it as *survival of the fittest.* The theory sheds light on the parameters that determine human's reactions towards environmental challenges.

The plot and content of *Who's Afraid of Solarin*? have bearings with the setting of the play. The setting depicts an environment where those (public servants and politicians) entrusted with the responsibility of providing decent and equitable services for the generality of the people are the ones that take corruption, cheating and extortion as their stocks in trade. It is in the interest of Femi Osofisan to expose these atrocities in the view to modeling a society for a better and equitable cohabitation.

Femi Osofisan

Femi Osofisan was born in Erunwon, Ogun State, Nigeria, in June 1946. He is a reputable writer who had made remarkable impacts, among literary icons. He had many awards to himself, among which is the Nigerian National Order of Merit (NNOM). Osofisan is a critic, poet, novelist, essayist and lecturer. His books include, *Morountodun*, *Midnight Hotell*, *Who's Afraid of Solarin*?, *Ajayi Crowther* and a host of others. His major theme is the conflict between good and evil. His works incline towards correcting the decadence in the society.

Synopsis of the Play

Who's Afraid of Solarin? explores the events that played out when a rascally and irresponsible traveler, Isola, is mistaken for the dreaded Public Complaints Commissioner, Solarin. Isola's presence throws panic among the corrupt Officials of the Local Government Council, among who are: Chief James Dada Gbonmiayelobiojo– Chairman; Mr Ayokanmi Olaitan-- Chief Magistate; Dr Bodunrin Alade Martins-- Chief Medical Officer, Chief Funso Fawolu-- Councillor for Education and Works, Mrs Abeni Animasaun –- Price Control Officer; Miss Kaokudi Animasaun-- Councillor for Cooperatives and Agriculture; Baba Fawomi-- Ifa Priest; Lamidi and Lemomu--beggers; and Isola Oriebora-- traveler from Lagos.

Actions commence with complaints and arguments among the Local Government Council Officers over the removal of some of the entitlements hitherto being enjoyed by them in their pay packages.Some of the officials have premonitions over their lots for the day, as they were formally oblivious of the situation:

Chairman: "I don't know for sure. But somebody has been sent from the headquarters,and he's travelling incognito" (6)

This information throws jitters among the Council members:

Chief Magistrate:"Incognito! *Sanponna* o! It must be Solarin" (6)

*Chairm*an: "What's worse, he has secrete instructions" (7)

Chief Magistrate: "It's Solarin! We're doomed! I don't think I can continue the game. I'm feeling sick" {7}

Councilor for Education: "I'm on leave, right from this moment! If anyone asks for me, I can't be found" (7)

Councillor for Cooperatives:"And I too, I'm going for treatment- in Cairo" (7)

Councillor for Education: "Why Cairo?" (7)

Councillor for Cooperatives: "The address is in Arabic, who here can read it?" (7)

At this moment they are planning to run away, but the Chairman disallows them:

Chairman: "Stop there, both of you! I forgot to mention it, but no one's going to move one pinch from this place until Baba Fawomi comes".(7)

The reprisal hands of guilt starts to haunt them, as they go into retrospect concerning the atrocities they had perpetrated:

Chief Magistrate: "There must be a hidden motive behind this. I spy the hand of

God. Ah, in my court" (8)

Councillor for Education: "It's a plan like daylight if you ask me. We begged you , didn't we, not to throw that poor man in jail last week. But you said you wanted his wife" (8)

In a bid to ward off the impending doom, they invites Baba Fawomi, the *Ifa* Priest, for divination. He compounds their apprehension, to make sure he has his own share of their loot. He gestures on some materials they must supply for Ifa to prevent the visitor from coming to them:

Baba Fawomi: "Hush, I say! I know everything. That's the final proof! And I beg You, please don't mention the question of professional fees yet, for I shall only be too happy to accept them.----" (16)

Before he starts to name his price some of the Council team had started to mention what they will give to him, provided the burdens on them are removed:

Councillor for Education: "Ten, no, fifteen percent of the contract to be awarded next week for the proposed Cultural centre!" (16)

Doctor: " Free vaccination for you and your family…"(16)

Chief Magistrate: "One year's pardon in advance!..." (16)

Price control Officer: "First choice over any goods seized this month from hoarders"(16)

At this moment, Baba Fawomi halts and scolds them for not giving him room for Ifa to name it's prices. They all apologizes and he continues:

Baba Fawomi: "Sacrifice! That's the only way to redeem your sins. For *Ifa* says he has seen you all, and everyone of you is a rogue. No, don't protest… every act of your life is exposed in these patterns. The fornication adulteries, forgeries, small and big embezzlements! The betrayals. the stupid…No, I won't go on, you all have enough crimes in your lives to justify your posts…" (18)

Chairman: "All right Baba. Tell us how it will cost us to repent." (19)

Baba Fawomi tells each of them what to provide and they all comply. The items include cows, goats, fowls, chickens, bails of white cloth, *yanyan* and so on. They all agree, as long as their fears are allayed. It is ironical for the Chairman and his team to utter statements that foreground their love for the masses they have maltreated and cheated so much. This follows Baba Fawomi's insistence to leave them to their fate on account of poor hospitality when he says:

Baba Fawomi: "Don't bother to shut the door, I am leaving. Giving toilet soap to Orunmila!... He'll soon be arriving." (23)

All: "What, Baba Fawomi! You won't do that ! Not to old clients? Consider our families! Think of the reputation of the town that will suffer. Think of the name of the fatherland!" (23)

Baba Fawomi does not take his leave without making additional demands:

Baba Fawomi: "Let me go, I say! You will see me in my home before I agree to change my mind…you will come properly loaded" (23)

Immediately he takes his leave, a set of people enter and announce that the visitor had already arrived the Pastor's house for some days past without them knowing. The Pastor cannot confirm the true identity of the visitor because he (the visitor) claims to be a traveler from Lagos. He tells the Pastor that he was attacked on the way by robbers who dispossessed him of all his possessions. While argument is still on concerning the true identity of the visitor, the Chairman enters and it is discovered that the visitor is Isola, who they mistakenly assume to be Solarin, awaited Public Complaints Commissioner.Part three of the play exposes the pastor as a corrupt and promiscuous fellow. While Lamidi and Lemomu are searching for the missing money in his room, they stumble into some love letters involving married women. Consider :

Lemomu: "…We've gone through the other room and found nothing. Exceptfor these love letters" (50)

Lamidi: Yes, but they are married women (50).

Baba Fawomi obliges to bail Pastor out of his corruption allegation, only if he can co- operate:
Baba Fawomi: I'm ready to help you, but you have to be willing to help yourself a little. You've got how many pockets … in your own interest , buy them off ! A bribe is a bribe, and all government officials are *susceptible* whether spirits or humans! It's the size that counts—(55)

The Chairman and his team come in contact with Isola, who they mistaken for Solarin. They are so afraid to appear to him that they have to rehearse their order of appearance when he is eventually ready for them:
Chairman: He'll soon finish his meal, and that's a consolation. Remember we are in it together… Now let's go through it again carefully. When he enters, what do we do? (65)
Councilor for Education: We fall flat on our bellies (65)
Councilor for Cooperatives:…we are to courtesy.

Interestingly , Isola is aware of all their intrigues and he is ready for them. He says:
Isola: Ah, they are beginning to come. All the better' if they arrive one by one. My dear you have to excuse us.(69)
Chief Magistrate: Oh Lord, I know I've made careless remarks about you but, as one judge to another, you can't let me down. I'll take the first step, take the second one for me…(69)
*Isola:*Do sit down. So you are the Magistrate here?(69)
Chief Magistrate: Yes, sir. I was promoted to that position some years back after due recommendation by the Fraternity. I've always been faithful to the cult's charter and paid my dues regularly…(69)

This is one of the reasons many of those in positions of authority (politicians or public office holders) misbehave and are inclined to satisfy their 'spiritual' dictators rather than serving the interest of the masses that voted them in. The Magistrate offers an envelope:
Chief Magistrate: Oh, nothing… I swear, a…a handkerchief (70)
Isola: You dropped an envelope… full of brand new notes.(70)
Chief Magistrate: Oh Lord, bail me out (70)

In turns the Council Officers offer hands of fellowship to Isola:
Price Control Officer: I have the honour to present myself. Mrs Abeni Mailo, Daughter of the late Reverend Durosimi, the famous pianist-composer, graduate of Isabatudeen Secondary Modern School, Ajilete. I am the Price Control Officer here (71)
Isola: Well come I've heard of you. I'm glad to meet the daughter of such a famous person, the late Reverend Mailo (71)
*Is*ola:Madam, you've heard of my engagement, no doubt?
Price Control Officer: Your Highness…I hopeyou'll count me as one of your friends. Let me prove it with this, if your Highness will do me the honour of accepting?,,,,,(72)
Isola: Oh thanks, very much! I'm lavish with my friendships when I see the proof! (72)

It is common for people to hide under the reputations of 'REAL' HONOURBLE, DIGNIFIED and DISCIPLINED individuals, present and past, to secure positions of honour, especially political positions. They usually behave contrary to revered conduct of such personalities whose names have been used to climb to the top. A very good example of such opportunists in the play is the Price Control Officer. In turn, Isola receives inducement from the Council members until he decides to act like the good/real Public Complaints Commissioner when it ,,is the Doctor's turn to appear to him:
Doctor: I have the honour to…to, excuse me, to present myself before you, your Excellency—Dr Bodunrin Alade-Martins…the…the

excuse me, Chief Medical Officer in charge of the hospital (76)
Isola: Isola: What's that in yourbag? (76)
Doctor: It's… it's some of the latest equipment we acquired recently… I thought you… excuse me, I thought you would like to examine it (76)
Doctor: You know, your Excellency! A widespread disease…of the pocket… (76)

Surprisingly, Isola flares up:

Isola: You're in a deep trouble, doctor. Trying to corrupt an official of the state (77)
Doctor: I…am so-r-r-rry, your Excelle-n-n- excuse me, please, they told me to… to do it. I was misled (77)
Isola: Quiet! Who misled you?
Isola: You are lying, doctor! You want to implicate responsible and decent officials. Doctor, I am going to make sure you're properly disciplined. A man in your position should know better (77)

Following this development, confusion sets in and Isola chases the Doctor. Instantly, Baba Fawomi enters with Isola's diary, which reveals that Isola is not the Solarin being expected, but a fake one. Within a spate of time, Lamidi appears with information:

Lamidi: Excellencies, there's a visitor outside. (85)
Lemomu: A gentleman in brown khaki shorts----(86)
Chairman: What! (86)
Lamidi: The inscription on his car will surely interest you (86)

The Chairman gives money to Lamidi and Lemomu in order to extract information from them:

Chairman: All right, take this! What inscription?
Lamomu: It says, 'Office of the Public Complaints Commissioner'.

There comes the dreaded cat let out of the bag!

All: What!!!
Chairman: Oh my God! Oh my head!
Lamomu: He's here, ladies and gentle men! He's arrived (86)
Lamidi: Yes, the real Public Complaints Commissioner has arrived.(86)

Conclusion

A stethoscopic consideration of the content of the play brings to limelight certain recurring issues that affect society and people as far as a call to duty and service to humanity are concerned. The main bane in the progress of the society is corruption. This cankerworm is laid bare to the reader at the beginning of the text---- where the Local Government Council Officials accuse one another in connection with what dirty corners each of them had cut in their respective duty posts. The Chairman, no less than the entire officials of the Council, is involved in myriads of corrupt practices during the course of his duties.Baba Fawomi (*Ifa* Priest) takes monetary and material bribes in his intention to prevent the visit of the Public Complaints Commissioner to the Council. Polycap (Chairman's boy) collects naira notes from Isola and divulges information to him. Isola (fake Public Complaints Commissioner) takes the advantage of the Council Officials' money and material gluttony to extort them. The Pastor is accused of adultery and fraud.

In a nutshell, people saddled with the responsibility of working for a better society in general are those swimming in the pool of avarice, covetousness and egocentricity. It is not far from the plain truth that replicas of the Local Government Council Officials depicted in this text abound all over the place. Femi Osofisan's *Who's Afraid of Solarin?* has presented a subject matter that will forever remain indelible in the minds of the readers.

Those in position of authority should be responsible and be above board in their day to day dealings with the peoplethey are saddled to serve. One's call to duty should be handled with the highest sanctity, so that the society will be better for all of us.

References

Ajimuda, O. (2011). Historical Determinism and African Drama: A Study of Yerima's Dramaturgy. Ph.d Thesis. Department of English, Ekiti State University, Ado-Ekiti, Nigeria.

David, W.& Timothy, Z.(2014). *A Call to Duty, Volume 1*. USA: Baen Books.

Egbuwalo,L.O., Adewumi, S.I & Ariyo(2011). The Instrumentality of the Writer in Achieving Artistic Melodies: A Review of Selected Works of Tayo Olafioye, Proceedings of The

Eleventh International Conference on Sustainable Development. Vol. 7, No 2,Ken

Educational Books, p.143.

Osofisan, Femi(1978). *Who's Afraid of Solarin?*Ibadan: University of Ibadan Press PLC.

Bullon (MainEditor)(2003). *Longman Dictionary of Contemporary English*: EnglandPearson Educational Limited.

https://www.mynigeria(com)personsFemi Osofisan2

https//en.wikipedia.org(wiki)Femi Osofisan.

https://study.com/academy/lesson/environmental-determinism-definition-examples-theory.html

https://www.sciencedirect.com/topics/social-sciences/environmental-determinism.

RUGIPO RESEARCH AND TECHNICAL JOURNAL

ESTIMATION OF ELEVATIONS OF UNOBSERVED LOCATIONS USING SIMPLE KRIGING METHOD

Authors
Olomoshola, O. Olanitori, A. and Olawole, S. A.
Surveying & Geoinformatics Department,
Rufus Giwa Polytechnic, Owo, Nigeria.
olomosholapatrique@gmail.com

Abstract:

Geo-statistical interpolation predicts values for cells in a raster from a limited number of sample data points. It is the process of manipulating spatial information to extract information and meaning from the original data (Chang, 2006). The selection of an appropriate estimation method is one of the fundamental decisions in resource estimation. The effects of selecting an inappropriate estimation method can lead to 50% error in the estimate (Dominy et al., 2002). There are different methods of interpolating spatial data such as Inverse Distance Weighted (IDW) Trend, Kriging, etc, and the choice of these estimation methods is based on the spatial correlation of the spatially distributed objects. For example, the inverse distance method is unbiased but does not minimize the estimation variance, while kriging is subject to certain conditions, such as providing the best estimate possible by a linear combination of the available weighted data as well as minimizing the error variance of the estimate.
This paper presents a study of the application of a linear geostatistical estimation technique; Simple kriging, in estimation of elevations of unobserved locations. Included in the study is a discussion on variography and its necessity in resource estimation. The theory of kriging as well as the simple kriging equations is discussed. Simple Kriging estimation techniques such as Histogram (frequency distribution), Normal Quantile-quantile (QQ) plots, Trend analysis, and Semi-variogram/Covariance were used to validate the elevations of the observed data. The elevation data were further analyzed using Cross validation method, and the result indicated that Simple Kriging method of interpolation is suitable for the elevation data observed.

Keywords: Geo-statistics, Interpolation, Kriging, Variogram, Estimation.

Introduction

Geostatistics refers to statistics of the earth, such as in geography and geology, and interpolation refers to the method of constructing new data points within the range of a discrete set of known data points (Kress, 1998). Geo-statistical interpolation predicts values for cells in a raster from a limited number of sample data points. It is the process of manipulating spatial information to extract information and meaning from the original data (Chang, 2006). It can be used to predict unknown values of any geographic point data, which can be elevation, rainfall, levels, gravity values etc. In other words, it can be defined as the process of using points with known values or sample points to estimate values at other unknown points.

It is an assumption that spatially distributed objects are spatially correlated, which means, things that are

close together tend to have similar characteristics. Spatial interpolation is used to create surfaces with densely populated x, y and z data and the output surface depends on the *Z*data supplied (elevation, rainfall, levels, gravity values etc.), to produce a surface in form of grids (raster), which can be used to depict the topography of a land.

A suitable interpolated method can be used to optimally estimate the values at those locations where no measurements were taken. The results of the interpolation analysis can then be used for analysis that cover the whole area for modelling.

There are different methods of interpolating spatial data such as Inverse Distance Weighted (IDW), Natural Neighbor Inverse Distance Weighted (NNIDW), Spline, Pointinterp, Trend, Kriging etc., in which Kriging method of interpolation was used to interpolate the elevation data of the study area.

Aim and Objectives

Aim

The aim of this study is to analyze the use of simple Kriging of interpolation method in estimating elevation values for the unobserved location of the study area.

Objectives:

i. To acquire elevation data at 25m interval.
ii. To interpolate elevation values to unobserved locations and produce a surface map using simple Kriging method of interpolation.
iii. To analyze the accuracy of the unpredicted values.

Study Area

The study area (Fig. 1.1) is located within Obanla Campus, North Central part of the Federal University of Technology, Akure in Akure South Local Government Area, Ondo State, Nigeria, with boundary coordinates of 735557.402mE, 800158.202mN; 735975.729mE, 808072.918mN; 735925.192mE, 807530.562mN and 735386.834mE, 807721.119mN, in Minna Datum, which has an approximate Area of 25 Hectares.

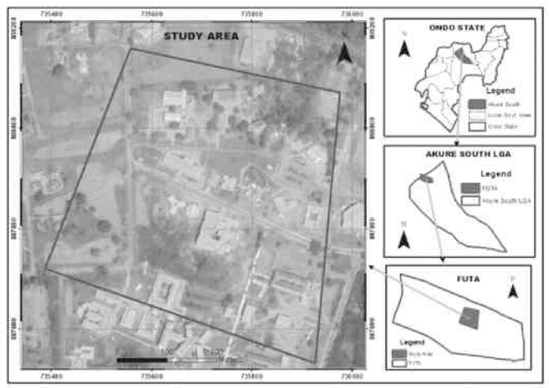


Fig. 1.1: Study Area Map

Conceptual framework and literature review

Spatial interpolation method (kriging)

Kriging is a geostatistical interpolation technique that considers both the distance and the degree of variation between known data points when estimating values in unknown areas. A kriged estimate is a weighted linear combination of the known sample values around the point to be estimated. Kriging procedure generates an estimated surface from a scattered set of points with z-values. Kriging assumes that the distance or direction between sample points reflects a spatial correlation that can be used to explain variation in the surface. The Kriging tool fits a mathematical function to a specified number of points, or all points within a specified radius, to determine the output value for each location. Kriging is a multistep process which includes exploratory statistical analysis of the data, variogram modeling, creating the surface, and (optionally) exploring a variance surface. Kriging is most appropriate when you know there is a spatially correlated distance or directional bias in the data. It is often used in estimating topo surface.The predicted values are derived from the measure of relationship in samples using sophisticated weighted average technique. It uses a search radius that can be fixed or variable. The generated cell values can exceed value range of samples, and the surface does not pass through samples.

Kriging is similar to IDW in that it weights the surrounding measured values to derive a prediction for an unmeasured location. The general formula for both interpolators is formed as a weighted sum of the data:

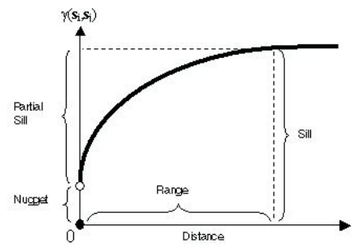


Fig. 2.1: Anatomy of a Typical Semivariogram.

The variance of the difference increases with distance, thus, the semivariogram can be thought of as a dissimilarity function. The height that the semivariogram reaches when it levels off is called the sill. It is often composed of two parts: a discontinuity at the origin, called the nugget effect, and the partial sill; added together, these give the sill.The nugget effect can be further divided into measurement error and microscale variation. The nugget effect is simply the sum of measurement error and microscale variation, and, since either component can be zero, the nugget effect can be composed wholly of one or the other. The distance at which the semivariogram levels off to the sill is called the range.

Covariance Function

The covariance function is defined to be;

$$\mathbf{C(si, sj) = cov[Z(si), Z(sj)]}$$

Where cov. is the covariance.

Covariance is a scaled version of correlation. Thus, when two locations, si and sj, are close to each other, they will be similar, and their covariance (a correlation) will be large. As si and sj get farther apart, they

become less similar, and their covariance becomes zero. This can be seen in figure 2.2 below, which shows the anatomy of a typical covariance function.

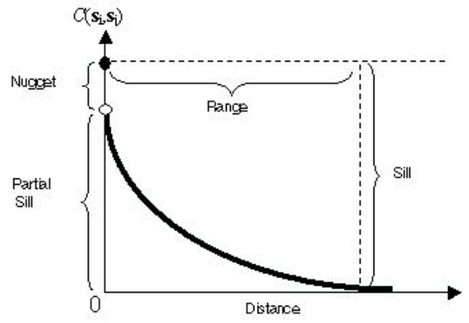


Fig. 2.2: Anatomy of a typical covariance function.

Materials and Method

Data Acquisition

The data set were obtained from field observation using South 350R Total Station instrument to obtain point elevation data (x, y and z co-ordinate). The x and y co-ordinates are used to fix the position of the points in space, the z co-ordinates denote the height. The point elevation data were observed at 25m interval. The following equipment were used in the execution of this project:

Hardware Components

- South 350R Total Station instrument and all accessories
- Tracking rods/ Prism Reflectors
- Computer (Acer Aspire E 14)

Software Components

- South Download Manager (Manufacture Software)
- Notepad.
- Microsoft word/ Excel
- ArcMap 10.5

Data Exploration

Data exploration is the first step in data analysis and typically involves summarizing the main characteristics of a dataset. This was carried out on ArcMap 10.5, using the geostatistical tools which are as follows:

Histogram

Histogram (frequency distribution) provided a one-variable description of the observed data. The frequency distribution displays how often the observed values fall within certain intervals or classes. In frequency distribution, the median and mean of the observed values must be close to validate the

observed value.

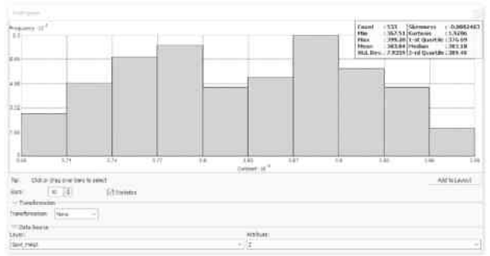


Fig. 3.1: Histogram of the observed data

From Fig 3.1 above it was observed that the mean of the observed data was 383.04m and the median was 383.18m, which shows that both values are close, which validates the correctness of the observed data.

Normal Quantile-quantile (QQ) Plot

Quantile-quantile (QQ) plots are an exploratory tool used to assess similarity between the distribution of one numeric variable and a normal distribution, or between the distributions of two numeric variables. If the distributions of the compared quintiles are identical, the plotted points will form a straight 45-degree line. The farther the plotted points deviate from a straight line, the less similar the compared distributions.

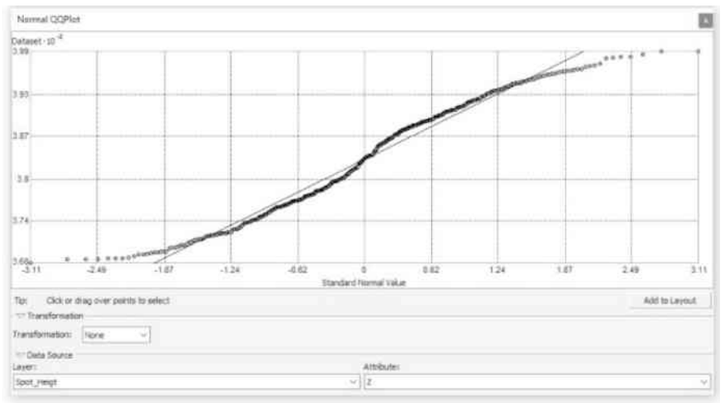


Fig. 3.2: Normal Quantile-quantile (QQ) Plot of the observed data

From table 3.2 above, the straight line is 45 degree, and the dots are the observed data. The dots are located around the straight line, which shows that the datasets follow the standard normal distribution.

Trend Analysis

Trend analysis provides a three-dimensional perspective of the data. The location of the sample points was plotted on the x, y plane, and above each sample point, the value is given by the height of a stick in Z dimension. In trend analysis, values are projected on to the x, z plane and y, z plane are scatter plots.

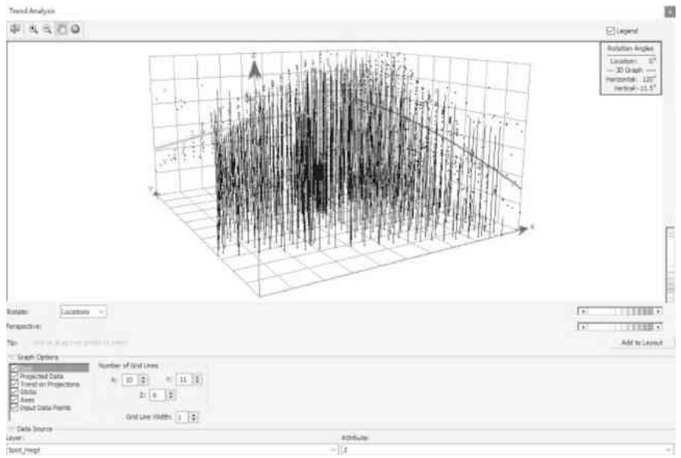


Fig. 3.3: Trend analysis of the observed data

Fig 3.3 shows that the trend is flat and less prominent as it does not really form a U shaped.

Semivariogram/Covariance Cloud

This shows the empirical semivariogram and covariance values for all pairs within a dataset and plots, then, as a function of distance that separates the two locations. It is used to examine the local characteristics of spatial autocorrelation within a dataset and look for local outliers.

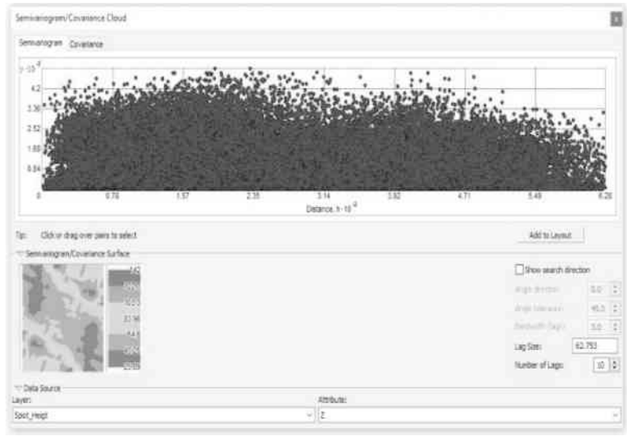


Fig. 3.4: Semivariogram/covariance of the observed data

Fig. 3.4 shows that there is an autocorrelation which allows models to be fitted for spatial relationship.

Results and Analyses

This chapter presents the results and analyses of the processed data.

Spot Height

The spot heights map showing the points elevation recorded as depicted in Fig. 4.1

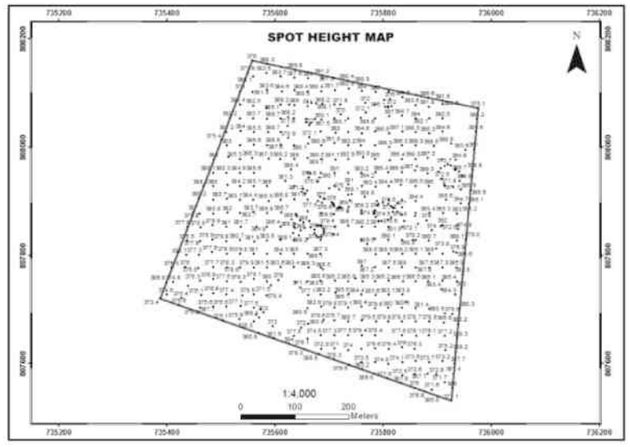


Fig. 4.1: Spot Height Map

Areas with no spot heights in Figure 4.1 are areas covered with buildings. The point with the least elevation is 367.512 m and the point with the highest elevation is 399.278m.

Interpolated Surface

Fig. 4.2 shows interpolated surfaces that have values at every point across their extent, produced from simple Kriging interpolation method. It shows ranges of elevation in which the least range of elevation is within 367.896m and 373.177m, and the highest range is within 394.299m and 399.087m.

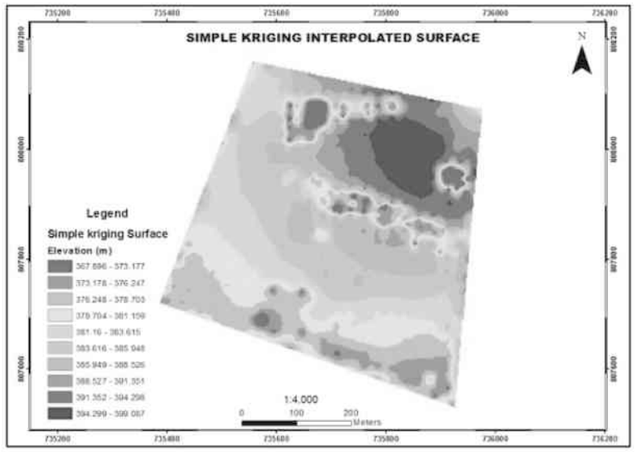


Fig. 4.2: Simple Kriging Interpolated Surface.

Cross Validation of Interpolated Surface

Cross validation shows how a model used for interpolation predicts the values at unknown locations. This serves as diagnostics that indicate whether the model and its associated parameter values are reasonable by comparing the predicted value to the observed value and useful information about the quality of the model.

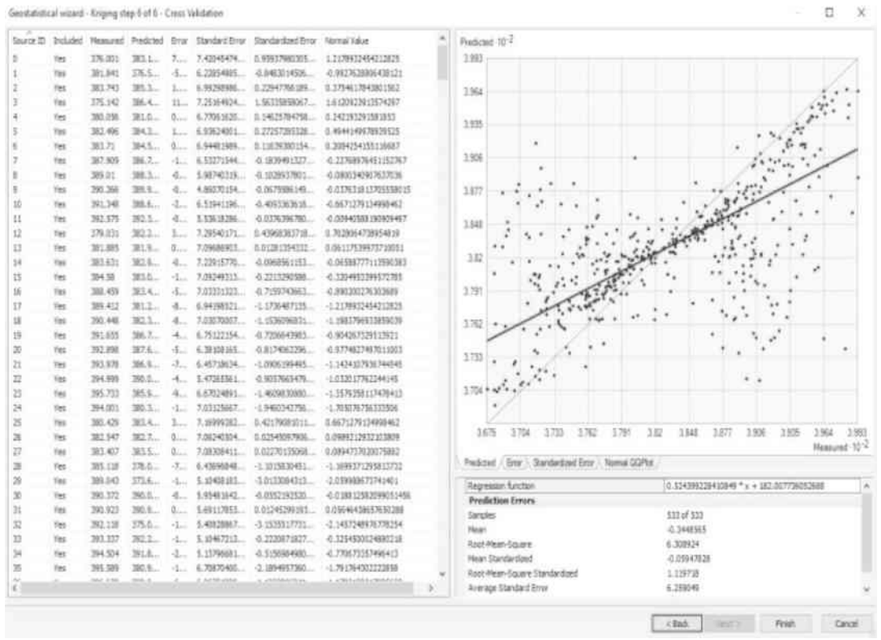


Fig. 4.3: Cross validation of Interpolated Surface.

Fig 4.3 shows the following;

i. The mean prediction error is -0.3448565, which close to zero (0)
ii. The Root Mean Square standardized error is 1.119718, which is close to one (1)

Conclusion

Simple Kriging has been successfully used to carry out the interpolation of point elevations obtained by field observation, by estimating elevation values in unknown areas. Data exploration such as Histogram (frequency distribution), Normal Quantile-quantile (QQ) plots, Trend analysis, and Semivariogram/Covariance were carried out to validate the elevation data observed.

The elevation data were further analyzed by cross validation method which showed that the mean prediction error was -0.3448565, which was close to zero (0), and also the Root Mean Square standardized error was 1.119718, which was also close to one (1), indicating that Simple Kriging method of interpolation is suitable for the elevation data observed.

References

Akima, H. (1970). *A new method of interpolation and smooth curve fitting based on local procedures*. *Journal of Association for Computing Machinery,* 17, pp589–602.

Armstrong, M. (1998). *Basic linear geostatistics*. Springer Verlag, Berlin (Germany), pp 153.

Burrough, P.A. & McDonnell, R.A. (1998). *Principles of Geographical Information Systems; Spatial information systems and geostatistics*. Oxford University Press. Oxford. UK, pp 333.

Chang, K. (2006). *Introduction to Geographic Information Systems*. Boston: McGraw-Hill: Higher Education.

Dominy, S.C., Noppe M.A. & Annels, A.E. (2002). *Error and uncertainty in mineral resource and ore reserve estimation: the importance of getting it right*. *Explor. Min. Geol*., 11(1-4), pp. 77-98.

Kress, R. (1998). *Numerical Analysis*. Springer, New York. http://dx.dol.org/10.1007/978-1-4612-0599-9.

Olea, Ricardo, A. (1999). *Geostatistics for Engineers and Earth Scientists*. Kluwer Academic.

Phillips, D. L, Dolph, J. & Marks, D. (1992). *A comparison of geostatistical procedures for spatial analysis of precipitation in mountainous terrain*. Agricultural and Forest Meteorology 58: 119–141.

Price, D. T. McKenney, D. W, Nalder, I. A, Hutchinson, M. F. & Kesteven, J. T. (2000). *A comparison of two statistical methods for spatial interpolation of Canadian monthly mean climate data. Agricultural and Forest Meteorology,* 101, pp 81–94.

Williams, C. K. I. (1998). *Prediction with Gaussian Processes: From Linear Regression to Linear Prediction and Beyond. Learning in Graphical Models*. pp. 599–621. doi:10.1007/978-94-011-5014-9_23. ISBN 978-94-010-6104-9.

RUGIPO RESEARCH AND TECHNICAL JOURNAL

ETHNOMEDICINAL AND PHYTOCHEMICAL PROPERTIES OF *UVARIA AFZELII* SC. ELLIOT (PUSS FINGER) AND *UVARIA CHAMAE* P-BEAUV *(*FINGER ROOT*)* IN IBADAN METROPOLIS

Authors
[1]Osabiya O. S and [2]Adeduntan S. A
[1]Department of Forestry and Wood Technology,
Rufus Giwa Polytechnic, Owo.
[2]Department of Forestry and Wood Technology,
Federal University of Technology, Akure.
Corresponding Author: Osabiya O. S., nifemijedidiah@gmail.com

Abstract:

The study investigated the ethno-medicinal and phytochemical properties of Uvaria. chamae and U. afzelii within Ibadan metropolis. The bark of Uvaria species were collected from the wild in Sanu village in Akinyele local Government and air dried at room temperature for fourteen days then milled into uniform powder. Thereafter, phytochemical analysis was carried out on the samples following routine procedures. Also, a questionnaire-guided ethno-medicinal survey was in five markets from four randomly selected Local Government Areas in Ibadan were. Data generated were analyzed using descriptive statistics such as frequencies and percentages. Chi-square test was used to test for significance association between variables. The result of the phytochemical properties from the study indicates that U. afzelii had greater saponin (0.31 mg/g) and flavonoid (0.12 mg/g) than U. chamae (saponin: 0.28 mg/g; flavonoid: 0.11 mg/g). while U. chamae possess more quantity of tannins (0.11gm/g) than U. afzelii (0.04mg/g). It was observed that 52% of the respondents had no-formal education. The study shows a significant association between socio-economic characteristics of the respondents and their ethnomedicinal uses of the plants. The medicinal potentials of U. chamae and U. afzelii as revealed from this study is enough evidence for its importance as one of the alternative remedies to orthodox medicine, hence it is highly important to cultivate the herbs and conserve the ones in the wild.

Keywords: Geo-statistics, Interpolation, Kriging, Variogram, Estimation.

Introduction

The use of medicinal plant as a source of relief from illness is as old as humankind. According to WHO (1991), 80% of the world population uses medicinal plants for treating disease, while 80% of African uses traditional medicine for primary health care (WHO, 2003). Historically, humankind depends on timber mostly more that non-timber forest product (NTFPS) probably because they did not know the usefulness of these products. But today the demand from forestry practice has gone beyond the production of only wood products. The non-timber forest products include food, medicinal plants, herbs, shrubs, oil, resin, tannin, sponge, rope and so on (Omoluabi and Okafor, 1994).

It is believed that for every health disorder, there exist a plant that could cure the ailment (Barbara and Thesis, 1989). At times, some of these medicinal plants are so effective that their application could prevent surgical operation usually prescribe by orthodox medicine. For instance, cancer, fibroid, hernia that may require surgical operation could be cured ethno- botanically without operation (Adebisi, 2008).

The phytochemical constituent of a plant will often determine the physiological action on human body (Ayoola *et al*, 2008). Phytochemical like alkaloid, tannin, saponin, flavonoid, cynogenic glycosides, cardiac glycoside, anthraquinones have various health benefits. They have been found to possess anti-malaria, anti-diabetic, anti-microbial, ant-inflammatory, anti-cancer, and anti-hypertensive effect

(Trease and Evans, 2005). As plant continue to be major source of drugs for the world populations, substances derived from higher plant alone constitute about 25% of prescribed medicine (Hanbugar and Hostettman, 1991). Harbone (1973) reported that approximately half of about 250,000 flowering plant species occurring globally is found in the tropical forests which continue to produce natural products with valuable compound for the development of new drugs.

Uvaria chamae P. Beauv, commonly known as a finger root Eru-iju by the Yoruba. belongs to Annonaceae family, *Uchamae* is an evergreen plant, scandent shrub which grows to a height of 3.6 - 4.5m. Leaves are aromatic, apex, stipulate, alternate, glossy, glabrous and the flower are fragrant, yellowish in colour, fruit are edible, (Bonger *et al*, 2005; Odungbemi 2008). It is a small tree native to the tropical rain forest of West Africa and Central Africa, where it grows in wet coastal shrub land, it is distributed from Guinea, Senegal, Zaire, to Southern Nigeria. (Arbonnier 2004). Burkill (1985) reported that the root has a wide spread reputation, it is taken internally for bronchitis, gonorrhea, catarrhal inflammation in Nigeria. The root (pounded or pulverized) is used for the treatment of nose bleeding, heart diseases (bronchi, lungs etc.) and blood in the urine, pile, and fever (Etukudo, 2003; Iwu 1993; Adam and Moss, 1999). *U. chamae* play antibacterial and antioxidant role in prevention cancer inflammation cardiovascular diseases (Varban *et al*, 2009).
Uvaria afzelii Sc. Elliot are plant species which belong to Annonaceae family. Its' 'common name is "Puss Finger" and it is called "Gbongbonse" by the Yoruba. It is a scrambling shrub or small tree up to 5m high, of secondary shrub, occurring from Guinea southern Nigeria (Burkill 1985; Odugbemi, 2008). Burkill (1985) reported that *Uafzelii* is used for treating gonorrhea, bladder, kidney, stomach ache and the root is used as an antidote against food poison.

Even though most Nigerian depend largely on medicinal plants in their environment more than western drugs, the potential of such plants as source of drugs are yet to be fully exploited. Medicinal plants are resources of new drugs and many of the modern medicines are produced indirectly from plants. (Saleh *et al* 2015).

There is need to gather information on Nigeria ethno-medicinal plants. However, the availability of these medicinal or herbal plants is being threatened due to deforestation, urbanization, and conversion of forest land to Agricultural land, many of these plant species are in wild, semi-cultivated, cultivated domestically, some of these medicinal plants have gone to extinction. Medicinal plant has been used for various ailments such as asthma, blood disorder, cancer, fibroid, and arthritis, to mention but few (Duke, 1987; Adeniji, 2004; Odugbemi, 2008). This study is aimed at determined bio-active constituent presents in *U. afzelii* and *U. chamae* as well as their ethno-medicinal uses.

Materials and Methods

Materials

Root bark of *Uvaria* species, Plastic container, Plain paper, Mortar, and pestle

Methodology

The bark of *Uvaria* species was collected from Sanu village in Akinyele Local Government Area within Ibadan metropolis. The plant sample was then air dried at room temperature for fourteen days and milled into uniform powder. The phytochemical analysis was carryout in Forestry Research Institute of Nigerian, Jericho Ibadan following standard laboratory procedures. Also, oral interview and questionnaire were administred to herbal sellers in each of the markets.

Area of study

The research was carried out in Ibadan, the capital of Oyo State which has dry and wet seasons. The wet season is between April and November and the rainfall is 1,200mm per annum while the dry season is

between November and March. The vegetation is lowland rainforest bounded in the North side by the derived savannah (Adebayo *et al* 2003).

Sampling Techniques
Ethnobotanical survey aspect of the study was carried out in some selected markets within Ibadan metropolis. These include Eleyele, Alesinloye, Oja-oba, Oje, and Bode.

Method of data Collection
A total number of 50 copies (10 per market) of structured questionnaire were administered randomly to respondents in each market that are directly engaged/involved in herb selling. These markets were zone as follows:
Zone 1: Eleyele market – Ibadan North West LGA
Zone 2: Oja Oba market – Ibadan South East LGA
Zone 3: Oje market – Ibadan North East LGA
Zone 4: Bode \Alesinloye market – Ibadan South West LGA

Quantitative and qualitative analysis of phytochemical constituent:
Determination of Tannins
Tanin determination was carried out using the method of Harborne (1984) as described by Sha'a et al, (2019). About 1 g of powdered sample was boiled in 10 mL distilled water, filtered when hot and cooled. The filtrate was adjusted to 10mL with distilled water. Then, a few drops of 1% ferric chloride reagent were added to 1 mL of the filtrate. The mixture was observed for the formation of blue, dark brown, blue black, green, or green-black coloration or precipitate.

Determination of Flavonoid
Flavonoid determination was carried out using the method of Harborne (1984) as described by Sha'a et al, (2019). About 1 g of plant material was boiled with 10 mL of ethanol

a) Two drops of ferric chloride were added to 5mL of the extract. A dusty green color was considered positive.
b) a small quantity of dilute NaOH was added to 5mL of the extract and drops of Conc. HCl were run down the side of the tube. A reddish coloration indicated the presence of flavonoid.

Determination of Cyanogenic Glycosides
Ethanol extract (0.2 g) was dissolved in 1 mL acetic anhydride and then 1 mL of dichloromethane. The solution was transferred into a dry test tube and by the means of pipette, 2 mL of concentrated sulphuric acid was added to the solution. At the contact zone of the two liquids, a brownish-red ring is formed; the supernatant layer became greenish denoting presence of sterols and triterpenes (Cho et al, 2013).

Determination of Cardiac Glycoside
A powdered sample (1 g) was extracted with 10 mL of 80% ethanol for 5 minutes on a water bath. The extract was filtered and diluted with equal volume of distilled water. A few drops of lead acetate solution were added, shaken, and filtered after standing for few minutes. The filtrate was then extracted with aliquots of chloroform, the extract was divided into two portions in evaporating dish and evaporated to dryness on a steam bath (Auwal et al, 2014).

(a) Keller-Killiani Test
(b)Kedde Test
The second portion was mixed with 1 mL of 2% 3, 5-dinitrobenzoic acid in ethanol. The solution was made alkaline with 5% NaOH after mixing. The formation of a transient purple colour, which turned brown on standing, was considered positive (Trease and Evans, 1989).

Determination of Anthraquuineone

Anthraquuineone determination was carried out using the method described by Auwal et al, (2014). Powdered sample (1 g) was boiled with 5 mL of 10% HCl for 5 minutes and filtered while hot. The cooled filtrate was partitioned against equal volumes of Chloroform (2 vols.) avoiding vigorous shaking. A clean pipette was then used to transfer the chloroform layer to a clean tube taking care not to include the aqueous layer. An equal volume of 10% ammonia was added to the chloroform extract. A pink, red or violet colour in the aqueous layer was considered positive.

Data Analysis

Data generated from the study were analyzed using descriptive statistics such as frequency, percentage, statistical mean. Chi-Square Test was used to test for significance relationship between variables. All statistical analysis was carried out using Statistical Package for Social Sciences (SPSS) version 20.

Results and Discussion

Table 1: Mean value of (mg / g) of the phytochemical component of *Uvaria afzelii* and *Uvaria chamae*

Phytochemical	*Uvaria afzelii* (Puss finger)		*Uvaria chamae* (bush banana)	
	Mg / g	Relative % of mean	Mg / g	Relative % of mean
Saponin	0.31	67.39	0.28	54.90
Flavonoid	0.11	23.31	0.12	23.53
Tannins	0.04	8.70	0.11	21.57
Anthraquinones	-	-	-	-
Cynogenic glycoside	---	---	---	---
Cardiac glycoside	---	---	---	---
Total	0.46	100	0.51	100

From the table, it was observed that saponin content in both *U. afzelii* (0.31 mg/g) and *U. Chamae* (0.28 mg/g) is considerably high. The identification of abundant presence of saponin in the root of the both plants may be responsible for their haemostatic activity where they arrest bleeding from damage or injured vessel. The presence of saponin in both plants agrees with work of George (1999) who observed that many plants produce saponin had these properties antifungal, antibacterial, diuretic, expectorant, analgesic, and healing characteristics. The results of the phytochemical analysis are like the findngs of Okwu and Iroabuchi (2004) where saponin was reported to be present in *U. chamae*.

Flavonoid was observed to be more in *U. chamae* (0.12 mg/g) than *U. afzelii* (0.11 mg/g). This is line with the report of Selamoglu (2016), who stated that Flavonoids are found ubiquitously in plants as a member of polyphenolic compounds which share diverse chemical structure and properties are known to have potent antioxidant activity due to intracellular free radical scavenging capacities. These protect cell against damage and improve exchange of nutrient and oxygen between the blood tissues, they also reinforce capillary walls. This also agreed with the finding of Amakoha *et al (*2002) who reported that present of flavonoid appear to protect the tiny capillaries that carry oxygen.

Also, from the study, both plants possess tannin in considerable quantity though *U. chamae* possess more quantity of tannins (0.11mg/g) than *U. afzelii* (0.04mg/g). Hassan *et al*, (2012) reported that Tannins are important compounds known to be potent cyclooxygenase-1 inhibitors and with anti-phlogistic activity. The mechanisms of anti-inflammatory activity may be related to the anti-phlogistic action of the tannins. The presence of tannin in both plants may account for their use as anti-inflammatory agents, cure for swelling, ulcer and stomach ache.

Table 2: Socio-Demographic characteristics of the respondents

Variable	Frequency	Percentage
GENDER		
Male	3	6.0
Female	47	94.0
Total	50	100.0
EDUCATIONAL LEVEL		
Non – formal Education	24	48.0
Primary Education	16	32.0
Secondary Education	8	16.0
Tertiary Education	2	4.0
Total	**50**	**100**

From the survey, the demographic characteristics of the respondents such as gender and education level, were considered. From the survey, female respondents (94%) accounts for the highest population and this agrees with the work of Oladeji and Agbelusi (2017) who reported that females engage more in the sales of herbal medicine than males. This may be since herb selling is considered a female job. Findings of the study revealed that 52% of the respondents had non-formal education, 28% had primary education, 16 % had secondary education, while only 2% had tertiary education. This implies that majority are illiterate in the business. According to Yakubu *et al.* (2001) it was observed that illiterates participated more in the business of herb than the literate.

Table 3: Frequency of from of application of *U. chamae* and *U. afzelii* for treatment

Variable	Frequency	Percentages
Powder	13	26.0
Boiling	30	60.0
Soaking	7	14.0
Total	50	100.0

In ethno-medicine, the mode of application of the herbal material is quite important. This study has revealed that in order of greatest importance, herbal sellers use *U. chamae* and *U. afzelii*in form of boiling and powder. This order supports the fact that boiling and powder will have longer shelf –life than either soaking or plant juice according to Sofowora (1993).

Table 4: Chi-square analysis showing relationship between the respondents' level of perception of ethno-medicinal uses of *Uvaria* species and their socio-economics characteristic

Socio-Economic value	Chi-square value	DF	Asymptotic value	Decision
Gender	38.720	1	0.000**	Significant
Educational status	22.000	3	0.000**	Significant

*** Significant and NS - Not Significant at p < 0.05*

From the Table chi-square analysis for gender, and education status of the respondents has a significant association with ethnomedicinal uses of both plants in this study. This implies that the ethnomedicinal uses of the plants are based on the socio-economic factors and this agrees with the observation of Adebisi (2008).

The importance of *U. afzelii* and *U. chamae* in curing ailments cannot be overemphasized as important phytochemicals like saponin, flavonoid, and tannin were present in the two plants in considerable

quantity, hence their high medicinal potentials. The result also showed that age, gender, marital status, education status, primary occupation of the respondents has significant association with the ethnomedicinal uses of *U. chamae* and *U. afzelii* in this study The medicinal potential of both plants as revealed from the study will help to preserve our cultural heritage and its impact will help to ameliorate diseases for the future development of our traditional medicine. Therefore, *U. chamae* and *U. afzelii* should be cultivated and be conserved as an alternative remedy to orthodox medicine. There should be an intensive awareness on usage and efficiency of forest trees like *U. chamae* and *U. afzelii* as alternative therapy.

References

Adams, M. R. & Moss, M. O. (1999). Food microbiology, Cambridge, The Royal Society of Chemistry, Pp. 471 – 476.

Adebisi, L. A. (2008). Nature's pharmacy in man's immediate Environment: Implication for primary health care delivery. Ibadan: University of Ibadan press. Pp8.

Adeniji, M. O. (2004). Herbal treatment of Human diseases. Ibadan: YNX International, Pp. 41 – 42.

Amakoha, R.A, Ubwa, S., Otokpa, T. & Shenge, G. (2002). Phytochemical composition and biological activities of Uvaria chamae. Urology, 54(6), pp1001- 120.

Arbonnier, M. (2004). Trees, shrubs and lianas of West African dry zones Germany. CIRAD press Ltd, Pp.243 – 248.

Auwal, M. S., Saka, S., Mairiga, I. A., Sanda, K. A., Shuaibu, A., & Ibrahim, A. (2014). Preliminary phytochemical and elemental analysis of aqueous and fractionated pod extracts of Acacia nilotica (Thorn mimosa). *Veterinary research forum: an international quarterly journal*, 5(2), 95–100.

Ayoola, G. A., Folawewo A. D., Adesegun S. A., Adepoju, O. O., Bello, A. A. and Coker, H. A. B (2008). Phytochemical and antioxidant screening of some plants of Apocynaceae from South West Nigeria. *African Journal of Plant Science. 2(9): 124 – 128.*

Barbara, O. & Thesis, P. (1989). The family herbal healing. Art press, One Park Street, Rachester, Vemont 05767.

Bonger, S. F, Parren, P. M. E T &Traore, (2005). Forest climbing plants of West Africa: Diversity Ecology and Management Zelhi: CAB International. Pp.342-348.

Burkill, H. M., (1985). Entry for *Lasiurus hirsutus* (Forssk.) Boiss. [family POACEAE]. In: The useful plants of West tropical Africa, 2nd edition. Royal Botanic Gardens, Kew, UK.

Cho, H. J., Do, B. K., Shim, S. M., Kwon, H., Lee, D. H., Nah, A. H., Choi, Y. J., & Lee, S. Y. (2013). Determination of cyanogenic compounds in edible plants by ion chromatography. Toxicological research, 29(2), 143–147. https://doi.org/10.5487/TR.2013.29.2.143.

Duke, J. A. (1987). Hand book of medicinal herbs. CRC Press, Florida, pp. 458.

Etukudo, I. (2003). Ethnobotany conventional and traditional uses of plants, Uyo: The verdict press, Pp. 10. Garden Plants DK Publishing Inc., N Y, 1997, 14 -18.

Hamburger, Matthias & Hostettmann, Kurt. (1991). Bioactivity in plants: The link between phytochemistry and medicine. Phytochemistry. 30. 3864-3874. 10.1016/0031-9422(91)83425-K.

Harbone, J.B. (1973). Phytochemical methods –1st ed. London: Chapman and Hall Ltd, pp. 49 – 88.

Harborne, J. B. (1984). Phytochemical Methods. Chapman and Hall London: New York.

HassanMusfizurMd, Shahid-Ud-DaulaA.F.M, JahanIsmet Ara, NimmiIshrat, AdnanTarek, Abdullah-Al-Mansur & HossainHemayet (2012). Anti-inflammatory Activity, Total Flavonoids and Tannin Content from the Ethanolic Extract of Ageratum conyzoides Linn. Leaf *Int. J. Pharm. Phytopharmacol. Res.*, 1(5): 234-241.

Iwu, M.M. (1993). Handbook of African Medical plants. Boca Raton, FL: CRC press, pp 367.

Odugbemi, T. (2008): A Text Book of medicinal plant from Nigeria. University of Lagos press.

Okwu, D. E & Iroabuchi, F. (2004). "Phytochemical analysis and antimicrobial activity screening of aqueous and ethanolic root extracts of Uvaria chamaeBeuv and Cnestis ferruginea". *J. Chem. Soc. Nigeria,* 29(2):112-114.

Oladeji, S. O. & Agbelusi, E.A. (2017). Capturing indigenous knowledge on medicinal plants use: Case study of selected communities in old Oyo national park, Nigeria *Afr J Tradit Complement Altern Med.,* 15 (1): 117-136.

Omoluabi, F. & Okafor, B. (1994). A survey reports on non – Timber forest product. A case study of Cross River State, 1994, FORMECU Ibadan. Publishing House, New Delhi.

Saleh, H. Azizollah, J. Ahmadreza, H, Raham, A. (2015). The Application of Medicinal Plants in Traditional and Modern Medicine: A Review of *Thymus vulgaris*. *International Journal of Clinical Medicine*,**06**,635-642. doi: 10.4236/ijcm.2015.69084.

Selamoglu, Z. (2016). Antioxidant Activity of Quercetin: A Mechanistic Review. Turkish *Journal of Agriculture - Food Science and Technology*. 4. 10.24925/turjaf.v4i12.1134-1138.1069.

Sha'a, K. K., Clarkson, G. P., & Artimas, S. P. (2019). Phytochemical analysis, proximate composition and antinutritional factors of Corchorus oliterius plant. *International Journal of Biological and Chemical Sciences*, 13(4), 2147-2157.

Sofowora, A. (1993). Medicinal plant and traditional medicine in Africa (2nd ed). Spectrum books Ltd. Ibadan.

Trease, G.E. and Evans, W.C. (2005). Pharmacognosy (14th ed). Elsevier, New Delhi, Indian,

Varban, D.I., Dudon, M., Varban, R., & Mundean, S. (2009). Research Concerning the organic Technology for satureja Hortensis L. *Culture Bulletin UASUM Agriculture,* 66(2), 225 – 229.

World Health Organization (1991). Guidelines for the practice of traditional medicine (TRM/Genva), Pp 6.

World Health Organization (2003). "Traditional Medicine" fact sheets number 34. Revised May, 2003.

RUGIPO RESEARCH AND TECHNICAL JOURNAL

CREATING VIRTUAL ARCHITECTURAL EDUCATION IN A TRADITIONAL ENVIRONMENT: PROSPECTS AND CHALLENGES

Authors

O. S. Ilesanmi[1], E. T. Ojo[1], I. E. Bankole[1], and OlusegunOlaiya Kolade[2]

[1]Department of Architectural Technology,
Rufus Giwa Polytechnic, Owo.

[2]Department of Art and Industrial Design,
Rufus Giwa Polytechnic, Owo.

Abstract:

The advent of computer technology has set off an information explosion that has changed civilization and indeed the entire workforce of the world. These changes presage a new context in which architecture schools must function. Traditionally, architectural education is basically between a group of persons; the teacher and the learner(s) in a defined classroom space. This mode of knowledge delivery makes the students to adopt a passive position (based on just listening to the teacher). This prevents the diversity of ideas, promotes repetitive learning and kills creativity. ***Virtual education*** *on the other hand refers to instruction in a learning environment where teacher and student are separated by time or space, or both. In this knowledge delivery mode, students' take responsibility of their learning process in an active way. Multimedia tools, electronic media like a discussion forum, chat room, voice mail, and e-mail are employed for communication. The benefits inherent in this type of learning process include sharing of resources and learning environment, promotion of collaborative learning, effective education delivery and educational programme enhancement. In this paper, the concept "virtual architectural education" is considered together with the inherent benefits for the architecture schools and profession.*

Keywords: Architecture, Computer, E-mail, Multimedia, Technology.

Introduction

Architectural education has over the years undergone some level of transition encouraged by the innovation and advancement of information communication technology (ICT) (Oko, 2005).This change is both necessary and desirable as stagnation of any kind is a recipe for the decay of the profession. ICT in architectural education means that there is a transition from the traditional mode of teacher to student knowledge delivery in a defined classroom space to knowledge infrastructure (laboratories, radios, television and the internet), from a classroom of a group of learners to individual learners, from a teacher as knowledge provider to a teacher as a tutor and a facilitator, from a set of text books and audiovisuals to multimedia materials (Arolosafe, 2005).

Virtual architectural education which is a new and unconventional approach to the education of architects is a fall out of the increasing technological advancement of today's world. Hitherto, architectural education was basically between a group of persons; the teacher and the learner(s) in a defined classroom space. As straight forward as this model may be; there is a fundamental and continuing failure to prepare students for the real world of practice (Chukwuma-Uchegbu, 2006).In the first place this mode of knowledge delivery makes the students to adopt a passive position (based on just listening to the teacher). This prevents the diversity of ideas, promotes repetitive learning and kills creativity which is so needed for a successful practice life.

In Virtual architectural education, the traditional design studio with drawing tables and T-squares are

replaced with computers and digitizers (Abubakar, 2006). This development is corroborated as necessary by Adeyemi(1986) who opines that architecture as a profession should not be confined to the creative wonder of the paper and pencil alone, it should rather take advantage of emerging design situations which can be attributed to the incorporation of new technologies in architectural education. This way; the student's imagination and creative thoughts are stimulated. This new mode of knowledge delivery which is based on flexible patterns of work, focuses on information gathering, processing and analysis, calls for an educational curricular change for the training of Nigerian architects who will be critical thinkers, able to interact with other professionals and the general society in an environment of rapid information exchange and technological changes(Sa'ad,2001)
This knowledge delivery mode has some prospects as well as some challenges and this is the focus of this paper.

Definition of Terms

Architecture:

The word "architecture" comes from the Latin word, "architectura" and ultimately from Greek,"arkitekton", which means "master builder". While the primary application of the word "architecture" pertains to the built environment, by extension, the term has come to denote the art and discipline of creating an actual, or inferring an implied or apparent plan of any complex object or system(http://en.wikipedia.org/wiki/Architecture)

Computer:
A computer is a machine which manipulates data according to a list of instructions which makes it an ideal example of a system. The ability to store and execute lists of instructions called programs makes computers extremely versatile and distinguishes them from calculators(http://en.wikipedia.org/wiki/computer).

E-mail:
E-mail (short for *electronic mail*; often also abbreviated as *e-mail*, *email* or simply *mail*) is a store and forward method of composing, sending, storing, and receiving messages over electronic communication systems. The term "e-mail" (as a noun or verb) applies both to the Internet e-mail system based on the Simple Mail Transfer Protocol (SMTP) and to X.400 systems, and to intranet systems allowing users within one organization to e-mail each other(http://en.wikipedia.org/wiki/e-mail).

Multimedia
Multimedia according to wikipedia free encyclopedia (http://en.wikipedia.org/wiki/ multimedia), is a digitally-unified media made up of the following components: sound, text, picture and movie. "Digitally-unified" means that different types of materials (sound, text, picture and movie) are digitally unified into information which is delivered by means of internet.

Technology*:*
The word "technology" means the application of science, especially to industrial or commercial objectives. It also means the scientific method and material used to achieve a commercial or industrial objective (http://en.wikipedia.org/wiki/technology):

What is virtual education?
Virtual education is a teaching and learning process based on the principles of active pedagogy (where the student takes the responsibility of a frequent and effective participation),with the characteristics of distance education (during most or all classes,students and teachers will not personally meet. This may however happen in a virtual space;with the possibility of synchronous(chatting with each other in real time using internet services) and asynchronous(using technologies that don't require that both are on-

line at the same time) interaction(Alejandro, 2007).
Virtual education refers to instruction in a learning environment where teacher and student are separated by time, space or both. The teacher provides the course content through course management applications, multimedia resources, the internet and video conferencing. The students receive the content and communicate with the teacher via the same technologies (en.wikipedia.org/wik/ve, 2007).

Types of Virtual Education
Three different modes of virtual education resulting from the combination of the number of virtualized activities have been identified namely: Totally virtual, Half virtual and Virtual support to face to-face course.

In the *totally* virtual educational mode, the traditional mode of face to face knowledge delivery is totally replaced with its virtual counterpart (*virtual instead of real*). In this case, teaching and learning are done by electronic means like e-mail, mailing lists, newsgroups, Internet Relay Chat, web and virtual learning communities' .The half virtual mode is a mixed mode of knowledge delivery resulting from the combination of virtualized and "traditional" teaching and learning activities. Here some of the activities are executed electronically (on-line) by the use of Internet facilities while some others are done in a face to face teacher -student interaction in a physical classroom (Van Dusen, 1997).The virtual support to face to-face course mode harnesses the energy of the new information communication technology in the service of traditional educational delivery method**(Dowlin, 2000)**.This teaching and learning mode was designed to enable teachers and students use data to help with instructional planning, delivery and reception. The whole teaching and learning experience is carried out in a face to face teacher -student interaction in a physical classroom. Educational materials for research are sourced from virtual libraries through the internet.

This encourages a dynamic system of relationships between the real and the virtual worlds as regards virtual educational programs, in which the virtual becomes a complement of the physical; improving its deficiencies. In this mode of knowledge delivery, information and communications technologies (ICTs) do not replace the need for good educational design and delivery. However, they provide additional possibilities for teacher- learner support, interactivity, and access to educational materials.

Elements of Virtual Education
The main elements of the virtual environment which applies to virtual architectural education as listed by Totkov and Samova(2000),include: Subjects and Objects. The subjects include the students, teachers, and administrator. The student is the center of any virtual educational system. He determines by himself the program, time and place of studying, pace and way of studying as well as the information and communication recourses for his own needs. Students in virtual education have a new role; they cannot stay passive consumers of knowledge anymore; they have to be involved in the process of obtaining new knowledge; to learn through solving tasks and using a wide variety of learning resources to purposefully present and share their ideas and opinions.

The teacher's role in the learning process is also changed from source of information to tutor in education. The teacher motivates, puts the goals as well as formulates the tasks, holds consultations to discuss the problems with the learners. He also evaluates the students progress and determines the proper learning resource for each virtual student .

The Administrator performs the following functions in the process of virtual education:
registration of the subjects, communication with students and teachers, provides
support of the data base for all subjects and objects, Inserting information and advertisement about

offering programs and courses, Preparing different data base report,
sending the reports to the teacher and the student, organizing the students in a group, determining the teacher of a given group and Inserting a new recourses in the library and the bookshop, Totkov, etal (2000).

The objects are common information recourses, learning program, learning course, learning material, learning test, library recourse, goods from bookstore, and message from message board, message from forum, e-mail and group.

Virtual Architectural Education in Nigeria (Prospects and Challenges)
The Nigerian architectural education
This is carried out at the following levels in Polytechnics and Universities.At the Polytechnics, we have the traditional distinction between the following categories:National diploma programme which produces architectural technicians is run for 3 years (2 years of tutelage and one year of industrial training). The Higher national diploma programme provides middle level manpower for the profession. It is run for 3 years (2 years of tutelage and one year of industrial training).

At the Universities, architectural education is taught at the following levels: Undergraduate level (Bachelor of Science, degree), Graduate level with award of the following degrees: Post graduate diploma, Master of Science and Doctorate degrees. It started in Nigeria with the offer of a single tier six years degree programme and awarded the Bachelor of Architecture (B.Arch) degree. The products of the universities were mainly to service the professional needs of the public and private sector of the economy. The two-tier system of Bachelor of Science (B.Sc) and Master of Science (M.Sc) degrees then came. The main aim of this change is the need to conform to the global trend as well as produce professional architects with strong research base to serve in the academia, research institutes, public and private sectors (Agoha, 2006).

Prospects of Virtual Architectural Education
Over the years, the number of architectural education aspirants has increased appreciably without a commensurate increase in the facilities and qualified instructors (Chukwuma-Uchegbu, 2006).Alternative ways of providing access to architectural education via virtual education needs to be fully explored. The following are the identified prospects of virtual architectural education by Osei and Fikile (2007):

1. Virtual education makes it possible for students anywhere who have access to Internet and Web connections to enroll in online courses.

2. It encourages new frontiers to architectural teaching and learning through enriching collaborative research among schools of architecture in Nigeria, Africa and other parts of the world.

3. It promotes cross-national, multi-disciplinary perspectives in the educational practice, and thereby equips students, faculty, and administrators with tools and resources that would enable them to successfully engage the academic world of the 21st century.

4. Virtual architectural education will enable the academia to take advantage of educational opportunities (such as virtual access to faculty and up-to-date educational materials through online libraries around the world) to become part of the global learning community.

5. Through virtual architectural education, fewer Nigerians will leave the country for opportunities elsewhere. Hence the issue of brain drain will be minimized if not eradicated.

Challenges of Implementing Virtual Architectural Education in Nigeria
While virtual architectural education holds promises, a number of obstacles have been identified which will have to be addressed before it can be fully utilized in Nigeria?

i. **Technological constraints:**

To implement technologies that allow virtual education, it is necessary to have more equipment (internet connected computers) for the on Campus students that are going to attend half-virtual courses, and also for those that will have virtual supports to their classes. Telephone and other communication infrastructure remain inadequate in many schools of architecture nationwide.

ii. **The lack of a trained cadre of professionals:**

The effective use of virtual learning technologies demands that the staff of any faculty be properly trained in using the virtual platform as a delivery mode. To date, few Nigerian architecture scholars are familiar with teaching in an online environment. This situation poses a major challenge in introducing virtual architectural education in Nigeria.

iii. **Cost of connectivity**

Any authentic virtual education requires the following basics: access to computers, Web browsers such as Explorer or Netscape, word processors, easy and inexpensive connections to Internet service provider (ISP). In addition, depending on the nature of a given course, students might be required to use a video cassette recorder to play videotape instruction and perhaps tape record lectures. All of these basics require funds which many individuals and institutions simply do not have.

Other challenges identified by Alejandro ,(2007) are listed below:
Resistance to change: This is two pronged; the teacher's resistance and the student's resistance to change. These are x-rayed below:

i. The teacher's resistance to enter into the technological era

Unfortunately, today there are professors that do not know how to read an email or how to take advantage of the internet to improve research. There are probably two big factors that influence this resistance: ignorance and lack of motivation, the last one due to certain unconscious resistance. Concerning the unconscious resistance, this could be the result of computer-related frustrations, the fear to face new things (fear of changes), or of the narcissistic idea (some kind of omnipotence) that there is nothing that the machine can do for us in the teaching-learning process.

ii. The teacher's resistance to change in the pedagogical level

To teach in a virtual classroom means to transform the traditional pedagogy toward an electronic pedagogy in which the teacher becomes a facilitator of the student's learning process. This "new" pedagogy supposes that the teacher should be qualified in new pedagogic techniques and should renounce, totally or partially the face to face interaction in class, and, for some members of the academia, this is very difficult.

For many lecturers, it can also be a threatening experience if they do not feel comfortable in writing, because interaction in virtual education is given mostly in this way. Facing this new course delivery mode could be a problem, when the teacher is already accustomed to the use of an easy pedagogy in which the same class is repeated semester after semester without having to make the effort of researching, of improving, or of enlarging the cognitive spectrum.

iii. The resistance of the students to change

Students have the habit to work in a space in which only the lecturer speaks and directs his class. In this case, the good teacher is the one that makes all the effort, while the bad teacher is the exigent one, the teacher who makes work their students' and the one that does not give everything. The consequence is that an enormous distrust is generated toward the facilitator teacher's role, which is the position of the lecturer in a virtual course. The “traditional” mode of lecture delivery; is a position that generates a lot of

satisfaction because of the power of recognition. It is also a position that prevents the diversity of ideas, promotes the repetitive learning and kills creativity.

Addressing the Challenges

The challenges can be addressed through the following ways:

i. **Creating a learner support system**.

Since the concept of virtual educational technology is still an emerging area in Nigeria, a learner support system needs to be put in place to assist students to comprehend all the technical details needed to make effective use of the technology. Research shows that virtual learning requires a lot of self-discipline on the part of the student; student isolation tends to be high, compared to conventional learning. , this study recommends that the virtual support mode should be encouraged at the under graduate level, while the half and totally virtual mode can be employed at the graduate level(with "mature" students).Strategies for reducing dropouts should be put in place to ensure successful completion of programs.

ii. **Need for higher educational institution, public, private sector corroboration.**

The inputs of educational institution, public and private sectorswould be very crucial in advancing the development of virtual architectural education. The private sector should assist with technologies for the delivery of virtual education. Government agencies should also formulate national policies to promote virtual education as well as invent campaigns to heighten awareness about its potentials. Academicians in the meantime should create locally-based content by way of curriculum review.

iii. **International corroboration of architecture schools.**

Nigerian schools of architecture will have to start institutional links to foreign schools of architecture utilizing virtual architectural education. Such programs will offer Nigerian students the opportunity to take courses online.

iv. **Solving the infrastructural obstacles:**

One of the major obstacles to virtual architectural education is the lack of a well-developed telecommunication infrastructure. Many institutions are less likely to benefit from the advantages offered by information technologies. The telecommunications infrastructure will have to be further improved with adequate energy back up in order to achieve an effective virtual architectural education in Nigeria.

v. **The need for faculty training**

This is essential if Nigerian architecture schools are to make any significant headway in applying virtual educational technologies. Faculty training could be offered by experts who have distinguished themselves in the use of emerging communications technologies.

Conclusion

The need to improve access to educational opportunities, at all levels, will lead to the innovation of Architectural education without walls (virtual architectural education). However, more than just resources are necessary to maximize the potential of virtual architectural education so as to transform architectural education in Nigeria. Careful attention to planning, funding, support, and incentives is a prerequisite for any institution wishing to change itself and prepare its students for the 21st century.

References

Abubakar,S.S. (2006). Evolution of the computer as a tool of design in architecture",

Aarches Journal, Vol.5 No. 2.

Adeyemi, A. (1986). Comments on William Porter's Presentation on "technology, form and Culture in architecture: misconception and myth". Proceedings of seminar10; Architectural.transformation in Islamic world at Granada Spain, 2006.

Agoha, B. (2006). "Raising architecture from department to faculty level: a framework for sustainable architectural education in Nigerian Universities in the 21st century." a paper presented at AARCHES Conference, February, Minna.

Alejandro, F. (2007). Challenges of virtual education(from http//www.vechallenges.org) accessed on the 18th September,2006.

Arolosafe, G (2005). "Use of ICTs in education". Paper presented at ETF Capacity building workshop for lecturers in Monotechnics and Polytechnic at Federal Polytechnic, Nekede, September 2005.

Chukwuma-Uchegbu, M.(2006). "Improving Instructional Quality and the Implication for the career of the Nigerian Architect Graduate",*AARCHES Journal*,Vol.5.No 2.

Dowlin, K. E, (2000). "The convergence of the methodology for the traditional school of library information and continuing education of the professional".A paper presented at the International Federation of Library associations and Institutions. Annual conference.Downloaded from www.ifla.org on September 20th 2007.

José, Silvio (2001). "Virtualization of the University". A Paper presented at TESALC UNESCO conference at Cracas, Venezuela, august 2001. Downloaded from www TESALC-UNESCO.org on September 20th 2007.

Oko, O.O, (2005). "Modern instructional techniques" Paper presented at ETF Capacity building workshop for lecturers in Monotechnics and Polytechnics at Federal Polytechnic, Nekede, September 2005.

Osei, D.&Fikile,M. (2007).Creating virtual learning communities in Africa: Challenges and prospects". Downloaded,from: (Http//www.firstmonday.org.issues/issue5_5/darkwa/index.htm//author)on September 16th 2007.

Sa'ad, H.T.(2001). "The changing role of the ever changing technology, socio-economic and political global environment, architects and architecture in Nigeria,".A paper presented in honour of Prof .E.A.Adeyemi.

Totkov,G.&Samova,E.P. (2000). "A multipurpose environment of type "virtual university"journal of international research, downloaded from www.eJournalnet.com September 20th2007.

Van,Dusen, (1997). "The virtual campus: technology and reformation in higher education". aspheric educational report,Vol.25 No.5, 1997.

Wikipedia, free encyclopedia(http://en.wikipedia.org/wiki/),accessed on September 17th 2007.

RUGIPO RESEARCH AND TECHNICAL JOURNAL

ENGAGEMENT OF HEALTH AND SAFETY PRACTITIONERS ON CONSTRUCTION SITES: ITS EFFECTS ON WORKERS' PERFORMANCE

Authors

Olowolayemo, O. E.[1], Williams, O. S.,[2] Ogunbode, A. B.,[3]Oyegoke, I. K.[4]and Popoola, O. M.[5]

[1,2&3]Department of Quantity Surveying,
Rufus Giwa Polytechnic, Owo, Nigeria
(E-mail: olowoseuneben@gmail.com,)
[4]Department of Building Technology,
Rufus Giwa Polytechnic, Owo, Nigeria
[5]Directorate of Physical Planning,
Rufus Giwa Polytechnic,Owo. Nigeria.

Abstract:

The construction industry has a reputation for having many reported accidents, with construction workers approximately three times more liable to experience fatal accident than those in other industries due to lack of engagement of safety practitioners in various construction sites. This study assessed the effects of engagement of health and safety practitioners on performance of workers on construction sites in Ondo State, Nigeria. This was with a view to reduce the occurrence of accidents on the construction sites in the study area. Primary and secondary data were used for the study. A hundred and thirty (130) valid questionnaires were administered among the workers and contractors working on the construction sites in the study area with a retrieval of one hundred (100). The data from the questionnaire was analysed statistically. Mean scores analysis was used to get the mean of the professionals' views on the effects of engagement of health and safety practitioners on the performance of workers on the construction sites and ANOVA was used to test the perception of the professionals and the contractors. Findings revealed that engagement of health and safety practitionersleads to efficiency of workers on construction sites. The study recommends that engagement of health and safety practitioners should be more paramount to all the stakeholders in the construction industry so as to reduce accidents on construction sites.

Keywords: Accident, Health and safety, Construction site, Construction workers, Engagement

Introduction

Despite the fast-growing construction projects in the past few decades, the challenges of health and safety in the construction industry have grown significantly. The safety record in the construction industry remains poor; construction industry remains one of the most dangerous sectors to operate. The severity of the risk of accidents also depends on the number of risks or risks identified. Influential factors include job stress, organizational factors such as incentives or bonuses, personal factors such as fatigue, work environment, and external factors such as climate (Hallowell and Gambatese, 2009). However, the most well-known causes of accidents on construction sites were working at height, working underground, working in confined spaces and near falling objects, hand luggage, hazardous materials, noise, dust, plant and equipment, fire, cables exposure, maintenance housing and ergonomics (Okoye, 2018).

According to Dodo (2014),health and safety is an important part of construction activities due to the uniqueness of the industry. Different trades and skills are needed to be carried out in a safe environment. However, individual's contribution determines the successful outcome of the projects.

Adherence to health and safety regulations remains one of the most important parameters to successful project delivery.Injuries and deaths associated with construction accidents are costly in the industry (Pearce, 2003).

In Nigeria, like many other countries in the world, construction is rising when it comes to a list of comparable risks and health risks. Taking a look at the statistics, the smallest detail is available in estimates of the level of accidents that occur on construction sites every year. From the statistics, it is found that most of the accidents and ill-health problems are not reported.However, limited data provided by the Inspection Division of the Federal Ministry of Labour and Productivity shows that the Nigerian construction industry accounts for about 7.5% of all occupational accidents, 49.5% of these injuries are fatal, 12.2% of minor injuries and 7.4% of minor injuries as stated in Umeokafor*et al*., (2014).

The construction industry is ranked second with injuries, behind mining industry (Mbuya and Lema, 2002). In any construction site, appropriate health and safety measures should be considered and used to reduce or eliminate the risk of death or injury at the construction site.

The study Area

Ondo state is one of the thirty-six states of Nigeria. The state which is also called the sunshine state is made of eighteen local government areas according to last election in October, 2020 (INEC). Most of the ongoing projects in the state were in the State Capital, particularly Akure South Local Government in Ondo central senatorial district. In view of this, the study was carried out in Akure South Local Government in Ondo central senatorial district.Other Local governments in the state are as follows: Akoko North-East, Akoko North-West, Akoko South-East, Akoko South-West, Akure North, Ese Odo, Idanre, Ifedore, Ilaje, Ile Oluji/Okeigbo, Irele, Odigbo, Okitipupa, Ondo East, Ondo West, Ose and Owo.

Literature Review

Health and safety practitioners play key duties in maintaining the health and safety of workers by carefully evaluating work performed on site on potential accidents and minimizing or preventing associated accidents (Ali, 2009)the levels of accidents and injuries in the Nigerian construction industry are very high. Idoro (2011) identified that the most appropriate way is to focus on operational efforts that address the factors that cause such accidents and injuries and the degree of control. Unfortunately, Olatunji and Bashorun (2006) regretted that although the certification received much support and public interest in contract procurement in Nigeria, the health and safety aspects of the contractor's work were not prioritized. The impact of health and safety inefficiencies on the Nigerian construction industry is unexplained and can be seen in the number of accidents and injuries resulting from construction activities across the country.

Duties of Health and Safety Practitioners

The duties of the health and safety practitioners include social and well-being of workers. In order to achieve this input and contribution between government, clients, contractors, workers, trade unions and other structures needed. Little attentionhas been given to work-related health, safety and environment concerns, but it can be very expensive if not addressed. Understanding and the ability to protect ourselves, our loved ones, our community and the things around us that we rely so much on to make it a priority is something we must have. The lives of workers and their relatives, clients, contractors and the community at large can be greatly affected by construction accident (Kirby and Hurst, 2004).

Health andsafety practitioners not only targets construction workers from one area but also needs to provide protection for immigrant workers (Bust et al. 2008).

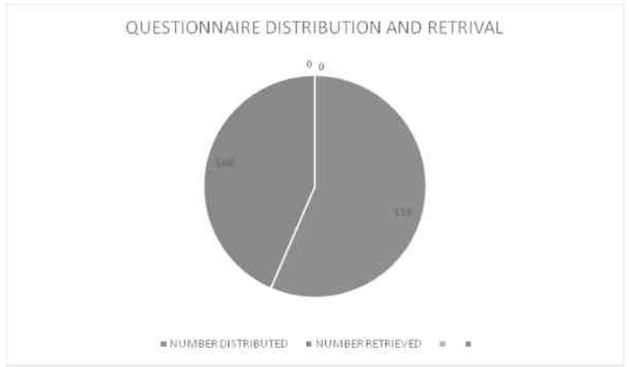
Methodology

In addition, data for the study were from both primary and secondary source. Primary data were mainly through well structured questionnaires and personal observation made during visits to the study areas. To identify potential respondents, a preliminary survey was done and found outthat most of ongoing projects in the state were in the State capital, particularly Akure south local government in Ondo central

senatorial district. In view of this, the study was carried out in Akure south local government in Ondo central senatorial district.From this arrangement, 10 construction site were randomly selected in the State capital.Sample sizes were determined, and respondents were identified.

Findings and Discussion

Figure 1 showed the number of questionnaire distributed and retrieved from different organizations that made up the population.

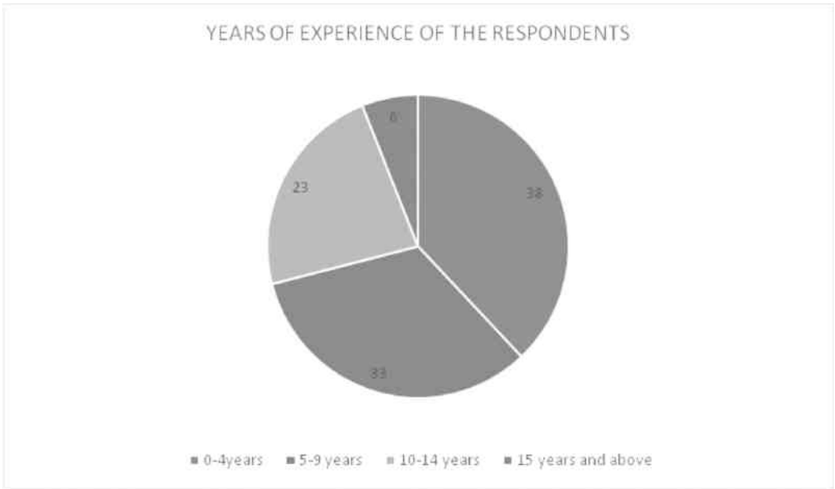


Data Analysis

The data from the questionnaire was analyzed statistically. Percentage was used to get the demographic characteristics of the respondents. While mean scores analysis was used to get the mean of the professional views on the effects of engagement of health and safety practitioners on the performance of workers on the construction sites and ANOVA was used to test the perception of the professionals and the contractors

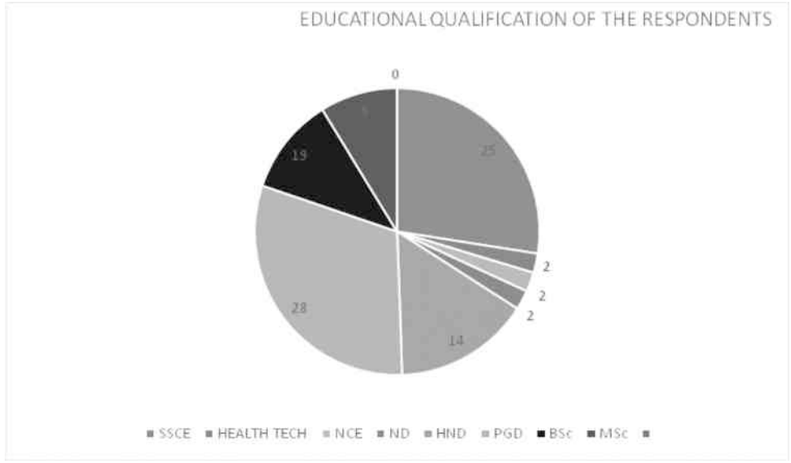
Demography Characteristic

Figure 2: Year of experience of the respondents



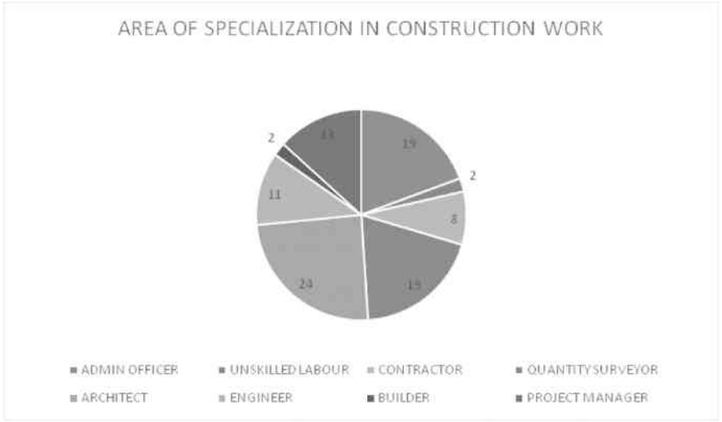
The year of experience of the respondents varies from 1 to 18 years, respondent within 0 and 4 years of experience were 38%, while respondent between 5 and 9 years of experience form 33%, 23% of the respondent had between 10 to 14 years working experience and 6% had 15 and above years of experience.

Figure 3: Educational Qualification of the respondents



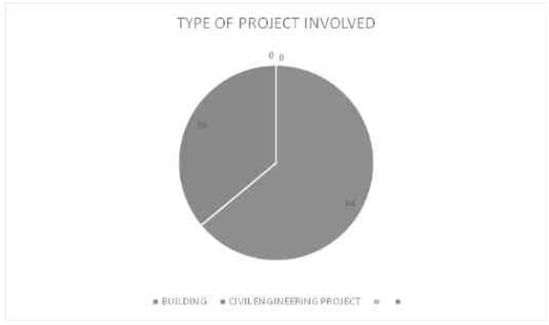
Also, the respondents varies in their educational qualification, 25% were SSCE holders, 2% were health tech holders, 2% were NCE holders, 2% were ND holders,14% were HND holders,19% wereB.sc. holders, also, 28% were PGD holders and 2% were Msc. holders respectively.

Figure 4: Area of specialization of the respondents in the construction work



The Area of specialization of the respondent in the construction work, 24% were Engineer, 19% were Architect, 19% were unskilled labor, 13% were skilled labor and 11% builder, also Quantity Surveyor made 8% of the respondent, Contractor and admin officer has 2% each.

Figure 5: Type of project involved



The projects engaged in by the respondents showed that 64% of them were engaged in building projects, and 36% were into civil engineering projects.

Table 1shows the mean score for each of the professional against the selected views to examine the effects of engagement of H&S practitioners on the performance of workers on construction sites.

Table 1: Mean score for each of the professional against the selected views

Specialization	Reduce accident	Improved health	Productivity	Morals	Efficiency	Postive effect	Total	Total rank
Contractor	5.0000	5.0000	5.0000	5.0000	4.0000	4.0000	31	2ND
Quantity Surveyor	4.0000	4.0000	4.0000	4.0000	4.1250	3.8750	27.375	8TH
Architect	4.2632	3.5789	4.1053	4.9474	7.0000	4.4211	31.737	1ST
Engineer	4.7500	4.9167	4.9167	3.2500	3.7083	4.6667	28.7501	3RD
Builder	3.8182	4.1818	3.8182	4.3636	4.1818	3.7273	28.4545	5TH
Project manager	4.5000	3.5000	4.0000	3.5000	4.0000	4.0000	28.5	4TH
Skilled labor	3.8333	4.0833	4.6667	4.2500	4.4167	3.5833	28.25	7TH
Unskilled Labor	4.0588	3.9412	4.3529	4.1176	3.8824	3.9412	28.3529	6TH
Total	4.2340	4.1702	4.3936	4.0957	4.5957	4.1489	29.0849	

Table 2 shows the results of ANOVA test of thesignificant difference in the mean score of the professionals and contractors' views, this indicates if there is significant difference in the mean score of the professionals and contractors' views.

Table 2: ANOVA Tableof the significant difference in the mean score of the professionals and contractors' views

S/N			Sum of Squares	Df	Mean Square	F	Sig.
1	The operation of the health and safety practitioners leads to reduction of accident on site	Between Groups (Combined)	11.923	7	1.703	2.767	.012
		Within Groups	52.928	86	.615		
		Total	64.851	93			
2	The involvement of health and safety practitioners has improved status of workers	Between Groups (Combined)	22.817	7	3.260	6.929	.000
		Within Groups	40.459	86	.470		
		Total	63.277	93			
3	The involvement of health and safety practitioners has improved the productivity of the workers	Between Groups (Combined)	14.628	7	2.090	11.368	.000
		Within Groups	15.808	86	.184		
		Total	30.436	93			
4	Health and safety practitioners can increase the employee morals	Between Groups (Combined)	33.631	7	4.804	8.884	.000
		Within Groups	46.508	86	.541		
		Total	80.138	93			
5	Engagement of health and safety practitioners leads to efficiency of worker on construction site	Between Groups (Combined)	142.487	7	20.355	.706	.667
		Within Groups	2480.151	86	28.839		
		Total	2622.638	93			
6	Positive effect of health and safety practitioners in the site for achievement of project's objective	Between Groups (Combined)	15.035	7	2.148	4.116	.001
		Within Groups	44.880	86	.522		
		Total	59.915	93			

For the objective, six questions were compared which relate to the objective in comparing the mean score of the professionals and contractors' view in relation to the questions. The questions picked are questions 1, 3, 4, 11, 13 and 14.The ANOVA table is used to test if there are significant difference in the mean score of the professionals and contractors' view. The operation of the health and safety

practitioners lead to reduction of accident on site since the p-value (0.12) is greater than significant value of 0.05, while for question 2,3, 4 and 6 there is no difference in their mean scores with the p-value(0.000) which is below the level of significance (α=0.05). For question 5, there is significant difference with p-value(0.666) greater than the level of significance(α=0.05), therefore,engagement of health and safety practitioners alsoincreases the efficiency of worker on construction site.

The study assesses the impact of engagement of health and safety (H&S) practitioners on construction site in Ondo State, Nigeria. A well-structured questionnaire was used to collect information from respondents. One hundred and thirty (130) questionnaires were administered, selected through random sampling method, with a retrieval of One hundred (100). Data collected were used to assess the level of engagemet of H&S practitioners on construction sites and examine the impact of H&S practitioners on performance of workers on construction sites in the study area. Data were analysed using mean scores analysis, descriptive statistics and standard deviation. The result of the data analysis shows that the respondents' view about the level of engagemet of H&S practitioners on site in the study area is high with 65%. Furthermore, the scores of each item were computed as a single measure for the level of engagement of H&S practitioners and was subjected to descriptive statistics, while a minimum and maximum obtained scores on the scale was 0 and 100 respectively with a mean and standard deviation (X=62.5 and SD=16.68). The result also shows that operation of the H&S practitioners leads to reduction of accident on site since the p value (0.12) is greater than significant value of 0.05, while for questions 2, 3, 4 and 6 there is no difference in their mean scores with the p-value (0.000) which is below the level of significance (α=0.05) for question 5 there is significant difference with p-value (0.666) greater than the level of significance (α=0.05).

Conclusion

The studyrevealed that engagement of H & S practitioners leads to efficiency of workerson construction sites.The result of H & S non-performance in Nigerian construction sites is untold and can be seen in the number of accidents and injuries arising from construction activities throughout the country.

Recommendation

Having seen the effect of engagement of H & S practitioners on construction sites,the study recommends that engagement of health and safety practitioners should be more paramount to all the stakeholders in the construction industry so as to reduce occurrence ofaccidents on construction sites.

References

Ali, T.H. (2009). *Influence of National culture on Construction Safety Climate in Pakistan.* Unpublished PhD Thesis, Faculty of Engineering and Information Technology, Griffith University, Gold Coast.

Dodo, M. (2014). The application of health and safety plan in Nigeria construction firms. *Jordan Journal of Civil Engineering,* Volume 8, No. 1, 81 – 87.

Hallowell, M. R., &Gambatese, J. A. (2009). Activity-based safety risk quantification for concrete

formwork construction. Journal of construction engineering and management, 135(10), 990-998.

Kirby, P., & Hurst, P. (2004). Health, Safety and Environment: A Series of Trade Union Education Manuals for Agricultural Workers.

Okolie, K.C. & Okoye, P.U. (2013). Appraising the influence of cultural determinants of construction workers safety perception and behavior in Nigeria. International Journal of Engineering and *Medical Science Research,*(1) 11 – 24.

Okoye, P. U. (2018). Occupational health and safety risk levels of building construction trades in Nigeria. *Construction Economics and Building*, *18*(2), 92-109.

Olatunji, O.A. & Bashorun, N. (2006). A system View of the Labour Profile Structure of the Construction Industry in the Developing Countries: Nigeria, A Case Study. *International Conference in the Built Environment in the 21st Century (ICIBE)*, Kuala Lumpur, 13 (15), 881 – 892.

Mbuya, E. &Lema N.M. (2002). Towards Development of Framework for Integration of Safety and Quality Management Techniques in Construction Project Delivery Process. *Proceedings of the 1st International Conference of CIB W107:* Creating a sustainable Construction Industry in Developing Countries. 11th – 13th November.

Pearce, D. (2003), *The social and economic value of construction: The construction industry's contribution to sustainable development*, CRISP, London.

Umeokafor, N.I, Isaac, D., Jones K.G & Umeadi, B. (2014). Enforcement of occupational Safety and Health regulations in Nigeria: An exploration. *European Scientific Journal*, Special Edition, 3, 93 – 104.

RUGIPO RESEARCH AND TECHNICAL JOURNAL

STRENGTH PERFORMANCE OF CONCRETE PRODUCED WITH CRUSHED BURNT BRICK AS ALL-IN AGGREGATE

Authors

Olotu F. M., Alejo, A. O. And Oyegoke, I.K.
Department of Building Technology,
Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria
Email: femichael2002@gmail.com

Abstract:

The study investigated the compressive strength of concrete producedwith Crushed Burnt Bricks as all-in aggregate with a view to establishing the suitability ofthe aggregate for concrete. Broken burnt brickswhich constitute disposal problems were obtained from the factory, crushed and sieved into aggregate sizes.Cement, all-in brick aggregate and water were combined to produce concrete specimens of size 150mm x150mm x 150mmusingmix proportions and water cement ratios.Specimens were Cured for 28 days before compressive strength test. The study revealed that brick aggregate concrete requires extra water; belongs to the medium density group; average strength ranged between 17.822 N/mm^2 and 26.67N/mm^2 for 1:2:4 mix ratio which compares favourably with the normal concrete while compressive strengths for 1:3:6 mix ratio ranged between 11.20 N/mm^2 to 14.66N/mm^2. Hence, crushed burnt brick as all-in aggregate requires high water cement ratioand was recommended for non-load bearing orrelatively lower density- requiringstructures.

Keywords: -in aggregate, Compressive strength,Concrete, Crushed Burnt Bricks, Waste.

Introduction

Concrete is the second most used material in the world. It is the combining of cement, fine aggregate, coarse aggregate and water. The major volume of concrete is the (fine and coarse) aggregates. The inclusion of aggregates in concrete reduces drying shrinkage and improves many other properties of concrete. Aggregates makes the most amount of the weight; are costly to transport so local sources are needed, but due to geographical constraints this is not available at all places.It is therefore necessary to source alternative local materials.

In eastern and north eastern states of India and Bangladesh where natural rock deposits are scarce, burnt clay bricks are used as alternative source of coarse aggregate. In these places Indian brick aggregates are traditionally used as coarse aggregate. The use and performance of concrete made with broken brick as coarse aggregate are quite extensive and satisfactory for ordinary concrete (Deyand Pai, 2013).

In Nigeria, there are very extensive areas of clay soil suitable for brick making. They vary in colour from almost dead white to practically black, texture vary almost as smooth as glass to open coarse grained. Some are quite light in weight and others dense and heavy. Clay suitable for brick making are composed mainly of silica in form of grains of sand and alumina which readily absorbs water to make the clay plastic, and which melts when burned. Present in all clay are materials other than the two mentioned above such as lime, iron, manganese, sulphur and phosphates. According to Otoko and Ephraim (2014), clay deposits carried out by the geological survey of Nigeria identified the principal clay deposit in various states of the country such as Benue, Plataeu, Imo, Ebonyi, Enugu and Ogun. The machinery and method of production of burnt bricks is the same all over the country. The process starts from the mining of the clay to its preparation and forming, drying and finally burning. In modern factories, load bearing,

non-load bearing and decorative brick are produced in accordance with set international specifications and standards.

The emergence of clay bricks stems from proven advantages of this material in terms of durability, economy, strength and versatility. These advantages over other building materials coupled with the huge deposit of raw materials for the clay –brick production have placed emphasis on its development as an alternative building material to cater for the ever-increasing demand and need for the various housing projects all over Nigeria. However, broken bricks in factories are usually heaped as spoils and transported periodically for the purpose of disposal. These wastes are no more recycled as they lost their binding power after undergoing the heating process, hence, brick factories are ever faced with the problem of breakages and disposal of wastes. The alternative uses of brick wastes are for hardcore in substructure and in the filling of pot holes in roads (Garba and Kabir, 2002).

Previous researches revealed that the crushed brick as alternative aggregate reduces concrete density, reduces natural aggregate consumption and is considered environmental friendly. Khaloo (1994) studied the properties of brick aggregates and compared the properties of concrete with brick aggregates and the concrete with stone aggregates and inferred that there is no reduction in strength of concrete for up to 20% replacement of stone aggregate with brick aggregates. Also, Poon and Chan (2006) investigated the possibility of using crushed clay brick as aggregate in sub-base materials. This study therefore investigated the strength performance of concrete produced with crushed bricks as all-in aggregates with a view to establishing the suitability of crushed burnt brick (wastes) as concrete aggregates.

Materials and Methods

Materials used for the study

The cement used was sourced from local supplier.Sand was obtained from river bed (dredged) and was sieved to remove unwanted particles in it. Broken bricks were obtained from the Nigeria Brick and Clay products limited, Kaduna Factory. Broken bricks from the spoil heap in factory were crushed and sieved into fine and coarse aggregate sizes with 20mm maximum size.The bricks consisted of various types produced in the factory, ranging from engineering to the decorative bricks but predominantly the load bearing bricks; manually crushed and sieved into fine and coarse aggregate sizes. Water free from harmful matters (drinkable) was used for all mixes.

The physical properties of the manually crushed brick aggregates were determined based on air-dry and saturated surface dry bases. These were determined according to relevant British standards.

Equipment/Apparatus

Equipment and apparatus used included weighing scale, revolving drum concrete mixer, mixing boards, 150mm cube mould, hand scoop, tapping rod, measuring cylinder, curing tanks, standard sieves (20mm-Pan), compressive strength testing (crushing) machine.

Grading of the aggregates

Crushed fine and coarse brick aggregates were graded to remove unwanted sizes. The aggregates were passed through sieves as 20mm, 10mm, 5mm, 2.36mm, 1.18mm, 0.6mm, 0.3mm and 0.15mm.

Particle shape and texture

The particle shape of the aggregate was determined by the visual method. The crushed brick aggregate contained angular shape particles as the predominant particle shape with a few flaky shaped particles. The surface texture of the aggregate could be described as a combination of smooth and rough. This is because the edges of the aggregates were rough while the top and bottoms were smooth.

Moisture properties of brick aggregate

For the determination of extra amount of water required the percentage moisture content and water absorption is required.

Required extra water = Absorption capacity (%) –Pore moisture (%).

Table1.0 Sieve analysis for crushed brick

BS Sieve size (mm)	Weight retained (Kg)	Percentage retained	Percentage passing	Cumulative percentage
19.0	6.0	10	90	10
9.5	22	36.67	53.33	46.67
4.75	12.6	21	32.33	67.67
2.36	5.6	9.33	23	77
1.18	2.5	4.17	18.83	81.17
0.6	1.4	2.33	16.5	81.17
0.3	2.6	4.33	12.17	83.5
0.15	6.7	11.17	1	87.83
Pan	0.6	1	0	99
Total	60	100		100

Table 2: Physical properties of brick aggregates

Number	Properties	Brick Aggregates	
		Coarse	Fine
1	Specific Gravity (Air Dry)	1.98	2.05
2	Bulk density(Kg/m^3) (Dry, Loose)	968	1008.4
3	Void ratio (%)	51.11	50.81
4	Absorption capacity (%)	11.851	10.926
5	Moisture content	0.949	3.864
6	Particle shape	Angular	Angular
7	Particle and texture	Smooth and rough	Smooth and rough

Table 2: Physical properties of brick aggregates

Concrete Experimental Details

Broken brickswere crushed and sieved into fine and coarse aggregate sizes with 20mm maximum size.The Concrete mixes were carried out using three water/cement ratios (0.6, 0.7 and 0.8) and mix proportions 1:2:4 and 1:3:6; five specimens for each test. All samples were cured for 28 days by complete immersion in water. Hence the study investigated the strength of concrete produced with crushed brick as fine and coarse aggregates.

Brick aggregates, Cement and Water were the materials used for the study. Two Mix proportions (1:2:4 and 1:3:6) and three water cement ratios (0.6, 0.7 and 0.8) with five sampleseach were used for the test.

Absolute Volume (A.V.) = Mix Ratio x Density/Specific gravity

Quantity of material (Kg) per m^3 = Mix Ratio x Density x 1m^3/ Total Absolute Volume

Moulding and compaction of concrete specimen

Concrete mixes were properly made and poured into oiled cube moulds in three layers of approximately equal depth with 25 number of tamping on each layer using a standard rod. Specimens were well labelled with identification mark. 150mm size cubes were used for all casting.

Curing of specimen

All concrete specimens were cured by complete immersion in water after 24 hours from time of casting. The curing was done for 28 days for concrete to attain maximum strength.

Density of specimen

The densities of specimens were determined at saturated surface dry condition.

Density= Average Weight /Volume of cube (mm^3)

Table 3.0Material required for each mix/water cement ratio

Identification	Concrete mix/w/c ratio	Material required	Quantity per m^3	Quantity for 5 cubes	Plus 15% for water
1A	1:2:4/0.6	Cement	337.949	5.7	6.56
		Fine brick	473.316	7.99	9.19
		Coarse brick	908.707	15.33	17.63
		Water	202.769	3.42	3.93
		Extra water	132.493	2.236	2.57
1B	1:2:4/0.7	Cement	326.901	5.52	6.35
		Fine brick	457.843	7.73	8.89
		Coarse brick	879.001	14.83	17.0
		Water	228.831	3.86	4.44
		Extra water	128.162	2.163	2.49
1C	1:2:4/0.8	Cement	316.553	5.34	6.14
		Fine brick	443.350	7.48	8.60
		Coarse brick	851.176	14.36	16.51
		Water	253.242	4.27	4.91
		Extra water	124.104	2.094	2.41
2A	1:3:6/0.6	Cement	251.309	4.24	4.88
		Fine brick	527.958	8.91	10.25
		Coarse brick	1013.613	17.10	19.67
		Water	150.785	2.54	2.92
		Extra water	147.789	2.494	2.87
2B	1:3:6/0.7	Cement	245.148	4.14	4.76
		Fine brick	515.015	8.70	10.01
		Coarse brick	988.764	16.69	19.19
		Water	171.604	2.90	3.34
		Extra water	144.165	2.433	2.80
2C	1:3:6/0.8	Cement	239.282	4.04	4.65
		Fine brick	502.269	8.48	9.75
		Coarse brick	965.105	16.29	18.73

Determining compressive strength

Crushing of cubes was done 28 days from the date of casting. Samples were removed from water and allowed to dry for sometime until they were surface-dried before crushing. The crushing machine used was motorised hydraulic compression machine of 1520KN capacity.

Precautions were taken in order to avoid variation in the result due to testing errors: the cubes were placed centrally in between the platens to avoid eccentricity in loading; uniform rate of loading was applied; all projections from the faces in contract with the platens were scraped off; the loading was applied through two smooth surfaces; the load was applied slowly until the concrete cube fails and the result was taken carefully to avoid error due to parallax.

Compressive strength is the load per unit area. F = P/A, where F = Compressive Strength (N/mm^2), P = Load at Failure (N) and A = Cross sectional area of specimen (mm^2)

Results and Discussion

Result of tests conducted on concrete produced with crushed burnt brick as all-in aggregates are presented below.

Table 4.0 Summary of Weight, Density, Failure load and compressive strength.

Identification	Mix/W/c ratio	Average weight of cubes (Kg)	Density of cube (Kg/m^3)	Failure load (N)	Cube strength N/mm^2
1A	1:2:4/0.6	7.17	2124.444	411.8	18.30
1B	1:2:4/0.7	7.23	2142.222	442.6	19.67
1C	1:2:4/0.8	7.14	2115.560	348.6	15.49
2A	1:3:6/0.6	6.64	1967.407	151.6	6.74
2B	1:3:6/0.7	6.97	2065.185	274.4	12.19
2C	1:3:6/0.8	7.25	2148.148	329.8	14.66

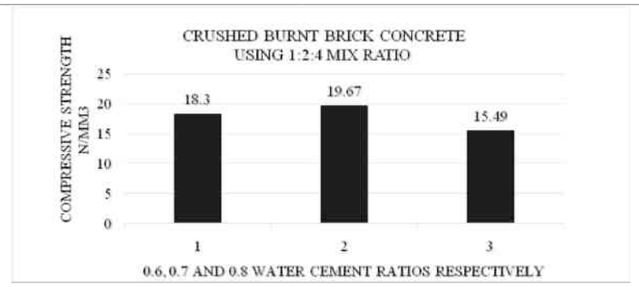


Figure 1: Compressive strength of concrete produced with crushed burnt bricks as all-in aggregate using mix ratio 1:2:4

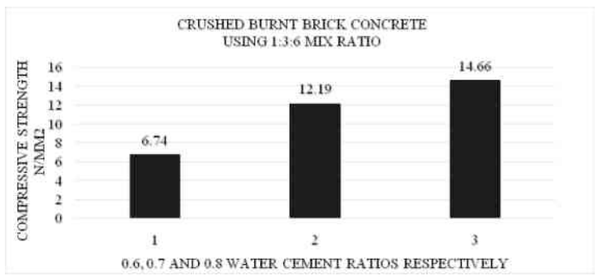


Figure 2: Compressive strength of concrete produced with crushed burnt bricks as all-in aggregate using mix ratio 1:3:6.

Conclusion

i. Brick aggregate need extra amount of water for mixing because of its high absorption capacity: 10.902% and 7.062% extra water are required for mixing Coarse and fine brick aggregates respectively. Hence an average of 8.258% extra water is required for 1:2:4 mix proportion while 7.53% extra water is required for 1:3:6 mix proportion.

ii. The density of concrete produced with brick as fine and coarse aggregate falls between the density for normal concrete (2355 to 2563 kg/m^3) and the density for light weight concrete (400.5 to 1762kg/m^3), thus they belong to the medium density group.

iii. The compressive strength of concrete produced with brick as fine and coarse aggregate compared favourably with that of normal concrete of 28N/mm^2 for w/c 0.6, 21 N/mm^2 for w/c 0.7 and 16 N/mm^2 for w/c 0.8. That is:

a. Brick Concrete (mix ratio1:2:4) w/c 0.7 and 0.8 have strength of 19.671 and 15.493 N/mm^2 respectively.

b. Brick concrete (mix ratio 1:3:6) W/c 0.8 have strength of 14.658 N/mm^2. These compare

favourably with normal strength, therefore concrete mix 1:2:4 and 1:3:6 with 0.8 w/c ratio give a very suitable strength compared to normal concrete.

Recommendations:

i. Due to high absorption capacity of brick aggregates extra amount of water (averaged 8.258% and 7.53% extra waterfor 1:2:4 and 1:3:6 mix proportions respectively) should be added forthe combined (all-in) aggregates.
ii. Based on the compressive strength results of brick – concrete specimens carried out, mix proportion 1:2:4isto be used withwater cement ratios 0.6, 0.7 or 0.8 whilemix proportion 1:3:6 is to be used with0.7or 0.8 water cement ratios only for the production of concrete with Crushed Burnt Brick as all-in aggregate.
iii. Density and Compressive strength result of concrete produced with crushed burnt brickcarried out revealed that crushed bricks as all-in aggregate aresufficiently suitable forlow density and non- load bearing structures. Hence crushed burnt brick all-in aggregates arerecommendedfor production of non-load bearing andrelatively lower density concrete structures.

References

ACI, Committee E1-07(2007). Aggregate for concrete. American Concrete Institute. Farmington Hills, Michigan, pp 26.

American Society for Testing and Materials (2003). Standard Specification for concrete Aggregates (ASTMC 33). West Conshohoeken, P.A.

BS EN 12620: 2002+A1: 2008(2008). "Aggregate for concrete", London, British Standard Institution.

BS EN 12390 2-(2009) Testing hardened concrete. Making and curing specimens strength test. (BS EN 12390-2: 2009) London, British Standard Institution.

BS EN 12390-3-(2009). Testing hardened concrete. Compressive strength of specimens (BS EN 12390-3: 2009). London, British Standard Institution.

BS EN 12390-7-(2009) Testing hardened concrete. Density of hardened concrete. (BS EN 12390-7: 2009). London, British Standard Institution Environmental Science,Pp 77-83.

Gopinnanda, D.&Joyanta P. (2013). Use of Brick aggregate in standard concrete and its Performance in elevated Temperature. *IACSIT International Journal of Engineering and Technology*, Vol. 5 No 4.

Khaloo, A. R. (1994). "Properties of Concrete using crushed clinker brick as coarse aggregate*", ACI Materials Journal*, Vol. 91, No. 2, pp. 401-407.

Nevile (2006). Properties of Concrete(4th ed). Copyright @ 2000, Asia: Person Education Pte Ltd.

Ojo-olotu,F.M. (2001). The Suitability of Broken Burnt Bricks as Concrete Aggregate: Unpublished B.Sc Project report submitted to the Department of Building, Ahmadu Bello University, Zaria, Nigeria.

Otoko, G. R. & Ephraim, M.E. (2014). Use of Building Clay in Concrete. *International Journal of Engineering and Technology Research*. Vol 2, No. 2. Pp 1-8.

RUGIPO RESEARCH AND TECHNICAL JOURNAL

COMBINATION OF ELECTRICAL RESISTIVITY TOMOGRAPHY (ERT) AND GEO-ELECTRIC SOUNDING IN GROUNDWATER DETECTION WITHIN THE BASEMENT ROCKS OF ISUADA-OWO, ONDO STATE, NIGERIA

Authors

Olanegan, P.O.[1], Fasunla, O.M.[1] and Olaitan, S.K.[1]
[1]Department of Science Laboratory Technology
(Physics with Electronics Unit),
Rufus Giwa Polytechnic, Owo, Ondo State.
***Corresponding E-mail: olaneganpaul@gmail.com**

Abstract:

Two-dimensional Electrical Resistivity Tomography (ERT) and Geo-electrical Sounding (VES) have been combined in locatingsuitable drill point for a household water supply within the crystalline rock environment of Isuada, Owo, Ondo State. In order to map the depth to the basement rock and detect possible fractures in the weathered zone, a multi-electrode Wenner array configuration involving 29 electrodes was used to collect data over 2 profile lines with minimum electrode spacing of 3m. VES data were also collected at a point coinciding with the location of a well formerly dug into the hard rock at about 3.1m depth. This is to be used in constraining the 2D measurements to ensure a reasonable interpretation. Inversion of 2D data was done using RES2DINV, which used the measured apparent resistivity field data to develop the 2D inverse model section while the VES data were processed with ZONDIP1D software. The VES result revealed a four layer case suggesting that the impermeable basement rock with a resistivity of 1052.5Ωm underlie the sampled point up to a depth of 14.84m beyond which a saturated fracture zone could be feasible with sharp drop in resistivity from 1052.5Ωm to 227.5Ωm. The 2D results along profile 1 reveals a low resistive anomaly (about 75Ωm) at 72m horizontal position which is the only promising fractured zone that is indicative of groundwater at depth between 10m to 13m. This is the recommended depth to drill for groundwater development in the complex crystalline rock of the studied location.Both the VES and the 2D resistivity inverse model show astrong correlation in delineating the depth of the already dug hole.

Keywords: 2D ERT,Crystalline rocks, Geo-electric Sounding, Groundwater detection, Isuada, Owo.

Introduction

Groundwater is an important natural resource which is largest proportion of water accessed for domestic use in semi-urban centres such as Isuada, Owo, Ondo State Nigeria owing to its relative higher quality when compared with surface water (Lateef, 2012).For residents in such areas who are predominantly low income earners, they prefer to dig their private wells or borehole, in order to access groundwater since public water supply is not available. Difficulties encountered in such attempts at sourcing for water in the crystallinebasement rock environment include encountering the impermeable rock which is a challenge to digging water wells. Uncertainties associated with drilling failed borehole therefore require adequate knowledge of the heterogeneous hydrogeology of the area before a borehole can be sited (Kumar, 2014).

Due to advances in geophysical instrumentation, field techniques and interpretation acquisition of data in 2-D space, and interpretation in the form of Electrical Resistivity Tomography (Imaging) has been made possible. Studies have demonstrated the possibility of using resistivity tomography for the detection of groundwater in hard rock environments (Jayeoba and Oladunjoye, 2015), such as water confined in the fractured basement rock (Anudu *et al*., 2012) and also in the unconfined weathered rocks in basement complex (Adepelumi *et al.,* 2013; Abdullahi and Iheakanwa, 2013; Sharma and Baranwal, 2005).To

enhance survey data interpretation and obtain better understanding of the subsurface, the ERT have also been successfully combined with other techniques such as Self-potential (Jinadasa and de Silva, 2009) and Vertical Electrical Soundings (Alisiobi and Ako, 2012; Muchingami *et al.,* 2012).

Electrical resistivity method is widely employed as an efficient and economical technique for groundwater exploration in various geological settings because different geologic materials exhibit more distinct resistivity contrasts when compared to other measurable geophysical parameters.

The geo-electric sounding, otherwise called VES (Vertical Electric Sounding), has also gained wide application in groundwater exploration in different terrains (Coker, 2012; Olorunfemi and Olayinka, 1992). Although no work has been documented to be done in the Isuada axis using ERT, VES has been employed in the neighbouring Rufus Giwa Polytechnic, Owo by Falowo *et al.,* (2015); Olanegan (2018) and also at Express, Okedogbon and Idasen axis by Ogundana and Talabi (2014) for groundwater assessment in the basement complex. Combination of VES and ERT is therefore applied in a household belonging to the Ogunmolas to understand the groundwater occurrence at the area. The household had have dug three unsuccessful water wells encountering the basement rock at average depths of 3.04m (10feet). Hence the need to apply geophysical techniques in order to determine the occurrence of possible fractures zones and the estimate the depth to drill for any subsequent groundwater development.

The primary aim of this research is to use a combination of VES and 2-dimensional electrical resistivity imaging techniques to assess the depth to the bedrock in the study location as well as determine whether there are fractured or weathered zones that could be indicative of prolific groundwater aquifer.

Description of the Study Area

Isuada is bounding Rufus Giwa Polytechnic, Owo at the eastern flank of the campus. It is located between Latitude 7.11528N to 7.23941N and Longitude 5.54159E to 5.61024E. Isuada has a tropical climate (Figure 1) with less rainfall in the wet season than in the dry season. The average annual temperature in Isuada is 25.3 °C. The average annual rainfall is 1404 mm. The driest month is January, with 8mm of rainfall. With an average of 250mm, the most precipitation falls in September. The warmest month of the year is March, with an average temperature of 27.2^{O}C while August is the coldest with an average temperature of 23.3^{O}C per year. The difference in precipitation between the driest month and the wettest month is 242mm. Average temperatures vary by 3.9^{O}C during the year.

Geologically, Isuada belongs to the basement complex of South West, Nigeria, which is underlain by Precambrian rocks. The major rocks in the area are granite, charnockites, quarzites, granite gneisses and migmatite gneisses. The granite rocks, which are member of the older granite suite, occupy about 65% of the total area. The magmatite gneisses, being the oldest rocks in the Nigerian basement, are both litho- and tectonostratigraphically basal to all superjacent lithologies and orogenic events (Rahman, 1976).

Methodology

Electrical resistivity studies in geophysics can be explained in the context of current flow through a subsurface medium consisting of layers of materials with different individual resistivity (Alile *et al.,* 2008). This method has variously been applied in groundwater studies and exploration for mapping aquifer configuration (confined and unconfined) aquitards, soil-bedrock interface topography, fracture zones, faults, and voids in the basis of their intrinsic resistive properties.

The resistivity ρ of a material is a measure of how well the material retards the flow of electrical current (Oursingbe *et al*., 2012). Resistivity imaging (ERT) surveys provides a realistic 2-D resistivity model of the subsurface, where resistivity changes in the vertical as well in the horizontal direction along the survey line are mapped continuously in complex geological and topographical terrains. A proper electrical image of the subsurface can be used to easily identify and map structural features related to fluid content, aquifer configuration and qualitatively, the groundwater flow direction (Kumar *et al.,* 2014). It is based on the assumption that resistivity does not change in the direction that is perpendicular to the survey line (Loke, 2004).

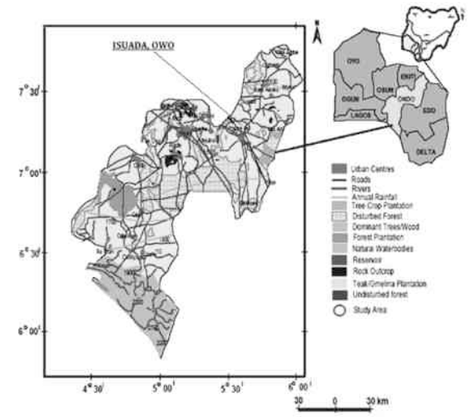


Figure 1: Map of Ondo State showing vegetation pattern of Isuada, Owo.

A. Instrumentation

In geo-electric, one-dimensional electrical resistivity prospecting, the basic equipment required are four non-polarizable electrodes (two current and two potential electrodes). For goods contact with the earth, some water or salt solution is often poured on the ground around the electrodes. The R-50 resistivity meter provided the power source for low frequency, direct current source was used for this work. The terrameter can send current through the earth as low as 40mA. The multi-electrode array configuration used with the equipment require twenty-nine electrodes, each is made of stainless steel with other accessories such as switching board for electrodes selection, hammer; twenty-nine (29) reels of insulated conductor cables and measuring tapes. The survey layout was designed to ensure that the VES result is used to understand the geologic sequence in the study area while the 2D profiles provide a lateral view of the subsurface resistivity with the for identifying the depth to the bedrock as well as to delineate the possible fractured or weathered zone that is saturated with water. Two profile lines are used with profile 1 having a length of 84m and profile 2 of length 105m. The geo-electric sounding point was located to at the point where already drilled failed well was found (Figure 2).

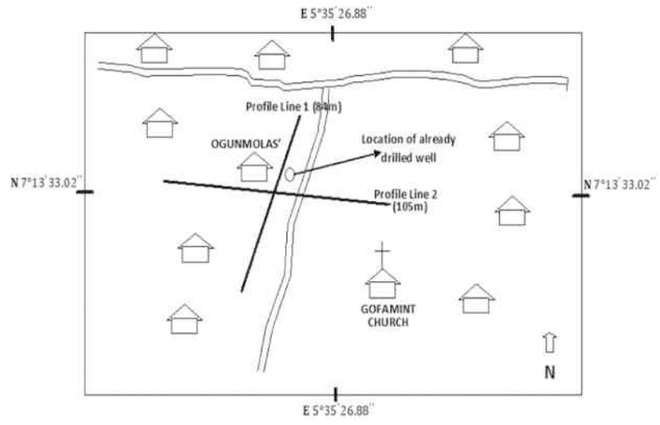


Figure 2: *Survey layout of the study area showing two ERT Profile lines and VES point.*

B. Acquisition of 2D Ert And Ves Data

A multi-electrode arrangement consisting of 29 electrodes was adopted for the work which requires that a maximum of nine datum levels was occupied while the maximum *a-spacing* was 9a (Figure 3). Wenner alpha array configuration was employed in the multi-electrode arrangement because of its strong signal

strength at depths. Profile line 1 of length 84.0m, requires that estimated maximum depth of investigation, Ze = 84m x 0.173 = 14.523m.Profile 2 has a length of 105m and is oriented perpendicularly across profile 1. Each transverse, which is the route of the survey line would follow, was first cutout. This is to ensure easy passage of cable and crew members as electrodes are positioned by the use of hammer at an inter-electrode spacing of 3m. The electrodes were nailed until a firm grip was maintained with the ground. The Garmin GPS [global positioning system] was used to determine the orientation of each profile line.

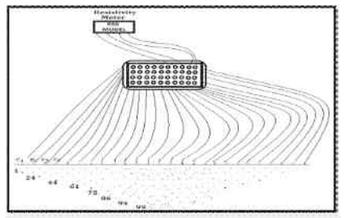


Figure 3: Multi-electrodes array showing sequence of measurements used to build up 2D-pseudosection. (After Loke, 2004)

Having marked the electrode positions, the cables were connected to the first four electrodes, where C1 and C2 are current electrodes while P1 and P2 are potential electrodes. After taking the first reading in station 1 (for electrodes 1-2-3-4), the switching is done by connecting the next needed electrodes (i.e. 2-3-4-5). The process is continued until station 43 for a=1m. For station 44, electrode spacing of 2a is used until station 83 has been reached. This process was taken for electrode spacings 3a, 4a, 5a, 6a, 7a, 8a and 9a which means that for the 29 electrode Wenner-alpha array used, the profile line requires that a total of 176 reading were taken.

The ERT data were processed using RES2DINVx64 Version 4.8.9 (by Geotomo Softwares) which is an iterative smoothness-constrained least-squares inversion method (Loke, 2004) which automatically subdivides the subsurface into a number of blocks, adopting least-squares smoothness constrained inversion technique to determine the true resistivity values after a number of iterations to narrow down the range of possible inverted models. The RES2DINV program displayed the output individually in three pseudo sections. The first pseudosection is a contouring plot of the measured apparent resistivity values input into the program. The second pseudosection which is a contour of the calculated apparent resistivity values is compared with the measured apparent resistivity field data to develop the inverse model section. The inverse model resistivity section is the third pseudosection presented in the result, being the approximate true resistivity values of the subsurface. This inverted section will be used for the interpretation of the profiles.

Results and Discussion

The VES data obtained were interpreted quantitatively by way curve matching and computer iteration technique. The ZONDIP1D software was used to process the VES 1 data. Percentage error was reasonably low at 4.8 % which means there was a good fit during curve matching**.** From the interpretation and modeling results, the geo-electric parameters of the subsurface layers were deduced as presented in the corresponding table (Table 1). Qualitative interpretation was based on resistivity range values of water and geologic materials as prescribed by Loke (2004).

Table 1: Result of layer parameter for VES 1.

Layer	Resistivity ρ (ohm-meter)	Depth to layer, z (meter)	Thickness of layer, h (meter)
1	214.2107	0	0.7784
2	79.6039	0.7784	1.6950
3	1052.5455	2.4735	12.4
4	227.5146	14.8439	8

The result is presented as field curve in Figure 4, the curve is a graph expressing the variation in apparent resistivity with increasing depth. The shape of the VES curves depends on the three factors, namely: thickness of each layer, number of layers in the subsurface and ratio of the resistivity of the layers.
The curve shows different layers with each layer having different resistivity, depth and thickness.

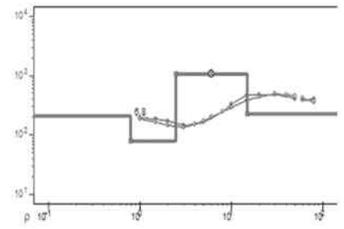


Figure 4: *Model curve for VES 1*

VES 1: The first layer has resistivity of about 214.2Ωm and is interpreted as the top soil which consists of lateritic sand up to a depth of 0.777m. The second layer has resistivity of 79.6Ωm and 1.695m thick is interpreted as a weathered rock layer mixed with porous sand. This is encountered at a depth of 0.778m and continued till 2.47m depth. The layer is a typical shallow unconfined water-bearing structure. Physical observation of the hole dug to about 2.8m shows a strong correlation with this resistivity drop at the depth of 2.47meters. The third layer has a resistivity of 1052.5Ωm is interpreted as the impermeable basement rock due to sharp increase in resistivity from 79.6Ωm. No groundwater should be expected within that layer of thickness 12.4m and continuing till a depth of 14.8m. The layer underlying this zone is characterized by a drop in resistivity at 227.5Ωm. This is possibly a fractured basement rock that is influenced by clay content or saturated with a conductive material such as water. If the fracture is water-bearing with permeability enabling lateral flow of groundwater a well drilled to a depth beyond 15m could produce groundwater. However the 2D ERT models obtained from Profile lines 1 and 2 could not confirm occurrence of groundwater at this depth.

Profile Line 1: Four iterations of the calculated apparent resistivity values yielded an inverse model with RMS error of 4.8% (Figure 5). This model section has resistivity ranging from 50Ωm to about 1400Ωm, covering a depth of 15.8m. The 48m horizontal position was designed to coincide with the VES point discussed above. The position of the water-filled hole is clearly mapped by the model up to a depth of about 2.98m with a resistivity of about 85Ωm. This is an acceptable resistivity value for fresh groundwater. The most probable aquiferous zone is mapped at a horizontal location of about 72m from a depth of about 2.9m to about 7.85m with resistivity of about 85Ωm. The occurrence of groundwater at this depth could be due to a fracture in the subsurface rock which is now recharged by the run-off of surface water during rain. The central lower portions of the model section from depth 7.5m to 15.8m is relatively high resistive(more than 1000Ωm) indicates that the basement rock is not permeable at that zone (Figure 6).

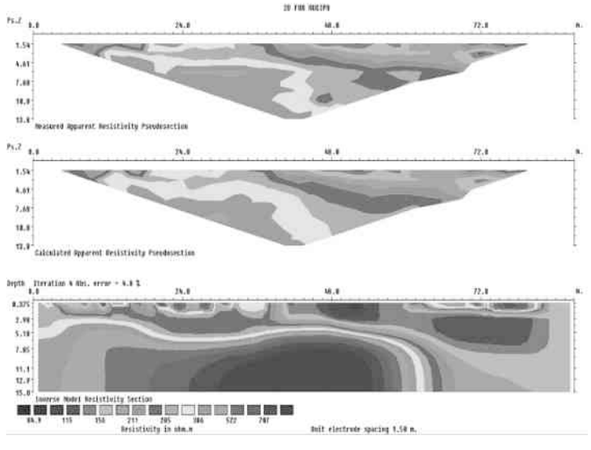


Figure 5: *Result of the processed data, presented as three pseudo-sections representing (i) the measured apparent resistivity (ii) the calculated apparent resistivity pseudo-section and (iii) the inverse model resistivity section.* ***(Profile Line 1)***

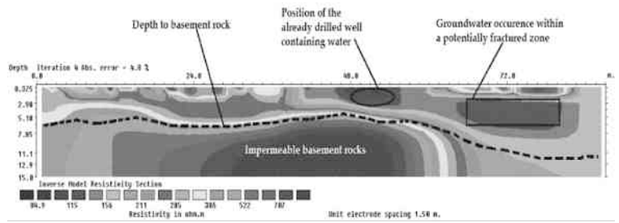


Figure 6: *Interpreted model for 2D profile 1.*

Profile Line 2: The inverse model was produced with four iterations and RMS error of 1.20%. It has resistivity ranging from about 70Ωm to more than 500Ωm. The depth covered by the model is 24.9m (Figure 7). The profile line was designed to map a higher depth than that of profile 1. The model shows evenly distributed horizontal layers of resistivity increasing with depth. The low resistivity section at 70m to 100m horizontal positions coincides with the location of a surface stream flowing in the area. This cannot be interpreted as groundwater zone as it is shallow. When compared with Profile 1 whose depth terminated at 15.8m, the depth from 12.8m to about 24.9m is interpreted as a continuation of the basement rock which does not have any prospect for groundwater.

Figure 7: *Interpreted section for Profile line 2*

Although the highest resistivity across profile line 2 is relatively lower than that of profile line 1, no groundwater occurrence could be suggested at such a high resistivity of about 500Ωm. Therefore, the chance of detecting groundwater within the subsurface along that profile line is very slim. Only in the profile 1 and the VES that we have areas that are suggestive of groundwater in the hard rock environment.

Conclusion

From this research work, it was concluded that in the study area, the suitable point for drilling a borehole or well should be at a distance of 72m horizontal position along the profile line (i.e. at 7°13'42.01"N and 5°35'27.42"E). The depth to drill should be from 12m to about 15m. The location of the already drilled hole could be drilled to a depth 15m and more in order to encounter the possible fractured layer detected in VES 1. The 2D resistivity imaging and VES techniques are suitable for detecting groundwater in a complex crystalline basement complex, rather than using VES alone. Magneto-telluric soundings and electromagnetic surveys could also be employed to cover higher depth than the ones occupied by this survey to map if there are other areas of possible groundwater occurrence.

REFERENCES

Abdullahi, N.K. &Iheakanwa, T. (2013): Groundwater Detection in Basement Complex of Northwestern Nigeria Using 2D Electrical Resistivity and OffsetWennerTechniques. *International Journal of Science and Technology.*2(7): 529-535.

Adepelumi, A.A., Akinmade, B.O., &Fayemi, O. (2013): Evaluation of Groundwater potential of BaikinOndo State Nigeria Using Resistivity and Magnetic Techniques: A case study. *Universal Journal of Geosciences*. 1 (2): 37-45.

Aizebeokhai, A. P., Olayinka, A. I. &Singh, V. S. (2010): Application of 2D and 3D Geo-electrical Resistivity Imaging for Engineering Site Investigation in a Crystalline Basement Terrain, Southwestern Nigeria; *Environmental Earth Science,* Springer D01 10, 1007/S12665-010-0464-Z

Alile, M.O., Jegede, S.I., &Ehigiator, O.M. (2008). Underground Water Exploration Using Electrical Resistivity Method in Edo State, Nigeria. *Asian Journal of Earth Sciences*, 1: 38-42.

Alisiobi, A. R., &Ako, B. D., (2012): Groundwater Investigation Using Combined Geophysical Methods, Adapted from Extended Abstract Prepared in conjunction with Poster Presentation at *AAPG Annual Convention and Exhibition*, Long Beach, Califormia, April 22-25.

Amadi, A.N., Nwawulu, C.D., Unwevho, C.I., Okoye, N.O., Okunlola, I.A., Egharevba, N.A., Ako, T.A. & Alkali, Y.B. (2011): Evaluation of the Groundwater Potential in PompoVillage, GidanKwano, Minna Using Vertical Electrical Resistivity Sounding. *British Journal of Applied Science and Technology*. 1 (3): 53-66.

Anudu, G.K., Essien, B.I. &Obrike, S.E (2012): Hydro-geophysical Investigation and Estimation of Groundwater Potentials of the Lower Paleozoic to Precambrian Crystalline Basement rocks in KeffiArea, North-Central Nigeria, Using Resistivity Methods.*Arabian Journal of Geosciences,*7 (8): 311-322.

Ayolabi, E. A., Folorunso, A.F., &Ariyo, S.O., (2008): 2-D resistivity imaging survey for water supply tube wells in a basement complex: A case study of O.O.U campus, Ago Iwoye Southwest Nigeria; *SIHD Djibouti Hydrogeology of Volcanic rocks*.

Coker, J. O. (2012): Vertical Electrical Sounding (VES) Methods to Delineate Potential Groundwater Aquifers in Akobo Area, Ibadan, South-western, *Nigeria Journal of Geology and Mining research*. 4 (2): 35-42.

Ehirim, C.N., &Ebeniro, J.O; (2010): 2-D Resistivity Imaging Applied in Ground Water Exploration in Awka, SE Nigeria. *Journal Archives of the physics Research,*2 (1): 37-45

Falowo, O. O., Daramola, A. O. &Ojo, O. O. (2015):Geophysical Investigation for Groundwater Potential in Rufus Giwa Polytechnic Owo, Southwestern Nigeria. *The International Journal of Engineering and Science (IJES)*.4 (11): 29-39.

Ganiyu, S.A., Badmus, B.S., Idowu, O.A., Oladunjoye, M.A. &Olurin, O.T.(2015): 2D Electrical Resistivity Imaging Investigation of Open Dump site in Basement Complex Formation.10 (33): 243-256.

Jayeoba, A., & Oladunjoye, M.A. (2015): 2-D Electrical Resistivity Tomography for Groundwater Exploration in Hard Rock Terrain. *International Journal of Science and Technology.* 4 (4): 156-163

Jinadasa, S.U.P, & de Silva, R.P. (2009): Resistivity Imaging and self-potential Application in Groundwater Investigation in Hard Crystalline Rocks. *Journal of the International Science Foundation of Sri Lanka*. 37 (1): 23-32.

Kumar, D. (2014): Efficacy of Electrical of Electrical Resistivity Tomography Techniques in mapping

shallow subsurface Anomaly. *Journal Geological Society of India*. 80 (9): 304-307.

Kumar, D., Ananda,R.V. &Sarma, V.S. (2014): Hydrogeological and Geophysical Study for Deeper Groundwater Resource in Quartzitic Hard Rock Ridge Region from 2D Resistivity Data. *Journal of Earth and Systematic Sciences*. 123(3): 531–543.

Lateef, T.A. (2012):Geophysical investigation for Ground water using Electrical Resistivity method – A case study of annunciation Grammar School, Ikere-Iga, Ekiti State, South – Western Nigeria. *Journal of Applied Physics.* 2 (1): 1-6

Loke, M.H. (2004): RES2DINV version 4.8.9—Rapid 2D resistivity and IP inversion using the least-squares method: Geoelectrical Imaging 2D and 3D-Geotomo Software, p. 130 accessed December 9, 2020, at http://www.geoelectrical.com/download.html

Meshram, S., &Khadse, S.P., (2015): Application of vertical electrical sounding (VES) for Delineating Sub-Surface Lithology for Foundations (CUG linia canal – A case study) *Journal of Geology and Geophysics*, 4 (4):1-5.

Muchingami, I., Hlatywayo, D.J., Chuma, C., &Nel, J.M.(2012): Electrical Resistivity Survey for Groundwater Investigations and Shallow Subsurface Evaluation of the Basaltic-Greenstone Formation of the Urban Bulawayo Aquifer. *Physics and Chemistry of the Earth*. 50 (52): 44-51.

Ogundana, A. K, &Talabi A. O.,(2014):Geoelectric Characterization of Aquiferous Units and its Implication on Groundwater Potential of Owo, Southwestern Nigeria.*American Journal of Water Resources*, 2 (2): 37-40. doi: 10.12691/ajwr-2-2-2.

Olanegan, P. O. (2018): Electrical Resistivity Technique For Delineating The Aquifer In Parts Of Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria.*The International Journal of Engineering and Science (IJES)*.7 (7): 79-87.

Olorunfemi M. D. &Olayinka A. I. (1992): Alteration of Geoelectric in Okene area and Implication for Borehole Sitting. *Journal of Mining and Geology*, 2 (5): 403-411.

Oursingbe, M., Zhonghua, T., Oyelola, B.W. &Mahamadou, Z. (2012). Groundwater Exploration in the Basement of Lake-Iro District-Chad Using Electrical Resistivity Imaging Approach. *Africa Journal of Pharmacy and Pharmacology*. 7 (9): 2720-2729.

Rahman, M.A. (1976): Review of the Basement Geology of the South Western Nigeria. *Journal ofMining and Geology of Nigeria. Elizabithan Publishing Company,* pp. 41-58.

Ratnakuman, Y; Rai; S. N; Thiagarajan, S, &Dewashish,K. (2012): 2D Electrical resistivity imaging for Delineation for deeper aquifers in a part of the Chandrabhaga River Basin, Nagpur District, Maharashtra, *India Current Science*, 1 (102): 61-69

Sandeep, M. H. & Sunil P. K. (2015): Application of Vertical Electrical Soundings (VES) for delineating sub surface lithology for foundations, College of Engineering Maharashtra, India Journal of Geology and Geophysics research, 4 (4): 1-5.

Sharma, S.P. &Baranwal, V.C., (2005): Delineation of Groundwater-bearing Fracture Zones in a Hard Rock Integrating Very Low Frequency Electromagnetic and Resistivity Data. *Journal of Applied Geophysics. 57: 155-166.*

Sikah, J.N., Aning, A.A., Danuor, S.K., Manu, E. &Okrah, C. (2016): Groundwater Exploration Using 1D and 2D Electrical Resistivity Methods *Journal of Environment and Earth Science*. 6 (7): 55-63.

RUGIPO RESEARCH AND TECHNICAL JOURNAL

IMPACT OF SUBSTRATES AND ASSOCIATED DEFECTS ON PAINT IN TROPICAL BUILDINGS' EXTERIOR: A REVIEW

Author
Kehinde Abiodun
Department of Architectural Technology,
Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria.
kenab62@gmail.com.

Abstract:

The use of paint as exterior finish of buildings in the tropical region is faced with multiple challenges due to the stresses of the factors of the climate such as rainfall and sunshine. Some of the areas within the tropics especially the ocean areas and the arid zones are also cumbered with atmospheric salt, salty water and salt infected sand. Most of the buildings in this area are finished with plasters that are made of sand, cement and water that are drawn from the area. The volume of contamination in the substrate determines the performance of the exterior finish. This paper identifies the types of paint in use in the area for building exterior. It also examines the impact that these contaminations have on painted exterior and defects that occur in paint that is applied as exterior finish in the tropical zone. A literature review approach was adopted for the paper, findings show that repainting is required between 5-7 years in tropical buildings due to multiple occurrences of defects. The paper concludes that multiple defects arise not only because of climatic factors but in combination with poorly prepared substrates.

Keywords: Building, Defects, Finish, Paint, Substrate.

Introduction

The surface on which paint is applied which is generally referred to as substrates determine to a large extent the performance during the life cycle of paint applied. The material of the substrate and its preparation before application is found to influence the rate, time and types of defects that develop in paint works. The impact of moisture, driving rain and high humidity in most parts of the tropical region coupled with the existence of salt in the atmospheric air especially in areas at close proximity to the sea and tropical arid zones aggravate the degradation of substrates.These will in turn influence the performance of exterior finishes especially paint. (Corvo *et al.,* 2010) identify the presence of moisture in poorly ventilated parts of buildings as a major cause of many defects in paintings. This agrees with (Brito V *et al*., 2011) that the presence of moisture causes multiple defects in painted surfaces.

Most tropical buildings in this modern age are built with sandcrete walls and are finished with plasters-usually a mixture of cement, sand and water. The use of sand from salty environments and inability to desalinate the water that is added during construction due to cost is one of the major causes of plaster/substrate contamination. The high level of humidity in this area also enhances the continuous penetration of the contamination and endogenic degradation. Other sources of substrate contamination include the deposition of filth in areas with high quantity of suspended particulate matters before paint is applied. The type of rainfall in the area that sometimes comes in sharp angles could lead to a wet substrate surface that can consequently lead to the application of paint on wet surface. Where supervision is inadequate painters who have been assigned to jobs a day earlier will only come to site and apply the paint to earn their daily wage without taking cognizance of the condition of the wall.

The aim of this paper is to identify the defects that occur due to the impact of the substrate on which paint is applied as exterior finish in the tropical environment. This is done to posit that defects in paint are not due to external factors alone or the quality of the product. Among other substrates such as wood, steel

and plastic; this paper examines the impact of plastered sandcrete walls on painted exterior. Plasters being semi permeable composition aid moisture transfer to paint film that is a porous material. The contamination of the plaster itself is subsequently transferred to the paint through moisture transfer. Continuous moisture transfer will lead to capillary condensation as submitted by (Rijniers, 2004) and consequently degrade the paint.

Materials and Methods

The paper looks into various existing literature on the subject matter. Ideals of previous researcher on the performance of paint applied various substrates – surfaces were examined through indepth studies of trends and phenomenon. Various defects that affected different categories of paints within the tropical environment were identified.

Review of different paint materials

Types of Paint

In modern development, the classification of paint is in three broad categories (Schwartz, 2002), which are commercial finishes, industrial coatings and architectural paints. A forth category which is artistic paints such as inks and dyes are now classified as paint. More work is concentrated on the architectural paints in this research. These are the categories that are used as building finishes through various methods of application to achieve aesthetics and fabric protection. (Walberg, 2007) identified two major types of architectural paints used as finishing materials in the building industry. These are oil based and water based paints. (Roy *et al.,* 1996) further subdivided the water base paint into Emulsion and algae resistant Emulsion paints.

Water Based Paint

Water based paint which is also known as latex, acrylic or emulsion is suspended in water before application. It is a fast evaporating, drying paint that contains pigment suspension in acrylic polymer emulsion. Though dilution is done with water, it is water resistant after drying. It gives the effect of water colour or an oil painting after use depending on the quantity of water used to dilute it. Other acrylic agents such as acrylic gel, media or pastes are also used in its dilution. It was invented by Leonard Bocour in 1946 and in 1949 Sam Golden improved it. It is water based and water borne. It is usually a mixture of two or more liquids in water which are normally unblendable.

Types of Water Based Paint

(Duggal, 2008) and (Dumitru *et al.,* 2010) identified the under listed as various types of water-based paint in use in the building industry. These are: Plastic emulsion paints- They are useful in wet porous surfaces. They are non-flammable emulsion that dries quickly with ease of application. They also have less offensive odour. They contain a dispersion of rubber-like resin polystyrene and polyvinyl acetate in water. They are alkali resistant paint that dries within few minutes and hardened in few hours. They can be used on the exterior surface of building where chemical attack by alkali is prominent (Roy *et al*., 1996).

Plastic paint is formed with plastic base while water is used as thinner to enhance spreading. They give high decorative, neat and aesthetic appearance to wall surfaces. They are highly economical; one of the advantages is the large area they can be used to cover in painting. Most architects specify these products for interior spaces of important buildings like showroom, city hall, *massionattee* and offices because of the cost that is considered high at the initial stage. They are rarely used on the exterior surfaces; this may account for dearth of literature on their durability when subjected to the stresses of climate and environmental challenges. The process of hardening is through oxidation like other paints.

Cement based paints have Portland cement either white or coloured as the base. They are recognized under ISO5410. They are mixed with water to reduce the viscosity during application. Proper curing is required to achieve desired strength and durability. One of the major characteristics of cement based paint is that it's one of the best paint products for exterior wall because of its strength, imperviousness and

durability. The application of aqueous solution of sodium silicate and zinc sulphate as undercoat on the substrate to be painted enhances their performance. The content of cementitious material prevents easy peeling of paint from the plastered walls and similar substrates.

Rubber based paint is another type of paint that is used on concrete and cement plastered substrates. The paint contains rubbers that are treated with chlorine gas that is dissolved in solvent with the addition of compliant pigments. They have high resistance to acid, alkali and moisture induced dampness. In an environment laden with high humidity and acidic contents the use of this paint may reduce the frequency of repainting (Duggal, 2008). Casein paints are also used in building exteriors as wall finish when drying varnish is added. They are tinted in any colour and are available in paste or powder form made of base like litho-phone and whiting.

Oil Based Paint

Oil based paint which is also referred to as alkyd or gloss consists of pigment suspended in drying oil, usually a mixture of resins and oil. It has a high viscosity which can be altered through the addition of solvents in order to increase the glossiness of the dried film. Its earliest known use was in caves at Bamiyan Valley in Afghanistan in 650AD which was discovered in 2008. Many of the historical pigments were harmful to human health and the environment; especially the use of lead (Orisakwe *et al.,* 2007 and Kim, 2011) even some that are in use in contemporary history are highly toxic. The principal constituent of oil based paint is the *base* which is usually a metallic oxide. It possesses binding properties which makes the paint film opaque. It helps in minimizing shrinkage cracks in the film during the process of drying. Some of the bases are red oxide, zinc white, white lead, oxide of iron, antimony white, titanium white, litho-phone and aluminium powder.

Another composite part of oil paint is vehicle which is also known as binder or solvent. It is the oil in which the base is mixed. It plays a major role in holding in suspension the constituent parts together. The spread-ability of the paint is enhanced through vehicle. Binders affect the durability, water resistance and toughness of paint. The resistance to physical weathering of painted surface and glossiness is determined by the vehicle used. Some of the binders-vehicle in use include: Tung oil, nut oil, linseed oil of various types, stand oil and poppy oil.

Linseed oil is the most commonly used (Ravikuman *et al.,* 2012). It is extracted from flax seeds. Tung oil is better than linseed oil and it is used for high quality paint. Poppy oil is prepared from poppy seed which dries slowly with enduring colour. Nut oil is extracted from walnuts. It dries quickly and it's almost colourless. The end product of nut oil is not durable. Driers which are known as plasticizers or resins are added as catalyst for the polymerization, oxidation and condensation of the vehicle in paint. Excess of driers in paint can lead to flaking failure. Driers are impervious to water, air and moisture to a great extent. It creates a very tough and hard film which reduces corrosion of metallic substrates when applied. Examples are manganese oxide, zinc, litharge and lead chromate.

Types of Oil-Based Paint

Oil based paints are used widely for painting various substrate and they work efficiently except on cement plastered walls in buildings though they are used in water prone areas such as kitchen, and toilets where tiles are not used due to fund. This occurs on rare occasions. The use principally covers the painting of wood, plastic, metal components and other materials. They are available in various types such as: Aluminium paints used for painting metal roofs, poles, storage tanks for water and roofing sheets. They are resistant to acid fumes and are highly heat reflective. They are used in painting objects that are meant to reflect even in the dark because of its high dispersive property (Vacher *et al.,* 2010).

Anticorrosive paint is essential for metal surfaces on building exterior in coaster environment (Roy, 1996). The function of anticorrosive paints as antidote to the reduction of metal corrosion in tropical coastal environment has been identified (Corvo *et al.,* 2008). They are suitable for the preservation of structural steel works against adverse weather conditions and acid fumes (Duggal, 2008, Corvo *et al.,* 2008). They inhibit the corrosion of metals by cutting down the water and air contact with the surface. They are composed of linseed oil as vehicle while zinc oxide, zinc chromate, iron oxide and lead are used

as pigments. Their ability to dry quickly and hardened are part of the condition responsible for their effective performance (Thanamongkollit *et al.,* 2011).

Cellulose paints harden by evaporation of the thinning agents unlike other paint that harden through oxidation. They are generally referred to as lacquers. They have high resistance to the stresses of climate and are not used primarily in buildings but for cars, airplanes and ships. They contain colloidal dispersion of cellulose derivative, resin and plasticizers in solvents and dilatants. The adhesion is enhanced by adding castor oil. This also improves the smoothness and toughness of the paint film.
Other types of oil paint include asbestos paints that are used in painting metal spouts, drainages and leakages in roofing sheets. These are also used to prevent dampness in basement and other damp prone areas in building. Bituminous paints are specially made for damp proofing in buildings to prevent water penetration. They are also used for iron works under water and are alkali resistant. The life span could be short when exposed to climatic changes of dry and wet seasons.

Discussion

Effects of Substrates on Paint

Varieties of causes are responsible for the performance of paint. Ranking first among these causes are the substrate on which the paint is applied. The substrate contributes to the durability or otherwise of paint. Dampness of substrate as reported in many studies is a risk factor of failure in painted wall and porous building materials in general (Corvo *et al.,* 2010, Brito V *et al*., 2011, Lee *et al.,* 2008, Koniorezyk *et al.,* 2008, Mukhopadhuyaya *et al.,* 2011). (Hinks *et al.,* 2003) observed the impact of sunlight and rain as major factors for the failure of paints on substrates.

Dampness results from traditional, convectional way of the construction process. The use of water in mixing mortar is inevitable, the water been used in the coastal area contain some quantity of salt which is detrimental to cement (Ahmad *et al.,* 2011). It is expected that the walls are allowed to dry properly before paint is applied, otherwise moisture will be trapped under the background which will eventually lead to multiple reactions that will wear out the paint.

Paints can influence evaporative drying processes which may lead to the extension, duration and intensity of the presence of moisture and dampness in surfaces (Massari *et al.,* 1993). (Mukhopadhyaya *et al.,* 2011) posited that moisture content determines the drying rate of substrates. The functional behavior of whole construction is influenced by the presence of moisture and its distribution within the substrate (Hall *et al.,* 2002). Paint therefore is greatly influenced by the presence of moisture on substrate because drying and oxidation is retarded on wet substrate than dry substrate (Brito V *et al*., 2011).

Although water-based paints are better used in wet humid areas that oil paint yet when used in saline laden environment, evaporation reduces and moisture builds up to the detriment of the paint (Goncalves *et al.,* 2009, Komshin, 2010, Anderson *et al.,* 2011). Activities that lower the rate of evaporation of moisture and dryness of substrates are therefore detrimental to painted surfaces.

The presence of filth and dirt on the surface of the substrate will hinder adhesion and aid peeling (Nepal *et al.,* 2010, Contant *et al.,* 2010, Hua-Tzu *et al.,* 2010). The surface of substrate should be clean and made free from dust before paints are applied. A substrate that contains lime and cement can lead to chemical reactions when paint is applied and consequently affect the colour and hardness procedure especially in oil paint. The influence of thermal movement aids failure and increases shrinkage of paint. Painting is not best carried out under intensive sunlight which is capable of increasing the drying rate beyond the required.

Problems and Defects of Paint

Paint defects ranked as the third most critical defects that require maintenance in residential buildings in

a study carried out in Sri Lanka (de Silva *et al.,* 2010). This buttresses the need for proper attention to the choice and use of paint for the exterior finish of building.The presence of soluble salt especially sulfates and chlorides have detrimental effects on the integrity of most paint systems (Moreillo *et al.,* 1999). All surfaces contaminated by salt will reduce the life cycle and aggravate failure when applied on steel; the effect of salt shows more quickly because of its corrosive nature. (Johnson, 1983); (Evans *et al.,* 1972) agree that most salts have the effect of increasing the rate of absorption of moisture from the atmosphere. This is aggravated by lowering the critical relative humidity for condensation. Some of the problems and defects of paints are:

Osmotic blistering: this results when a paint layer is applied on a substrate contaminated with soluble salt. The blisters are filled with water and latter with corrosion products from metallic substrate used in buildings. A painted surface that water permeates will experience dampness. This will accelerate the osmotic force by the difference in the concentration of the solutions on either side of the film. It will promote the diffusion of water through the semi permeable paint layer.
Peeling: the presence of adhesion reducing substance like salt aid the peeling off of paint. Inherent in a high humidity area on substrate is a disadvantage to paint.

Chalking: highly porous substrates that are not properly primed increase the sucking of moisture from dry paint and causes chalking. This is the progressive powdering of paint film on painted surface. This is caused by polymer degradation of paint matrix due to ultra violet radiation attack that generates through high solar radiation. It is also caused by lack of adequate oil in the primer. The action of sunlight accelerates chalking. Erosion: this is accelerated chalking that occurs as a result of external agents such as air movement, driving rain and wind abrasion. Cracking: this is due to unequal expansion or contraction of paint coats as a result of incomplete curing and drying before the next coat is applied.

Flocculation: the process by which the disperse phase comes out of suspension in flakes. Coalescence: the instability that occur in paint when small droplets bump into each other and combine to form progressively longer droplets.Creaming: this is the migration of one of the substance to the top or the bottom, depending on the relative densities of the two phase of the emulsion under the influence of buoyancy or under centripetal force when centrifuge is used.

Flaking: it is caused by moisture penetration through cracks on the coatings which leads to the loss of adhesion between paint film and substrates (Hinks *et al.,* 2003).The loss of adhesion between the substrate and paint layer aids it, infact, any paint applied on friable surface will flake especially on vulnerable surfaces like oily hardwoods. The use of plastic emulsion reduces the effect of flaking. Wrinkling, crawling or rivelling occurs when the viscosity of the paint film is high. It is a process that prevents the lower layer of the paint from drying and thus leads to shrinking and folding which tend to collect dirt filth. In extreme cases sagging may occur. Aligorating: the sliding over of one layer over another of the paint film when a hard paint is applied on a soft paint or vice versa. This occurs mostly in historical buildings and in the process of repainting previously painted surfaces.

Bloom occurs as a chemical reaction to the environment when there are defects in the quality of paint or when the area painted is poorly ventilated. It is the formation of dark or dull patches on the painted or polished surface. Poor workmanship, weathering action and low quality paints are the causes of flashing which is characterized by the appearance of glossy patches on painted surface.

When the paint film is not opaque enough so much that the colour of the substrate can be seen under the paint film, then grinning occurs. Checking is a mild form of cracking which is sometimes referred to as fine cracks. Where checking occurs on the external wall in a saline laden environment, the penetration of salt crystals is increased and the damaging effects become more pronounced.

The formation of pinholing of the surface on wet paint surface through the formation of blisters or bubbles of small sizes is referred to as bubbling. It results from the process of application through trapped moisture, gases or air. It usually results to cracking and peeling. Bittiness arises as a result of addition of filth and dirt to the substrate from the atmosphere or through dirty tools. It affects the surface smoothness of the paint finish.

Pimpling results from poor flow of paint due to high viscosity. It forms spots on the finish surface. Variability of colour in the same batch due to poor supervision of the production process causes aesthetics problems. It leads to floating and differential discolouration on the same surface of the building. (Komshin, 2010) discovered that soluble salt in porous substrates will affect paint films. The discolouration of the paint therefore depends largely on the condition of the substrate.Other problems of paint include wrong choice for a particular substrate in a particular environment, unprepared background, rising damp and humidity. They all have impact on the adhesion of paint. The content of alkali in concrete and mortar must be militated against during construction to prolong the service life. Areas exposed to prolonged dampness require attention during painting.
The defects can be summarized as itemized below (Hinks *et al.,* 2003, Radfar *et al.,* 2010):

Common causes:

- Loss of adhesion;
- Poor paint quality, uneven application;
- Damp background, high porous background, dirty background;
- Chemically unstable background;
- Incompatibility between substrate and paint;
- Permeability of coating

Common symptoms:

- Flaking- loss of adhesion especially in old buildings;
- Peeling (differential movement);
- Checks/ crazing (paint quality);
- Bubbling/ blistering (mixing/application fault or moisture/resin entrapment;
- Cissing (patchy adhesion);
- Chalking (eroding of surface);
- Blooming (chemical response to environment);
- Wrinkling (uneven paint application);
- Balling/saponification (poor drying out/alkaline reaction);
- Colour variability and
- Bittiness/pimpling (incorporation of filth and dirt)

The impact of paint range from health aggravated problems, environmental problems and increased embodied energy. Traditional painting materials and processes can have harmful effects on the environment. The use of lead is one of the most pronounced problems of paint to human health and potential chemical contaminants in the environment (Orisakwe *et al.,* 2007, Winder, 1993).

Orisakwe *et al.,* (2007) opined that lead, cadmium, nickel and other industrial metals used as materials for producing paint varnishes have adverse health implications. Heavy metals are an environmental and public health hazard which can result from paint industries (Nduka *et al.,* 2007). Paint commonly used in the tropical region may contain high level of heavy metals which may be responsible for undocumented and unintentional ingestion and diseases (Nduka *et al.,* 2007).

Solvents in paint contain high quantities of volatile organic compounds (VOCs). These are considered harmful to the environment and the people involved in the production line. This is linked to organic solvent syndrome (Spurgon, 2006). Thereduction of VOCs as much as possible is recommended for better compliance to human health (Osemeahon, 2011).

Lead is used as pigment and additive to hasten drying, increase durability and for the sustenance of fresh appearance. The effect of moisture which causes corrosion is also reduced through the addition of lead. However, as a poisonous metal, it can damage the nervous system (Osemeahon, 2011). It also causes blood and brain disorders in children. (Khan *et al.,* 2011) categorically states that its environmental pollution is a major hazard throughout the world.

Advantages and Disadvantages of Using Paint

The use and application of any material goes with its merits and demerits. Some of the ***advantages*** of using paint include the following: the freedom to change the colour of the building at will, availability of varieties of colours to choose from, the ease of maintenance methods, the ease of application, especially on low cost and low rise buildings, you don't have to keep the catalogue of previously used paint, it can easily be blended and supplied when needed unlike some other finishing materials, paints are corrosion inhibitors especially in metal substrates and it serves as a line of protection to substrates. However, it has some ***disadvantages*** that militate against its efficiency. Some of which are: quick occurrence of defects, the reduction of evaporation of moisture from the substrate, frequent repainting, the interval of 5-7years is too cumbersome for high rise buildings, it is not cost effective on the long run, most of the materials for production are toxic and hazardous to human health and the chalking effect easily stains when contact is made.

Conclusion

The defects that occur in painted exterior of buildings in the tropical region due to the reactions that are generated by the substrates on which paint is applied is examined in this paper. This review revealed that defects or failure in paint are not as a result of the impact of external factors of climate or the quality of the paint alone. The presence of contaminants in the substrates on which paint is applied is found to contribute to the quick deterioration especially in areas with high humidity with salt content (Folorunso *et al.,* 2013). The action of continuous moisture transfer within the substrates can aid the penetration of contaminants into the paint film as a porous material. This causes chemical reactions within the paint film and the development of defects. Two major types of paint are commonly used in the tropical region for exterior finish. These are oil and water base paints. However, the use of oil base paint is not common when sandcrete wall is the substrate. Water base paint otherwise called emulsion or acrylic paint that is more susceptible to moisture penetration is mostly applied as exterior finish in the tropical region. Although the contaminants within the substrate do impact negatively on the paint, its application still serves as the last line of protection to the substrate. As much as paint is not advised for multistory buildings within the tropical region because of frequent maintenance, it is the easiest material to handle and replace as exterior finish of buildings ((Folorunso *et al.,* 2017).

References

Ahmad, A. G. RahmanH.F.A.(2011). *Treatment of salt attack and rising damp in heritage buildings in Penang*, Malaysia,15(1): 93-113.

Anderson, B,Frisvad, J.C. SondergaadI.B., Rasmussen, I.B& Larsen, L.S. (2011). Associations between fungi species and water-damaged building materials. *Journal of Applied and Environmental Microbiology*, 77(12): 4180-4189.

Brito, V,Goncalves, T.D&Faria. P. (2011). Coatings applied on damp building substrates: performance and influence on moisture transport. *Journal of Coating Technology Research,*8(4): 513-525.

Contant, S. Junior, G.C, Machado, P.F& Lona, L.M.F. (2010). Evaluation of the effect of dry film biocides on paint film preservation using neural networks. *Brazilian Journal of Chemical*

*Engineering,*27(4): 61-71.

Corvo, F, Perez, T,Dzib, L.R. Martin, Y., Castaneda, A. & Gonzalez, E. (2008). Outdoor-indoor corrosion of metals in tropical coastal atmosphere. *Corrosion Science*, 50: 220-230.

Corvo, F, Reyes J, Valdes C, Villasenor F, Cuesta O, Aguilar, D.& Quintana, P. (2010). Influence of air pollution and humidity on limestone materials degradation in historical buildings located in cities under tropical coastal climates. *Water Air Soil Pollution* 205: 359-375.

de Silva, N, Ranasinghe M. Maintainability risk of condominiums in Sri Lanka. *Journ**al of Financial Management of Property and Construction* **2010, 15(1): 41-60.**

Duggal, SK. *Building materials*. New Delhi, New Age International Publishers Limited; 2008.

Dumitru, P,Jitaru I. Improving *hiding power obtained by variation of fillers for interior emulsion paints.* REV.CHIM (Bucharest) 2010, 61(5): 479-482.

Evans, U.R, Taylor, CHA. *Corrosive Science* 1972, 12(3): 227-246.

Folorunso, C.O, Ahmad, M.H. Performance and resistanceof paint used as exterior finish in salt laden environment. *Structural Survey*, 2013, 31(3), 214-224.

Folorunso, C.O, Akingbohungbe, D.O & Ogunruku, M.P. Choice Prediction Factors in Building Exterior Finishes' Selection in Lagos, Nigeria: Clients' Perspective. *International Journal of Research in Engineering and Social Sciences*, 2017, 7(1)14-20.

Goncalves, T.D,Pel, L, Rodrigues, J.D. (2009) Influence of paints on drying and salt distribution processes in porous building materials. *Journal of Construction and Building Materials* 2009, 23: 1751-1759.

Hall, C& Hoff, W.D.Water transport *in brick, stone and concrete.* New York, Spoon Press, 2002.

Hinks, J& Cook, G.*The technology of building defects.* UK, Spoon Press, Taylor & Francis Group;2003.

Hua-Tzu, F, Hong-Hsiang, K.*Method and apparatus for paint curing.* United States Patent Application Publication 2010, US2010/0227082A1: 1-8.

Johnson, W.C. *New concept for coating protection of steel structures,* In Berger, DM and RF Wint, editors, ASTM Philadelphia; 1983, p28-43.

Khan, A.N,Munir, U, Turnbull. I& MacDonald, S. Lead poisoning imaging. *Journal of WebMD Professionals* 2011, 12(4):1-9.

Kim, J.A, Kim, S, Kim, H.J,& Kim, Y.S. Evaluation of formaldehyde and VOCs emission factors from paints in small chambers: the effects of preconditioning time and coating weight. *Journal of Hazardous Materials* 2011, 187(1-3): 52-57.

Komshin AS. Mathematical modeling of the process of measurement control of the degradation of construction materials. *Measurement Techniques,*2010, 53(9): 976-982.

Koniorczyk M, Garwin D. Heat and moisture transport in porous building materials containing salt. *Journal of Building Physics* 2008, 31(4): 279-300.

Lee ST,Swamy RN,Nim SS, Park YG. (2008) Durability of mortars made with recycled fine aggregates exposed to sulfate solutions. *Journal of Materials in Civil Engineering* 2008, 20: 63-70.

Massari ,G& Massari, I.*Damp buildings: old and new.*Rome, ICCROM, 1993.

Morcillo, M. Soluble salts: their effect on premature degradation of anticorrosive paints. *Journal of Progress in Organic Coatings* 1999, 36: 137-147.

Mukhopadhuyaya, P,Batcheller D, Kumaran MK, Lackey JC, Van Reenan D, &Normandin N. Correlation between water vapour and air permeability of building materials: experimental observations. *Journal of ASTM International* 2011, 8(3):1-14.

Nduka, JKC,Orisakwe OE&Maduawguna CA. Heavy metals other than lead from buildings in Eastern Nigeria. *Journal of Toxicology and Industrial Health* 2007, 23: 525-528.

Nepal, B, Rai BK. Reducing paint waste in a colour sample manufacturing industry. *International Journal of Business Excellence* 2010, 3(2): 86-205.

Orisakwe, OE, Nwachukwu E,Osadolor HB,Afonne O.J, &Okocha CE.Liver and kidney function test among factory workers in Nkpor, Nigeria. *Journal of Toxicology and Industrial Health* 2007, 23: 161-165.

Osemeahon, SA. Copolymerization of methaylol urea withethylol urea resin for emulsion paint formulation. *African Journal of Pure Science and Applied Chemistry* 2011, 5(7): 204-211.

Radfar, R,Jassbi& J,Ghoreishi F,Khanmohammadi S.A & lborzzi M. Proactive quality paint thickness control using ANFIS.*In proceedings of Systems, Man and Cybernetics,* 2010IEEE International Conference; 2010, p5-10.

Ravikuman, H.R,Shwetta,S.R,&Karigar, C.S. Biodegradation of paint: a current status. *Indian Journal of Science and Technology* 2012, 5(1): 1977-1987.

Rijniers, L.A.*Salt crystallization in porous materials: an NMR study*. Unpublished PhD Thesis, Eindhoven University of Technology, Netherlands 2004.

Roy, SK,Thye LB,& Northwood DO. The evaluation of paint performance for exterior applications in Singapore's tropical environment. *Building and Environment* 1996; 31(5): 477-486.

Schwartz, M. *Encyclopaedia of materials, parts and finishes-second edition.* USA, CRC Press LLC; 2002.

Spurgeon A. Watching paint dry: organic solvent syndrome in late twentieth century Britain. *Journal of Medieval History* 2006, 50(2): 167-188.

Thanamongkollit, N, Miller KR,Soncek MD.Synthesis of UV-curable tung oil and UV-curable tung oil based alkyd. *Progress in Organic Coating* 2011, http://dxdoi.org/10.1016/j.porgcoat.2011.02.003.

Vacher, S, Hernandez C, Bartschi &Poussereau N. Impact of paint and wall paper on mould growth on plasterboards and aluminium. Building *and Environment* 2010, 45: 916-921.

Walberg, RL. 2007, Different types of paint and when to use them,Ezine Articles, 3, available athttp://Ezinesarticles.com/?expert=Ray_L_Walberg, accessed 15th October, 2011.

Winder, C. Lead production and development. *Neurotoxical Journal* 1993, 14(2-3): 303-317.

RUGIPO RESEARCH AND TECHNICAL JOURNAL

INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) IN ARCHITECTURAL EDUCATION: THE CHALLENGES

Authors

[1]Ilesanmi, O. S., [2]Alejo, A. O. and [3]Olowoyo, A. S.
[1]Department of Architectural Technology
[2&3]Department of Building Technology
Rufus Giwa Polytechnic, Owo, Nigeria

Abstract:

Architectural education, beyond training the students to become architects, impacts in them the appreciation of the responsibilities relating to public health, safety, and welfare. Architecture is no longer a personal philosophical or aesthetic pursuit by individuals, rather, it has to consider everyday needs of the people and use technology to give a livable environment. In the present age, architectural education must have to grapple with the recent integration of technology, in particular, facilities offered by information and communication technology. Electronic technologies have moved architecture from the drawing board to cyberspace. The world is now a global village in which new information and methods are easily and quickly available to people at different poles of the globe. It is the position of this paper that in order to remain relevant in the ever-competing forces within the building industry, architectural education must show the impetus to continue to draw from technological advancements associated with the use of computers.

Keywords: Architecture, Education, Communication, Information, Technology.

Introduction

The global architecture classroom' has existed for several years, along with more recent concepts such as the 'virtual field trip'. Marcos Novak (1997) posits that "currently the most advanced and most dramatic solutions of architectural problems could not have been conceived without the computer". Students and teachers can now exchange information at the click of a mouse button. Global positioning systems (GPS) can be attached to automatic data logging devices and linked direct to palmtop, laptop and desktop computers and entered onto remote databases accessible to schools worldwide. Digital cameras and camcorders feed images straight onto school or departmental websites and video conferencing allows students to exchange information and ideas in real time, with other schools and organizations. News, images, and animations are instantly and constantly available on the web.

Classroom activities such as electronic worksheets can direct students to a whole range of existing online resources. Sa'ad (2001) states that "opportunities offered by electronic technology include the possibility for client, sub-contractors and the general public to take a tour of the proposed project and site while in the architect's office". However, many educational practitioners lack the time, will, confidence and opportunity to develop information and communication technology (ICT) competence, and ICT skills are now a crucial requirement both for teachers and students. This paper aims at examining the ICT challenges to the academic practitioner in the field of architecture.

Developments in Information and Communication Technology

Information and communication technology (ICT) has been defined by the Information Technology Association of America as "the study, design, development, implementation, support or management of computer-based information systems, particularly software applications and computer hardware". ICT deals with the use of electronic computers and computer software to convert, store, protect, process,

transmit and retrieve information securely. Throughout its history, an alliance between the military and various industries has existed in the development of electronics, computers and information theory.

Today, the term ICT has so developed as to encompass many aspects of computing and technology, and the term has become recognizable more than ever before. One cannot but agree with Hans Blumenfeld (1971) that it is the task of architects "to foresee what will happen as a consequence of human actions and to guide these actions in such a way that they help rather than hinder each other in achieving their goal". Aspects of ICT include: data management, computer networking, database systems design, software design, management information systems, systems management, and others. There are several challenges which architectural educators should consider in implementing either initial or advanced ICT concepts or practices. However, this paper will proceed to examine architecture and its education.

Architecture and Architectural Education

Architecture is the art and science of designing buildings and structures. A wider definition would include the design of the total built environment – from the macro level of town planning, urban design, and landscape architecture to the micro level of construction details and furniture. Architectural design involves the manipulation of mass, space volume, texture, light, shadow, materials, programmes, and other elements in order to achieve an end which is both aesthetic and functional. Nkwogu (2001) submits that "theories about the nature of architecture are concerned with identifying key variables like space, structure, form, function, time, order or social processes in terms of which buildings, in particular and the built environment in general should be seen and evaluated". This distinguishes architecture from the applied sciences of engineering which usually concentrate on the structural and feasibility aspects of designs.

In every usage, architecture may be seen as subjective mapping from a human perspective to the elements or components of some kind of structure or system, which preserves the relationships among the elements or components. At present, part of the architectural profession, like their counterparts in other disciplines, responded to modernism and post-modernism by going to what they considered the root of the problem. They felt architecture should not be a personal philosophical or aesthetic pursuit by individualists; rather it has to consider everyday needs of the people and use technology to give a livable environment. Joseph Masheck (1993) admits that "while the rise of engineering in later eighteenth-century France began to pose a challenge not so much of one aesthetic against another as of pragmatics against aesthetics, French architecture in the 'Revolutionary' period was already preoccupied with the question of armament and utility". Architecture today usually requires a team of specialist professionals, with the architect as one of them and most often the leader.

During the last two decades of the 20th century and into the new millennium, the field of architecture saw the rise of specialization within the profession itself, in terms of project type, technological expertise or project delivery methods. The most significant development in the profession is the mainstreaming of sustainability. Sustainability in architecture was pioneered in the 1970s by architects such as Edward Mazria and Ian McHarg in the US and Brenda and Robert Vale in the UK and New Zealand. Architects are now expected to integrate sustainable principles into their projects in the light of climate change. "The energy problems of developing countries require especially close attention to climatic features so that industry, technology and urbanization use them to positive advantage, whilst, at the same time comfort and health standards can be raised" (Markus and Morris, 1980).

These developments in the field of architecture are not isolated from the developments in other fields of human endeavour. The world is moving into a global village such that new information and methods are easily and quickly available to people at different poles of the globe. The main forces of globalization are the expansive developments in the field of information and communication technology. In the many years of conferences on the teaching of computer skills or application of computers in the design studios, we see discussions about the needs, methods, and benefits of teaching the use of computer tools. A few of

the papers review how students learn but not many report how computer tools can be directly beneficial to the students' learning. Sa'ad (2001) identifies the main factors determining global architectural development in the next few decades as:

- Technological innovation, especially information Technology (IT),
- Concern for the environment - Financial management, and
- Democratization of decision-making.

We shall subsequently examine some of the framework of alternatives available in the teaching and learning of architecture.

ICT in Architecture Education

Ann Taylor (1981) maintains that the concept of integrated learning is not new.

General and art education literature often testifies to the value of integrated and 'applied' learning, which promotes the use of acquired knowledge in solving problems. Thus to encourage creativity, a student must be given a challenge, along with the freedom to pursue a solution with a variety of tools. Visualization and graphic communication are some of the most important of these tools, but they are often sadly neglected in the classroom. There are several major factors that should be considered in implementing either initial or advanced ICT packages in the teaching and learning of architecture. The focus here is on systems which provide data on a continuing basis and not with specific computer techniques such as selective information retrieval or graphical output. Some of the most important decisions for architects in data system design are:

1. Determining the extent to which the system to serve architects should be integrated with other departments and/or agencies. Here, the word 'integration' has at least three dimensions, namely integration of input, integration of storage, and integration of organizational arrangements.
2. scope of the system concerned with how much ground area the system should cover, with a consideration of the geographic jurisdiction of the architectural environment or department while making allowances for further integration.
3. Volume of data which is concerned with the volume of data the system would be designed to handle.

Challenges to Architectural Education in Nigeria in the Information Age

The world of architecture is heavily influenced by the revolution in information technology (IT). Virtual Realty (VR) has profound implications on architecture. Secondly, electronic technologies have moved architecture from the drawing board to cyberspace with profound implications on the architect and the practice of architecture (Sa'ad, 2001). The fundamental focus of architecture education is to make the students professional architects, with the main goal being to contribute to the development and attainment of humane and responsive environment. Olotuah (2001) maintains that “the central issue in architecture is thus the quality of the human habitat and its design to accommodate a diverse and complex range of human activity.” The general goal of architectural education is more involving and challenging since it seeks the advancement of the profession of architecture through the generation of new knowledge, promotion of academic excellence and the provision of research opportunities. Architectural education needs continuous streamlining of goals and objectives. Taking good cognizance of the broad areas of problems in our architectural educational system as outlined by Chukwuali (2001).

- The problem of adaptation of education to specific socio-economic condition.
- The problem of elimination of barriers in specialization.
- The problem of missing links in the information system.
- The problem of misplaced emphasis.
- The problem of undeveloped potentials.
- The problem of activation of personality.

This paper will put emphasis on the challenges that result from the enormous advances in the information age propelled by the momentous developments in information and communication technology. All who

are involved in the education activities should be most concerned with the implication of all the changes resulting from ICT as have been highlighted in this paper, and the education of new generation of architects should be made to cope with this new order. ICT key skills are now a crucial requirement both for teachers and students. Yet the reality is that the uptake of school ICT is still very patchy. Experience suggests that it is better to start with an achievable target and to build on that initial success. The following may be explored the more:

Word Processors

The most basic word processor has tremendous ICT potentials when used imaginatively. Apart From the primary uses in reporting and record keeping, worksheets or exams, most word processing packages allow other architectural ideas to be pursued. Maps, images can be copied, for instance from the web and pasted into word processed documents. Arrows can be drawn to identify key locations and test can be incorporated and linked to questions. The graphic tools available on most word processing applications, e.g. Microsoft Word, can be used to draw simple flow-line maps, proportional circles, and isoline maps. These can be superimposed onto self-drawn maps or those acquired e.g. from the internet. Data collected during field trips, can be neatly tabulated and then selected to plot a variety of charts and graphs, which can then be pasted into other documents.

The Internet

Despite the great potential offered by the internet, the reality is that the world-wideweb still remains the 'world-wide-wait for many users, either due to limitations of access, poor search routines or slow loading of inappropriate websites. Staff and students should be encouraged to run their own websites allowing publication and exchange of information and data and customized links to useful websites. Schools can participate in interactive projects where students exchange ideas and information world-wide. There is also scope for live videoconferencing and links to technical expertise.

Email

Email access has become a reality for many students and staff. This opens up a wide range of possibilities when used imaginatively. The bottom line is that time and distance are no longer handicaps to instant communication. The same work assignment can be emailed to a whole group, either within school or at home and during vacations. Similarly, work can be emailed back. Hyperlinks to useful websites can be embedded into an email message, directing students to relevant online resources. Text and graphics can be sent as attachments and linked to appropriate tasks. Opportunities offered by electronic technology can never be over emphasized and remains a great challenge to our architecture educators.

Coupled with these, globalization of professionalism has forced many foreign institutions to look beyond traditional systems. The problem is that we are just not equipped to compete with other professionals abroad and our architectural students are not in tune with developments in other institutions abroad.

Conclusion

The great advances in information and communication technology have their own shortfalls and drawbacks. Computer-Aided-Design (CAD) has proved a wonderful design tool for architects but other stakeholders are beginning to question whether the architect that exploits these new tools, actually knows how these wonderful designs can be constructed. ICT has revolutionized speed of design, transmission of design information over long distances and usual effects of architectural design but not constructability. However, the architect can no longer afford to work without ICT facilities. This should be taken care of by the academic curricula so that our future architects do not feel outdated or inferiors before their peers from foreign Universities.

References

Ann, T. [1989]. *New Horizons for Learning "On the Beam"* "Perspectives on Architecture and Children" Vol. IX, No. 2 Winter.

Chukwuali, C. B. [2001]. "The Basic Problems of Architectural Education: A Nigerian perspective In Architects and Architecture in Nigeria; U.O. Nkwogu [Ed], Association of Architectural Educators in Nigeria [AARCHES], pp 145-154.

Edward, F.R. Hearle, [1965]. "*A Framework of Alternatives in Planning"* "Electronic Data Processing in Planning [Chicago Illinios: American Society of Planning Officials,].

Hans, B. [1971]. *The Growth of Cities*, "The Role of Design" in David Lewis [Ed.] [New York: Wiley-Interscience].

Joseph, Masheck, [1993]. *Building Art* [New York: Cambridge University Press].

Markus, Novak, [1997]. *Architectural Design Special edition on Architecture in Cyberspace*. "Next Babylon, Soft Babylon"

Olotuah, A.O. [2001]. "Pedagogy and the Verve of the Pursuit of Architect-Teachers" In Architects and Architecture in Nigeria; U.O. Nkwogu [Ed], Association of Architectural Educators in Nigeria [AARCHES], pp 77-90.

Sa'ad, Hamman Tukur, [2001]. *Architects and Architecture in Nigeria* "The Changing Role of_the Architect and Architecture in the Context of the EverChanging Technological Socio-economic and Political Global Environment" in U.O. Nkworgu [Ed.] [Akure Nigeria: Shalom Publishers] pp 1-16.

Nkworgu, U.O. [2001]. *Architects and Architecture in Nigeria.* "Understanding Theory and Appreciating Criticisms in Architecture" in U.O. Nkworgu [Ed.] [Akure Nigeria: Shalom Publishers].

RUGIPO RESEARCH AND TECHNICAL JOURNAL

EXPERIMENTAL INVESTIGATION AND PERFORMANCE EVALUATION OF THERMAL-BEHAVIOUR ON MULTI CAVITY POROUS MEDIA

Authors

Adepo,S.O.,Imoukhuede, K.A.andAyodele, O.R.
Mechanical Engineering Technology Department,
Rufus Giwa Polytechnic, Owo
e-mail. adeposegun@yahoo.co.uk; kademola05@gmail.com;
olakunle_ayodele@yahoo.com

Abstract:

The principal materials used to study the fluid flow and the thermal behaviour of multi cavity porous media of different cavity shapes and numbers, and to validate the effects and compare the thermal behaviour of different types of multi cavity porous media are the SCB (Solid Concrete Blocks), HCB2Hand HCB3H (Hollow Concrete Blocks two and three Holes respectively).The fluid flow and the thermal behaviour of the multi cavity porous media of solid concrete block (SCB) of size (450 x 225 x 225)mm made using plane river sand with maximum size 4.75mm and specific gravity of 2.6 homogenously mixed with ordinary Portland cement of 43 grade confining to NIS 0871200(3), and hollow concrete block with 2 cavities (HCB2H) and hollow concrete block with 3 cavities HCB3H made using the plane river sand with maximum size 4.75mm and specific gravity of 2.6 homogenously and of size (450 x 225 x 225)mm.The web thickness (m) for the solid concrete block is 50mm and the face shell thickness and void area in % for the SCB is zero. While the web thickness, face shell thickness (mm) for the HCB2H are 50.8mm and the void area % is 37.04 while the web thickness are face shell thickness for the HCB3H are 38.1mm and the void area is 44.4.The results show that the average result for the fives (5) specimen for the compressive strength N(mm) for SCB, HCB2H, and HCB3H are 4.856N/mm, 3.458N/mm and 2.999N/mm and for the thermal conductivities in $Wm^{-1}K^{-1}$ the average result for the fives (5) specimen for the SCB, HCB2H, HCB3H gives 0.656, 0.481, 0.227 in $Wm^{-1}K^{-1}$ considering the average values for the compressive strength of the thermal conductivities of specimens. It is observed that the physical strength of the concrete block decreases as the number of cavity increases, while the thermal resistance increases. In conclusion, a typical concrete block is much economical if it contains more number of cavities better thermally efficient than when it has no cavity orthe cavity size is reduce. The hollow concrete block with two cavities is preferred considering both strengths are conduction resistancebility.

Keywords: Hollow Blocks, Cavities, Experimental, Fluid Flow, Thermal Behaviour.

Introduction

As with another technological problem, the treatment of fluid flow and heat transfer to porous media has been a combination of direct empirical response on one hand and a more rigorous first principle approach on the other hand. While most of the empirical treatment do not use any significant background knowledge base and accordingly are rather short circle, the fundamental approach build up a knowledge base. A porous medium being a heterogeneous system made of solid matrix with its void filled with fluids can be treated as a continuum log property according for the role of each of the phase in transport through this system of phases.

The heat challenges inside a building have received a lot of attention, largely because it affects the comfort of human beings that may be inside such buildings. The heat inflow are out-flow to a building depends on the materials and the design used in the construction of such buildings. A principal material used is the building blocks. Available on the market today are several kinds of bricks with different

dimension, with or without cavities made with day, concrete or wood which are characterised by different thermal properties (Roberto floret and Paolo principle (2014). The most commonly used design has cavity inside the block, the size, shape and number of cavities play a vital part in the heat transfer that takes place between the surroundings and the room. This has therefore suggested the need to investigate the varieties of cavity options that can be explored to adequately minimize the energy requirement either for cooling or heating in a building.

In the south west part of Nigeria, hollow concrete blocks (HCB) are the most commonly used construction material due to their light weight, improved thermal and acoustic insulation characteristics. The main factors that influence heat transfer in hollow concrete block walls are the size, position and shape of voids, the geometrical characteristics of the mortar joints and the thermal conductivities of the constituent materials (C. Caruana and C..Yousef (2014). Nauaratnarasiah, e tal (2014) showed that a higher void cement hollow block offer the potential for energy savings, decreased raw material usage and reduced environmental impact Also, . (Mohamed A, Antar and Hassan Baig (2009) processed that an increase in the number of cavities in the layout of the block as well as the cavity layouts has a direct effect on reducing the heat flux without compromising the strength of the building block

Materials and Method

Materials

Solid and hollow concrete blocks of size (450 x 225 x225)mm, made using plate river sand with maximum size 4.75mm, and specific gravity of 2.6 homogenously mixed with ordinary Portland cement of 43 grade confining to NIS 087,2000 (specification for clay blocks and bricks full index to Nigerian Industrial Standards [NIS] (2000) was used for the experimentation.

Equipment for Experimentation:-An experimental rig comprising among others, heat, source porous media temperature measuring equipment will be set up to observe thermal behaviour of the sample under same thermal and environmental conditions.

Experimental Procedure: -The following process is employed to achieve the thermal behaviour of the multi cavity porous media.

- Extensive literature survey on heat and mass transfer are porous media concepts taken.
- Design fabrication of various moulds for the production of the various porous media.
- Production of the various porous media.
- Heat transfer experiments on the various porous media.
- Development of a thermal non equilibrium model.
- Validation and performance evaluation of the result of thermal non equilibrium model using the experimental data obtained
- Five specimens for Solid Concrete Block, (SCB), Hollow concrete Block two (2) Holes (HCB2H) and Hollow Concrete three (3) Holes, (HCB3H) were experimentally investigated by considering the compressive crushing strength of the five (5) different specimens from each of the classes of blocks under investigation.
- The thermal conductivity for each of the samples was determined using the steady state method by measuring the temperature difference ΔT across the samples in response to an applied amount of heating power.

Methodology

Investigating the physical characteristics of a multi cavity porous media was carried out as for mechanical strength, web thickness, face shell thickness, void area and thermal conductivities from literature. Naview – stokes equations (Bird et al 1960). Henry Daray (1856), Coulard et al (1988), Whitaker 1986, HSU and Cheng (1990), Chen and Chen (1992), Singh et al (1993), Song and Viskanta R, Chen L et al (1998) did sufficient research in these areas.

Extensive literature survey on heat and mass transfer and porous media concepts was carried out. This was followed by the Design fabrication of various moulds for the production of the various porous media and heat transfer experiments was carried out on the various porous media and later development of thermal non-equilibrium model and the vaccination of the result of the thermal non-equilibrium module using experimental data obtained.

Performance Procedure:-The following performance parameter for the thermal behaviour of multi cavity porous media was estimated compressive strength of the specimen in Nm^{-1} and the thermal conductivities of the specimen in ($Wm^{-1}K^{-1}$).

Results:-

Table 1: Shows the specimen specification.

	SCB	HCB2H	HCB3H
Dimension(mm)	450x225x225	450x225x225	450x225x225
Web thickness(mm)	0	50.8	38.1
Faceshell thickness(mm)	0	50.8	38.1
Void area (%)	0	37.04	44.44

Performance Evaluated on Compressive Strength (Nm^{-1})

The mechanical strength of the specimens were experimentally investigated by considering the compressive crusting strength of five (5) different specimens from each of the classes of blocks. The results are shown in table 2.

Table 2: Parameters Evaluated on Compressive Strength of Concrete Blocks; (SCB), (HCB2H) and (HCB3H)

Specimen	Block SCB	Block HCB2H	Block HCB3H
Specimen 1	4.63	3.53	3.01
Specimen 2	5.52	3.48	2.90
Specimen 3	4.60	3.42	2.95
Specimen 4	4.92	3.42	3.31
Specimen 5	4.61	3.44	2.80
Average	4.856	3.458	2.994

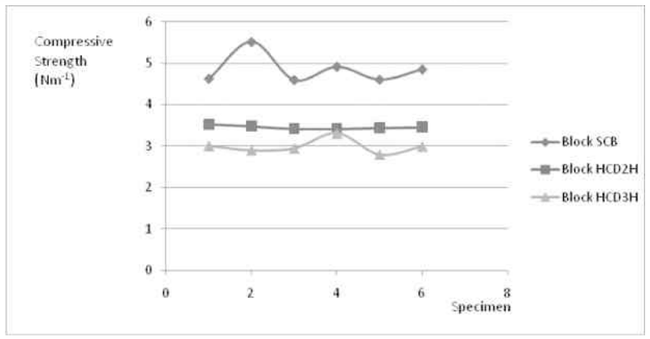


Fig 1.0 **Compressive Strength of Concrete Blocks; (SCB), (HCB2H) and (HCB3H)**

Parameters Evaluated on the Thermal Conductivities ($Wm^{-1}K^{-1}$).

The thermal conductivity of the specimens were also experimentally investigated on five (5) different specimens from each of the classes of blocks. The results are shown in table 3.

Table 3: Parameters Evaluated on the Thermal Conductivities ($Wm^{-1} K^{-1}$) of Concrete Blocks; (SCB), (HCB2H) and (HCB3H)

Specimen	Block SCB	Block HCB2H	Block HCB3H
Specimen 1	0.657	0.485	0.225
Specimen 2	0.654	0.475	0.228
Specimen 3	0.661	0.488	0.224
Specimen 4	0.658	0.477	0.230
Specimen 5	0.650	0.482	0.227
Average	0.656	0.481	0.227

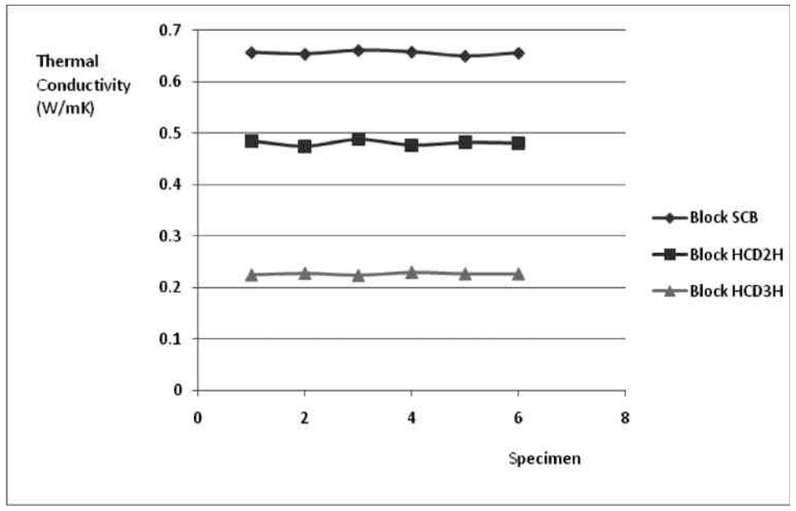


Fig 2.0 **Thermal Conductivities of Solid Concrete Block (SCB), (HCB2H) and (HCB3H)**

Results and Discussion

This study identified the design fabrication of various moulds for the production of various porous media and heat transfer experiments in the various porous media and development of thermal non equilibrium mode and the validation of the results of thermal non-equilibrium model using experimental data obtained. The study further identified the compressive strength and the thermal conductivities. This makes the need for the experiment to be obvious in building construction. The SCB, HCB2H and HCB3H were experimented and tested for performance evaluation. The results of the experiment in the table shows that for considering the average values for the compressive strength of the specimens and the average values for the thermal conductivity of specimens, it is observed that the physical strength of the concrete block decreases as the number of cavity is increased, while the thermal resistance increases. This makes it more difficult to effectively combine the two parameters in the selection of suitable concrete blocks for building construction.

Conclusion

Generally, a typical concrete block is much economical if it contains more numbers of cavities and better thermally efficient than when it has no cavity or the cavity size is reduced. The hollow concrete block with two cavities is preferred considering both strength and conduction resistance ability

References

Bird, R.B, Steward, W.E & Lightfoot, E.N: Transport phenomena 1st ed. Wiley New York, 1960.

Coulaud, O, Moree, P.&Caltagirone, J.P: Numerical Modelling of non linear effects in laminar flow through porous media. Journal of fluid mechanics (1988), 190, 393-407.

Whitaker, S. Flow, in porous media. A theoretical deviation of Darcy Law Transport in porous media (1986). 1, 3-25.

Chen, F.& Chen, P. Convection in superposed fluid and porous layers. Journal of fluid mechanics (1992), 234, 97-119.

Singh, A.K, Leonard, E.&Thorpe, G.R: Three dimensional natural convection in a confined fluid overlying a porous layer. Journal of Heat Transfer (1993), 115, 631-638.

Song, M.&Viskanta, R. Natural convection flow and heat transfer within a rectangular enclosure containing a vertical porous layer. International journal of heat and mass transfer (1994), 37, 2425-2438.

HSU, C.T & Cheng, P. Thermal dispersion in a porous medium.International journal of Heat and Mass Transfer (1990), 33, 1587-1597.

Chen, L,LiY& Thorpe, G.L. High-RayleigJi number natural convection on enclosure containing a porous layer.Heat transfer (1998), J.S lead Taylor and Francis 1998, 423 428.

Caruana, C.&Yousif, C. (2014):Heat Transfer Characteristics of Locally Manufactured Hollow Concrete Blocks Sustainable Energy 2014. The 1st Annual Conference

Terry, M. T.(2004) Thermal Conductivity:-Theory Properties And Applications Fourth Edi.KluwerAcademic/ Plenum Publishers, New York, US App 187-202

Nauaratnarasiah, S., K.N Anusari, K.N &Samindika, N. (2014): Effect of Void Area on Hollow Cement Mansonry Mechanical Performance.Arabian Journal for Science and Engineering 39, 7569 -7576.

Robert, F.&Paolo (2014): Thermal Performance of Hollow Clay Brick With Low Emissivity Treatment in Surface Encloses Coating.A Journal of Coating and Surface Engineering 4. 715 – 731.

Specification for Clay Bricks. Full Index to Nigerian Industrial Standards NIS (2000).

Mohamed, A. &Antar, H. (2009): Conjugate Conduction- Natural Correction Heat Transfer in a Hollow Building Block. Applied Thermal Engineering 29,Pp 3716 – 3720.

Y and Buildings 75, 330 – 349

Zhaug y, du.k. He j. Yang l. Lly&Ll,S (2014): Impact Factors Analysis on the Thermal Performance of Hollow Block Wall Energy.

Rogers, G.F.C. & May, Hew, Y.R (1992). Engineering Thermodynamics Work and Heat Transfer 4th Edition. Longman and Technical..

RUGIPO RESEARCH AND TECHNICAL JOURNAL

EFFICACY OF EDDY CURRENT AND INDUCTIVE PROXIMITY SENSOR: A CRITICAL REVIEW

Authors

Aponjolosun, J.K. andFaweya, J.A.
Department of Electrical/Electronic Engineering Technology
Rufus Giwa Polytechnic, Owo, Nigeria.
Email: johnsonkay1@yahoo.com

Abstract:

Eddy current and Inductive sensors come in a wide variety of shapes, sizes and designs and are widely used to measure position or speed, especially in harsh environments. All inductive sensors can be said to work on transformer principles and they all use a physical phenomenon based on alternating electrical currents. Inductive sensor which conveys a displacement of an object into a change of inductance which is associated with circuitry can be used for monitoring the displacement of the object. The sensor can be designed for determining both axial and rotational displacements of an object. This paper examines the relevance of sensors, particularly Eddy and Inductive in today's technology development.

Keywords: *Actuator, Copper tube, Detector circuit, Magnetic field, Sensitivity*

Introduction

In today's fast-growing world, the most innovative and attention seeking technology is definitely Sensors. The word sensor itself defines why this technology has been developed i.e. sensing the target or signal (Decker and Kostka, 2008). Sensor comes in various types. Placko and Dufour (1992) agree that Eddy current measurement is an inductive method based on the extraction of energy from an oscillating circuit. This energy required to induce Eddy currents in an electrically conductive material. Eddy current sensors do not recognize non-conductive materials. For this reason, dust, dirt and oil do not affect the measurement. This fact, combined with the sensor's robust, temperature-compensated design, enable measurements in harsh, industrial environments (Decker and Kostka, 2008). A proximity sensor often emits an electromagnetic field or a beam of electromagnetic radiation (infrared, for instance), and looks for changes in the field or return signal. The object being sensed is often referred to as the proximity sensor's target (Kejík and Kluser, 2004).

Different proximity sensor targets demand different sensors. A **proximity sensor is one example of sensors which can generally be defined as** a sensor which is able to detect the presence of nearby objects without any physical contact (Passeraub, 1997). Inductive proximity sensor for example will always require a metal target which could either be ferrous or non-ferrous materials (Lontis and Struijk, 2010). The maximum distance that this sensor can detect is defined as nominal range. Some sensors have adjustments of the nominal range or means to report a graduated detection distance. Proximity sensors can have a high reliability and long functional life because of the absence of mechanical parts and lack of physical contact between sensor and the sensed object. According to Faraday's law: "*any change in the magnetic environment of copper tube will cause a voltage to be 'induced' in the copper tubing" (*Ripka and Tipek, 2010). Proximity sensors are commonly used on smartphones to detect accidental touchscreen taps when held to the ear during a call (Lontis and Struijk, 2010).

There exist many known transducers from which an electrical signal is derived. Common examples are electrical resistances, and inductances, where an element by its deflection allows the generation of an electrical quantity. The resistor transducer necessitates the contact of elements which results in friction

(Fraden, 2004). This friction did not only cause unwanted wearing but also requires the initial threshold of force to overcome the friction. This may limit the applicability of the device where minute displacements are involved. Also, the threshold level which must initially be overcome, will vary as a result of the wearing of the elements thereby causing varying outputs for the same displacement (Lontis and Struijk, 2010). A solenoid transducer is an example of a well-known inductive transducer. Usually, the devices involves a freely movable ferromagnetic core which is moved in and out of a coil to vary the inductance of the coil.

It is an object of the invention to provide a sensor of mechanical displacement, through the use of an inductive transducer which allows for accurate control of the output characteristics ZDecker and Kostka, 2008). Another object is to provide for a sensor which can be designed in certain configurations for axial displacement and in other configurations for rotational displacement (Fraden, 2004). A yet further object is to provide for an inductive transducer which is accurate yet relatively inexpensive to produce; small in size and which may be readily modified to suit customers desired output (Decker and Kostka, 2008). These and other objects are achieved by the present invention hereinafter described. A basic embodiment of the invention provides for a ferromagnetic core i.e., ferrite, to be located within a conductive tube having a shaft adjacent thereto. The core and tube are located in a housing which has a winding or coil located thereabout. In this embodiment and those hereinafter described, the housing, which may be made of a plastic material will provides the bearing surface with the tube rather than the ferrite, thereby allowing less friction, wear and longer use than when the ferrite provides the bearing surface Yan et. *al*., 2010). The coil depends on the induction of the position of the conductive tube. When the tube is completely shielding the core, the induction of the coil is low with the conductive tube confining the flux lines. As the shaft is displaced so is the conductive tube thereby exposing the core to the coil. This core offers much less reluctance than the conductive tube and serves to increase the flux density and induction of the coil.

Eddy Current Sensors

Eddy currents, also called **Foucault currents** are loops of electrical current within conductors by a changing magnetic field in the conductor, due to Faraday's law of induction (Gramz and Stepinski**, 1994)**. Eddy currents flow in closed loops within conductors, in planes perpendicular to the magnetic field. They can be induced within nearby stationary conductors by a time-varying magnetic field created by an AC electromagnet (Garcia-Martin, 2011) or transformer, for example, or by relative motion between a magnet and a nearby conductor. The magnitude of the current in a given loop is proportional to the strength of the magnetic field, the area of the loop, and the rate of change of flux, and inversely proportional to the resistivity of the material.

An Eddy current creates a magnetic field that opposes the magnetic field that created it, and thus, Eddy currents react back on the source of the magnetic field. Thus, Eddy currents are a source of energy loss in alternating current (AC) inductors, transformers, electric motors, generators and other AC machinery, requiring special construction such as laminated magnetic cores to minimize them. Eddy currents are also used to heat objects in induction heating furnaces and equipment, and to detect cracks and flaws in metal parts using Eddy current testing instruments (Garcia-Martin, 2011).

Basic Theory of Eddy Current

Eddy-Current sensors operate with magnetic fields. The driver creates an alternating current in the sensing coil in the end of the probe. This creates an alternating magnetic field which induces small currents in the target material; these currents are called eddy currents. According to Lenz's law, eddy currents create an opposing magnetic field which resists the field being generated by the probe coil (Garcia-Martin, 2011). The interaction of the magnetic fields is dependent on the distance between the probe and the target. As the distance changes, the electronic sense the change in the field interaction and produce a voltage output which is proportional to the change in distance between the probe and target. The target surface must be at least three times larger than the probe diameter for normal, calibrated

operation; otherwise, special calibration may be required (Ripka and Tipek, 2010).

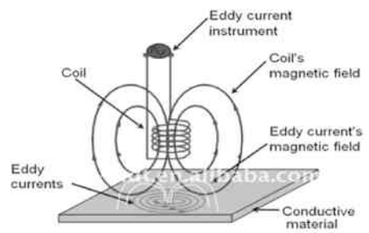


Figure 1: Principle of eddy current sensor

Eddy current sensors have been studied for a number of years as a method of non-destructive testing and non-contract measurement. Figure 1 shows the basic features of Eddy current sensor. Based on Faraday's law of electromagnetic induction,

$$E = \frac{d\Phi}{dt} \qquad (1)$$

Where ε is the induced emf and dΦ/dt is the rate of change of the magnetic flux

When the alternating voltage or current is applied to the induction coil, it generates an oscillating magnetic field, which induced eddy current on the surface of the conductive target, according to the principle of Eddy current induction. Eddy current circulate in a direction opposite to that of the coil, thereby reducing the magnetic fluxes in the coil and thereby its inductance. Eddy currents also dissipate energy and thereby lead to an increase in the resistance of the coil.

The complex impedance varies with the displacement between the inductor coil and the target. At fixed frequency and infinity target, the quality factor Q(x) can be explained as:

$$Q(x) = \frac{L(x).x\omega}{R(x)} \qquad (1)$$

with ω, the pulsation of the current/voltage, L(x) et R(x) respectively the inductance and the resistance over the range x

Merits and Demerits of Eddy-Current Sensor

Merits:

Compared to other noncontact sensing technologies such as optical, laser, and capacitive, high-performance Eddy-current sensors have some distinct advantages as presented by Gramz and Stepinski, (1994)

- Tolerance of dirty environments
- Not sensitive to material in the gap between the probe and target
- Less expensive and much smaller than laser interferometers
- Less expensive than capacitive sensors

Demerits:

- Extremely high resolution (capacitive sensors are ideal)
- Large gap between sensor and target is required (optical and laser are better)

Operating Principle of an Inductive Proximity Sensor

For an inductive proximity sensor, this operates under the electrical principle of inductance. Inductance is the phenomenon where a fluctuating current, which by definition has a magnetic component, induces an electromotive force (EMF) in a target object (Reese *et. al.* 2003). To amplify a device's inductance effect, a sensor manufacturer twists wire into a tight coil and runs a current through it. An inductive proximity sensor has four components (Decker and Kostka, 2008); the coil, oscillator, detection circuit and output circuit. The oscillator generates a fluctuating magnetic field the shape of a doughnut around

the winding of the coil that locates in the device's sensing face. When a metal object moves into the inductive proximity sensor's field of detection, Eddy circuits build up in the metallic object, magnetically push back, and finally reduce the Inductive sensor's own oscillation field (Decker and Kostka, 2008).

The sensor's detection circuit monitors the oscillator's strength and triggers an output from the output circuitry when the oscillator becomes reduced to a sufficient level (Fraden, 2004). The invention relates to an inductive proximity sensor having a sensor element including a resonant circuit whose output signal depends on the damping by an electrically conductive object and to a method for the determination of the presence and/or of the spacing of an electrically conductive object. Inductive proximity sensors detect electrically conductive metals on the basis of the eddy current principle. An alternating magnetic field which is radiated into space in a directed manner is built up by means of an electric resonant circuit from a coil and a capacitor which is called LC resonant circuit (Reese *et. al.,* 2003).(a) `

If an electrically conductive object moves into the range of the alternating field, Eddy currents are induced in the target by the alternating field which in turn give rise to a magnetic field which is oppositely directed to the exciting magnetic field (Decker and Kostka, 2008). The generation of the eddy currents removes energy from the exciting magnetic field and thus influences the impedance of the coil or damps the LC resonant circuit. An output signal of the LC resonant circuit, e.g. its oscillation amplitude, represents a measure for its damping which enables the detection of the metallic object. The object can, for example, be a switch cam which can trigger a switching signal via the proximity sensor.

Inductive proximity sensors are used for non-contact detection of metallic objects. Their operating principle is based on a coil and oscillator that creates an electromagnetic field in the close surroundings of the sensing surface. The presence of a metallic object (actuator) in the operating area causes a dampening of the oscillation amplitude. The rise or fall of such oscillation is identified by a threshold circuit that changes the output of the sensor (Fraden, 2004). The operating distance of the sensor depends on the actuator's shape and size and is strictly linked to the nature of the material as presented in Table 1

Table 1: Sensitivity with different metals

Sensitivity when different metals are present. Sn = Operating distance.	
Fe37 (Iron)	1 x Sn
Stainless steel	0.9 x Sn
Brass - Bronze	0.5 x Sn
Aluminium	0.4 x Sn
Copper	0.4 x Sn

Inductive sensors describe the nature of metals and senses whether they are ferrous or not. They have wide range of usage like discovering the missing parts, fathoming the location or to count the number of objects. They are a better replacement of switches which makes them more feasible (Decker and Kostka, 2008). They have relatively higher speeds and are more reliable. The oscillation produces an electromagnetic field in front of the sensor, because the coil is located right behind the “face” of the sensor. The technical name of the sensor face is “active surface” (Reese *et. al.,* 2003). When a piece of conductive metal enters the zone defined by the boundaries of the electromagnetic field, some of the energy of oscillation is transferred into the metal of the target. This transferred energy appears as tiny circulating electrical currents called eddy currents. This is why inductive proximity are sometimes called eddy current sensors (Decker, and Kostka, 2008). **Sensor will have an analogue output signal as shown in Figure 2.**

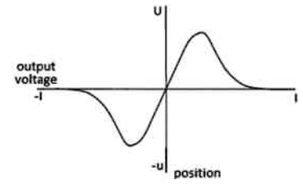


Figure 2: Output voltage *U* of the Inductive and Eddy current sensor with permanent magnets

The amplitude of the signal depends on the speed of the approach. The flowing eddy currents encounter electrical resistance as they try to circulate. This creates a small amount of power loss in the form of heat (just like a little electric heater). The power loss is not entirely replaced by the sensor's internal energy source, so the amplitude (the level or intensity) of the sensor's oscillation decreases (Gramz, and Stepinski**, 1994)**. Eventually, the oscillation diminishes to the point that another internal circuit called a Schmitt detects that the level has fallen below a pre-determined threshold. This threshold is the level where the presence of a metal target is definitely confirmed (Trigger Sachs, 2012)

Factors to be considered in the Design

The following rules should be considered when designing the sensors (Trigger Sachs, 2012):
(i) The surface dimensions of the target at the operating distance should be large enough to prevent variations in the sensor position producing changes in the output signal. This can be achieved experimentally by varying the surface diameter or magnetic field computations.
(ii) The thickness of the target should be larger than the skin depth, which is defined as

$$\delta = \frac{1}{\sqrt{0.5.\omega.\mu.\sigma}} \qquad (1)$$

Where:

δ is the skin depth

ω is the angular frequency

μ is the absolute permeability of the target

σ is the electrical conductivity

Selection criteria for an Inductive Proximity Sensor

Selecting the correct inductive proximity sensor for an application can be an intimidating process. There are literally thousands of models available from various vendors in order to have a good starting point to narrow down the field is essential. At this point, it will be assumed that an Inductive Proximity Sensor is the type of sensor being selected (Placko and Dufour, 1992). The answers to the 8-Q (Eight Questions) answers the best selection criteria for an Inductive Proximity Sensor.

1. What sensing distance is required to detect the target?
Inductive sensors typically have a sensing range starting from around 0.8 mm (3 mm tubular style) up to 40 mm (30 mm tubular style). Models having a sensing distance longer than 40 mm do exist, but the majority of applications fall under the 40 mm detection distance.

2. What is the Target Material?
Since we are discussing inductive sensors, the target must be metal – but what kind of metal? The standard sensing distance of an inductive sensor is based on a target of ferrous mild steel (Fe 360). An inductive sensor will detect non-ferrous metals such as aluminium, brass, copper or stainless steel – but at a shorter detection distance (Trigger Sachs, 2012).
3. What is the factor and mounting style needed?

The most popular form factors are tubular models however compact rectangular housings are also available. If limited space is available, a rectangular form factor may be the best choice as some of these are only 5 mm in depth (Ripka and Tipek, 2010).

4. What will be the size of the target?
Per the IEC specification there are two basic rules for the proper target size. As stated by Ripka and Tipek (2010), Rule 1 indicates the target size should be flat, square in shape, and have sides at least as long as the sensor coil's diameter (12mm sensor = 12mm x 12mm target). Rule 2 indicates the target size should be equal to 3 times the rated operating distance (Sn) of the sensor. The target should then be the **larger** result of these two rules. An inductive sensor will detect a target smaller than these recommendations, but at a reduced sensing distance.

5. What will be the shape of the target?
As referenced above, a flat metal target of the appropriate size is the best target for an inductive proximity sensor. A flat metal target will provide the best detection distance.

6. What electrical requirements are needed?
For this answer the control interface will need to be known. What electrical voltage is needed to interface to the controller and what output type is needed? Your PLC or interface controller will dictate the voltage and output type needed (Passeraub, 1997).

7. What connection method is required?
The majority of inductive sensors sold are quick disconnect type. This means they have an integrated quick disconnect and must have a mating cable connected. For DC sensors, the connector is usually a M5 x 0.5, M8 x 1, or M12 x 1; it's normally the customer's preference that drives the requirement (Lontis and Struijk, 2010). Hopefully, these criteria will help us narrow down your search for the correct inductive proximity sensor.

Types of Inductive Sensor

There are various forms of inductive proximity sensors (Fraden, 2004). A significant advantage of inductive sensors is that the associated signal processing circuitry need not be located in close proximity to the sensing coils. This allows the sensing coils to be located in harsh environments which might otherwise preclude other sensing techniques (Römer *et. al*., 2005).

Merits and Demerits of Inductive Proximity Sensors

Merits:

- Ignores water, oil, dirt, and non-metallic particles
- No need for external supply as it works with electromagnetic fields
- Withstands high shock and vibration environments
- Reduced cost
- Increased accuracy
- Compact size – notably with stroke length compared to traditional LVDTs.

Demerits:

- the linearity depends on the effective load resistance
- the temperature dependence of the stator windings
- a high armature reaction; and
- harmonic oscillations of more than **10%** of the output signal.

Conclusion

Eddy-Current sensors are useful in any application requiring the measurement or monitoring of the position of a conductive target, especially in a dirty environment. Proximity sensor has the biggest advantage that you don't need to bring your object or target in contact with your sensor so your object is saving from getting disturbed. It can detect signals of any target hurdles in its field. Latest development in the sensor makes it easy to adjust the range of sensor. Nowadays proximity sensor is getting much more prominence because of its advantages and easy to handle properties. Mobile devices are widely using this sensor to detect user's guide. A sensor which converts a displacement of an object into an electrical signal for monitoring said displacement having: a housing; a coil about said housing; a ferromagnetic core located in said housing and positioned so as to be capable of varying the induction of said coil as a result of varying the amount of exposure of the core to the coil.

References

Decker, W& P. Kostka, "Inductive and Eddy Current Sensors," *Sensors Set*, pp. 255–313, 2008.

Fraden, J, *Handbook of Modern Sensors - Physics, Designs and Applications (3rd Edition)*. 2004.

Garcia-Martin, J, J. Gomez-Gil, & Vazquez-Sanchez, E. "Non-destructive techniques based on eddy current testing," *Sensors (Basel)*, vol. 11, no. 3, pp. 2525–2565, 2011.

Gramz, M, & T. Stepinski, "Eddy current imaging, array sensors and flaw reconstruction," *Res. Nondestruct. Eval.*, vol. 5, no. 3, pp. 157–174, 1994.

Kejík, P, C. Kluser, R. Bischofberger, & R. S. Popovic, "A low-cost inductive proximity sensor for industrial applications," in *Sensors and Actuators, A: Physical*, 2004, vol. 110, no. 1–3, pp. 93–97.

Lontis E.R and L. N. S. Struijk, "Design of inductive sensors for tongue control system for computers and assistive devices.," *Disabil. Rehabil. Assist. Technol.*, vol. 5, no. 4, pp. 266–71, 2010.

Passeraub P, "Inductive proximity sensor with a flat coil and a new differential relaxation oscillator," *Sensors Actuators A Phys.*, vol. 60, no. 1–3, pp. 122–126, 1997.

Placko, D and I. Dufour, "Eddy current sensors for nondestructive inspection of graphite composite materials," *Conf. Rec. 1992 IEEE Ind. Appl. Soc. Annu. Meet.*, pp. 1676–1682, 1992.

Proximity Sensor [online] Available at: https://en.wikipedia.org/wiki/Proximity_sensor#Types_of_sensors.

Reese, T.G, O. Heid, R. M. Weisskoff, &V. J. Wedeen, "Reduction of eddy-current-induced distortion in diffusion MRI using a twice-refocused spin echo," *Magn. Reson. Med.*, vol. 49, no. 1, pp. 177–182, 2003.

Ripka, P & A. Tipek, *Modern Sensors Handbook*. 2010.

Römer K, P. Blum, and L. Meier, *Handbook of Sensor Networks*. 2005.

Sachs J, *Handbook of Ultra-Wideband Short-Range Sensing: Theory, Sensors, Applications*. 2012.

Yan, R, Q. Yang, W. Yang, S. Hou, and W. Yan, "Dynamic model of giant magnetostrictive acceleration sensors including eddy-current effects," in *IEEE Transactions on Applied Superconductivity*, 2010, vol. 20, no. 3, pp. 1874–1877.

RUGIPO RESEARCH AND TECHNICAL JOURNAL

DIGITAL SWITCH-OVER IN NIGERIA: AN UNENDING JOURNEY?

Author

Ajimuda, Olufunso Stephen
Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria.
ajistephen68@gmail.com

Abstract:

At the beginning of the twenty-first century, there was the call for an improvement in broadcasting and the need to totally switch over from analogue to digital broadcasting, hence the International Telecommunication Union (ITU), the international body in charge of telecommunication and broadcasting, directed all countries to implement this. Given the 17th June, 2015 deadline by the International Telecommunication Union for all countries to switch from analogue to digital technology, it was imperative that Nigerians key into the directive. Since then, Nigeria has made several unsuccessful attempts at completely transiting from analogue to digital broadcasting. The study examined the difference between analogue and digital broadcasting, the meaning of switch-over, digital broadcasting in Nigeria and the various unsuccessful attempts at switching over from analogue to digital broadcasting, the problems militating against the switch-over, advantages that can accrue from the switch-over and recommendations on how to achieve a successful switch-over. The framework for the study is the Diffusion of Innovation Theory, which seeks to explain how, why and at what rate new ideas and technology spread through cultures.

Keywords: Digitization, Switch over, Analogue, Broadcasting, Innovation.

Introduction

At the beginning of the twenty-first century, there was the call for an improvement in broadcasting and the need to totally switch over from analogue to digital broadcasting, hence the International Telecommunication Union (ITU), the international body in charge of telecommunication and broadcasting, gave a directive to all countries to implement this. The International Telecommunication Union (ITU set 17th June, 2015 as the deadline for all broadcast stations all over the world, especially television, to switch over from analogue to digital broadcasting. The question first worth asking is what is the difference between analogue and digital broadcasting?

Analogue broadcasting, according to https://www.nbc.gov.ng, (2008), is the transmission "that involves the broadcasting of encoded analogue audio and analogue video signal, one in which the information to be transmitted, the brightness, the colours of the points in the image and the sound waves of the audio signals are represented by continuous variation of some aspects of the signal." Analogue, especially in television, may be wireless or can require copper wire used by cable converters. Digitization, according to Idachaba (2018), "is the process of conversion of analogue information in any form: text, photograph, voice, etc, to digital form with suitable electric devices, such as a scanner or specialized computer chips, so that the information can be processed, stored and transmitted through digital circuits, equipment, and networks." Digital switch- over is described "as the process of launching the Digital Terrestrial Television (DTT) platform and switching off Analogue Terrestrial Television (DTT) platform" (Idachaba, 2018).

According to Adeniyi (2009), the International Telecommunication Union's position on migration was informed by the development in telecommunication technologies which enable a more efficient use of radio frequency spectrum and improved quality pictures and audio. Previously, everyone relied on audio spectrum for TV transmission but this had inherent restrictions. Adjacent analogue transmission were

found to be subject to interference, forcing, the regulatory bodies to leave spaces between channels and only allocate a small percentage of available spectrum for transmission to ensure high quality transmission and reception in the areas served. “The innovation has changed broadcasting from its traditional mode of transmission to the current trend of Digital Terrestrial Transmission (Omale, Ekhaerafo & Essien, 2016).

As at 2009, ten countries had switched over to digital broadcasting. The first country to make a wholesale switch to digital over-the-air terrestrial broadcasting was Luxemborug in 2006, followed by the following countries: Netherland (2006), Finland, Sweden and Swizerland (2007), Belgium and Germany (2008), United States of America, Canada, Norway and Denmark (2009). After 2009, many other countries have switched over to digital television.

Given the 17th June, 2015 deadline by the International Telecommunication Union for all countries to switch from analogue to digital technology, it was imperative that Nigerians key into the directive. Since then, Nigeria has made several unsuccessful attempts at completely transiting from analogue to digital broadcasting.

This study is out to look at the various unsuccessful attempts by Nigeria to switch over from analogue to digital broadcasting, the problems militating against the switch-over, advantages that can accrue from the switch over and recommendations on how to achieve a successful switch-over.

Synopsis

McQuail (2005) defines digitization as the process by which all media texts can be reduced to a binary code and can share the same process of production, distribution and storage. It is a method of storing, converting and sending data in the form of binary digits, which is easy to compute. Kombol (2008) defines digitization as "an advanced form of information transfer in which messages are converted into a series of 1s and 0s (binary digits) and sent over a channel to a receiver."

Digitization is, therefore, the transformation of all kinds of information, such as text, sounds and pictures into a uniform system based on the digits one and zero. This information can be combined together in an infinite number of ways. Through this, different forms of media have been made more compatible, because they are reduced to digital equivalent bits of information. Thus, digitization, in practical term, can “only ever be an approximation of the signal it represents” (Asemah, 2011).

Types of Digital Broadcasting.

Kombol (2008), states that digital television usually has three elements in its service. He identifies these three elements as “the physical path, the assembly and the return path. The physical is responsible for the signal reaching the television screen and the assembly path has to do with the presentation of the programme to viewers. Finally the return path is concerned with the ability of viewers to channel feedback in various forms back to the broadcaster.” Kombol (2008) goes further that in the United Kingdom, digital television is transmitted in four different ways. They are:

(1) Satellite: This provides one digital transmission service and has the capacity for hundreds of channels. It is possible for satellites to provide a two-way path but more than one way service is provided. The transmission standard used by satellite is referred to as “open TV”.

(2) Digital Terrestrial Television: This type of television broadcast is a land based transmitter network. Signals that are broadcast through this form are received by an antenna. There are no return paths in the service, hence it is a one-way affair. The transmission standard used in this type of network is referred to as “MHEG-5”. Digital Terrestrial Television (DTT) stands for the all-digital terrestrial broadcast services for sound and television (Aginam, 2017).

(3) Cable: Cable has the capacity to transmit more than two hundred channels. Also, cable service can provide fast internet access and standard telephone connection. The versatile natures of cables make it

possible for the return path to be used by viewers. The transmission standard used by cable is referred to as liberate.
(4) Telephone Connection (DSL): In most advanced countries, telephones are made to convey the television signals. This is by increasing the band width of telephone services and viewers are made to choose the television programmes which are to be transmitted to their phones.

Digital Broadcasting in Nigeria.
"Digital Broadcasting has become increasingly an unavoidable alternative to the analogue system" (https://www.nbc.gov.ng, 2008). Thus, Nigeria's quest at switching to digital broadcasting took root in December 2007 when the Late President Umaru Musa Yar-Adua approved that the Nigerian Broadcasting Commission should set in motion and pilot Nigeria's digitization programme towards a target date of June 17, 2012. According to https://www.nbc.gov.ng, 2008, “The Nigerian Broadcasting Commission recognizes digitization, the conversion of the broadcast and communication system from analogue to digital as an important global movement driven by the International Communication Union, that will revolutionise broadcasting as we know it."

According to (https://www.nbc.gov.ng), in June, 2008, the commission hosted a stakeholders' meeting chaired by the then Honourable Minister of Information and Communication, Professor Dora Akunyili, and in October 2008, the National Broadcasting Commission constituted a Presidential Advisory Committee made up of experts from a wide range of human endeavours, especially business and economics. This committee was to create a road map for the take-off of digital broadcasting in Nigeria.

In December, 2009, the Committee submitted its report to the Minister of Information and Communication, detailing the best approach the Government can take in realising the migration. It also recommended, among other things, the adoption of a new broadcast model, based on two classes of digital broadcast licenses. They are: content license that legally empowers broadcasters to provide content and signal distribution license that provides broadcast companies with the authority to create the transmission platform for other broadcasters. It also recommended the implementation of certain digital standard such as DVB- 7 and MPEG 4 (terrestrials digital television), DBV – (satellite), DVB-H (mobile TV) and IBDC system for FM digital.

With the Committee's report, the Nigerian Broadcasting Commission set the target of 17th June 2012 as the change date but this was not successful. Again the Nigeria Broadcasting Commission gave another deadline of 17th June, 2015 in line with the international directive that every country should fully migrate from analogue to digital broadcasting by that date.

It is no longer news that Nigeria failed to meet up with the second digital TV transmission deadline of June 17, 2015. At the international symposium on digital switch-over held at the ITV Headquarters in Geneva on June 17, 2015, the gathering was told of the failure of the country to meet up with the 2015 date and the possibility of the switch-over taking place by June 17, 2016 (https://t.guardian.ng, June 22, 2015). Also on that day, the Nigeria Broadcasting Commission issued a statement through Mallam Awwalu Saliu, the Head of Public Affairs, that “Today, June 17, 2015 is the deadline for the *Region One* of the International Telecommunication Union, ITV, to complete the implementation of their transition programme from analogue to digital terrestrial television. Nigeria belongs to this region." He adds that “At the moment, Nigeria has reached about 20% penetration of the 26 Million TV households (TVHN) in the country.”

After also failing in her desire to switch over by June 17, 2016, the National Broadcasting Commission announced a new switch-over date of 17th June, 2017. Talking of the June 17th 2017 expected switch-over date, the Director General of the National Broadcasting Commission announced that “June 17, 2017 is a BENCHMARK DATE for digital switch-over in our country. Our mission remains constant to switch off

analogue completely when we achieve up to 95 percent access to free Digital Television content across our country" (https://www.nbc.gov.ng).

The June 17, 2017 date also failed. At a press conference, on the 17th of June, 2017, the Director General of the National Broadcasting Commission gave reasons for Nigeria's inability to fully switch-over to digital broadcasting. He said that the process was "dogged by a host of controversies. First, the second the National Signal Distributor, Pinnacle Communication Limited has been in dispute with the NBC. They were in court, because of a host of grievances arising from the way that the contract with them had been handled by the NBC…After several meetings, we reached an agreement, and Pinnacle Communications accepted to drop their litigation against the NBC" (https://www.nbc.gov.ng).

The Director General also announced that the Commission had successfully launched the switch-over for Abuja in addition to the earlier pilot launch in Jos in April, 2016 through the help of Pinnacle Communication. He explained that:

> The company mobilized very significant financial and other logistical resources, which helped us to achieve a successful launch in the FCT …offering in the process thirty local, regional and national channels to viewers in Abuja. (https://www.nbc.gov.ng).

One of the problems the Commission also faced, according to the Director General, "is that our Set-Top-Box manufacturers had committed resources to the importation of 850,000 STBs from China, but because EFCC had seized funds from the NBC, under the *ancient* regime at the NBC, we could not meet our commitment, which totaled the sum of 526 million naira" (https://www.nbc.gov.ng). The DG also hinted that the next phase of the Digital Switch-over in Nigeria is "a plan to launch in one state from each of the six geo-political zones of Nigeria: Kaduna in the North West; Gombe in the North East; Kwara in the North Central; Osun in the South West; Delta in the South-South; and Enugu in the South East" (https://www.nbc.gov.ng).

In October, 2019, there was a report that the Nigeria Broadcasting Commission planned to begin analogue switch-off by 2020. According to the report, the National Broadcasting Commission said, "plans are underway to begin analogue switch-off in six locations starting with Abuja as from next year." Speaking at the 72nd General Assembly of Broadcasting Organisations of Nigeria in Lagos, the Director General, NBC, Mallam Modibo Kawu said that other regions that would be switched off are: Kaduna, Enugu, Ilorin, Osogbo (https://punchng,com, October, 28, 2019).

In another twist, a report credited to the Director General of the Nigeria Broadcasting Corporation, Modibbo Kawu, stated that the switch-over might not come into fruition until 2021. According to him, " the 2021 date is a 25-month period during which the NBC hopes to complete the switch-over. The commission will begin with densely populated areas, including Lagos, Kano and Port Harcourt as test grounds …What we have decided to do is to consider taking digital broadcasting to all those major population centres. In the past, we started with regional rollout, we chose a state by geo-political zone. But with a little mapping process, we now have all the major population centres. Indeed, over the next 15 to 25 months, the possibilities are that we are going to the rolling out in these major centres." (https://t.guardian.ng, May 27, 2019) Kawu further said that the NBC had been discussing with a South Korean company on the acquisition of Set-Top-Box (STB) or decoders. According to him, the company has accepted to come and put facilities in place to produce one million STBs in Nigeria so that "we can have boxes that will service the roll out in different locations…In the past, the Original Equipment Manufacturers (OEM) in China insisted they are paid before production." (https://t.guardian.ng, May 27, 2019).

This new template and timetable recently led to the inauguration of digital switch over in Lagos on April 21st 2021. According to the current Director General of the Nigerian Broadcasting Commission,

Armstrong Idachaba, " With this roll-out in Lagos, a projected five million Lagos residents are instantly going to access digital television services not only for broadcasting but with converged opportunities to telecom and other ancillary services."((https://t.guardian.ng,April 21,2021).

Currently, most television stations in Nigeria broadcast analogue signals, though in recent years a steadily growing number of predominantly foreign-owned satellite firms have made the transition to digital broadcasting such as Multichoice, a South African firm that owns and operates the Digitals Satellite Television (DSTV) pay service, NTA Star TV, a joint venture between the state-controlled Nigerian Television Authority (NTA) and Startimes, a Chinese firm, also broadcast digitally. A number of the country's other broadcasters ":have invested in switching to a digital signal, though the majority continue to operate analogue stations as well." (https://oxfordbusinessgroup.com).

But the question of when exactly the country's digitization process, which officially began in 2007, will be finalized, is yet to get a definite answer.

Theoretical Framework

The study is going to use an already established theory for the theoretical framework. The theory is the **Diffusion of Innovation Theory.**

Diffusion of Innovation Theory

Diffusion of Innovation is a theory that seeks to explain how, why and at what rate new ideas and technology spread through cultures. According to the theory, "innovation should be widely adopted in order to attain development and sustainability. It is the process of spread of a given idea or practice over time, via specifiable channels, through a social structure such as the neighbourhood, a factory or a tribe." (www.communicationtheory.org) The concept of diffusion was first studied by the late 19th century by German and Austrian anthropologists such as Friedrich Ratzel and Leo Frobenius. Everett Rogers, a professor of Communication Studies, popularized the theory in his book, *Diffusion of Innovations,* in 1962.

Everett posits that diffusion is the process in which an innovation is communicated through certain channels over time among members of a social system. He states that there are four main elements that influence the spread of new ideas: the innovation, communication, channels, time and social system. The innovation relies much on human capital. The innovation must be widely adopted in order to self-sustain. Within the rate of adoption, there is a point at which an innovation reaches critical mass. The categories of adopters are innovators, early adopters, early majority, late majority and laggards. Rogers also adds that very important to this theory is process. Individuals experience five stages of accepting a new innovation: knowledge, persuasion, decision, implementation and confirmation. If the innovation is adopted, it spreads through various communication channels.

Diffusion of Innovation Theory originated in communication to explain how, over time, an idea or product gains momentum and diffuses (or spreads) through a specific population or social system. The end result of this diffusion is that people, as part of a social system, adopt a new idea, behaviour or product." (https://sphweb.bumc.bu.edu)

Challenges Expected from Digital Switch-Over in Nigeria

Despite the developments in broadcasting in Nigeria, investors face a lot of challenges like financial strangulation that may make digitization difficult. It is a common knowledge that broadcasting is a very capital intensive venture. All equipment from the digital tape, to television and radio transmitters are bound to be imported but the access to fund is scarce and limited. Thus financial difficulties will greatly affect public broadcasting in Nigeria when digital broadcasting finally takes effect. Each of Nigeria's estimated 44m television- viewing homes will be required to install a Set-Top Box (STB) to enable them

to receive a digital signal. At an estimated cost of around N5100 per STB, the total cost to the country was estimated at N691bn (5414.6m) in 2013. (https://oxfordbusinessgroup.com).
One of the characteristics of public broadcasting in Nigeria is the national content. This is an area that will be affected by digital broadcasting as there will be an increased influx and control of broadcast content, particularly direct-to-home service by foreign interests. This may portend more destabilizing long term consequence for the nation. Our peculiar socio-cultural, socio-economic and ethno-cultural diversity demands that the nation guard and protect her collective heritage as a nation. This will be affected by digital broadcasting, moreover as foreign content has taken over many facets of our national life through the internet/ social media. A renowned broadcasting entrepreneur, Dr. Raymond Dokpesi, who is the chairman of Daar Communications, expresses his fear on the issues of the influx of foreign content as a result of digital broadcasting thus:

> I know the radio and television mould the child and help build individuals. Television, in particular, may be the simple most influential tool, not only in shaping public opinion but also in sculpting mindsets. It is potentially dangerous to leave such potent tools such as radio and television at the whim and behest of foreigners (Dokpesi, 2009).

Another problem to be faced is that digital broadcasting will involve the use of cables and satellite to access televisions and radio; the rural dwellers will be greatly affected as they might not have access to information, education and entertainment because they have to pay to access these. This fear is expressed in a report by Osuagwu and Akinboade (2012) that, "There is the fear that the public who access television services free on air will have to spend a little more when digitization is completed, for everyone will now have to purchase a Set-Top-Box (STB-decoder) before television signals can be received." This is less of a problem if services are better and subscribers get value for money.

One other area that needs to be addressed is the issue of training of staff in broadcasting houses on how to handle the digital equipment to be acquired. Without adequate training of staff, moving to the digital era in Nigeria will continue to meet with some difficulties.

As computers are mainly expected to perform some of the jobs before now performed by human beings, there is bound to be job cut which might greatly affect the economy. This issue also has to be properly addressed.
One of the challenges also expected from digital switch-over in Nigeria is the lack of enough awareness on the part of the viewers on what digital switch-over entails. This might create a problem. As for now, there seems to be lack of enough sensitization of end users of the broadcast media by the relevant agencies. For example, according to Ms. Beth Thorem, UK Digital Communication Director, the United Kingdom spent seven years in educating the people on what they needed to expect from digital broadcasting before switching over. According to Igyor (2009), “One of the reasons for the slow diffusion of digital technology in some countries has been the lack of knowledge about the technology.”

There are also environmental issues to contend with. The introduction of digital broadcasting will create the problem of large number of analogue receivers to be discarded during digital television transition. The discarded television sets, if not properly disposed of might lead to pollution. This is because such sets are sources of toxic metals such as lead, barium, cadmium, chromium etc. For example, in the United States of America, an estimated 99 million unused analog receivers already discarded posed serious problems before they were disposed.

One of the challenges Nigeria broadcast stations will also have to contend with is lower revenue, which might lead to loss of profit. This is because an increase in the number of competing channels would bring about a reduction in the size of the average audience for each programme broadcast. As average audience declines, the programming cost per audience increases and without a corresponding increase in advertising revenues, the average profit of television channels will be reduced.

Digital Television reception can also be affected by severe weather conditions such as storms and high winds. This can lead to fluctuations in the broadcast signal or total loss of signals. Thus, the subscribers might not have adequate value for money.

Expected Advantages of Digital Broadcasting in Nigeria

One of the advantages to be derived from digital broadcasting, especially in television, is enhanced picture and audio quality. Rodman (2006) says digital broadcasting "promises television pictures that are clear and crisp as a Cineplex feature." Digital television supports many different picture formats defined by the broadcast television system, which are a combination of size, aspect and ratio (width to height ratio). With digital television broadcasting, the range of formats can be broadly divided into two categories: High Definition Television (HDTV) and Standard Definition Television (SDTV). These formats have improved definition (rendering of fine details) according to how many individual elements are provided to construct the picture. This definition is expressed in the number of horizontal lines and picture elements (pixels) in each line that are used for different formats.

One other expected advantage of digital broadcasting is more spectrum efficiency, as a huge spectrum will be available for television and radio broadcasting. Ocholi (2009) argues that "technology has opened a world of possibilities for broadcasting as a huge spectrum will be available." As a result, more frequencies or wave lengths will be available for broadcast stations in the country. This will also increase the number of television channels available to the population as a minimum of four programmes and four channels can be transmitting simultaneously from a station, using the same bandwidth originally used for a single programme or channel in analogue transmission. This is called “multiplexing or multicasting”. Digital links with the use of data compression generally have more efficient bandwidth usage than analogue links. According to Emeka Mba, the Director General of the National Broadcasting Commission:

> The overall benefit of digital TV broadcast is that it frees up a lot more spectrum that can be used for broadband penetration and other telecommunication needs. It also ensures higher quality of TV signals. Most importantly, it enables a lot more players to come into the production end of television. Imagine, if the eight megahertz, which we use for standard analogue broadcast today is taken to digital, it means that the space that one station uses now can be used by over 20 TV stations… it gives more space for a lot of players to come into the industry ((https://www.nbc.gov.ng,2014).

In addition to freeing up a considerable amount of valuable spectrum for use in other industries – notably telecommunication, information and communication technology, the transition can lead to rapid growth in the television industry in itself. Based on recent forecast, Nigeria is set to be one of Africa's largest television markets in the foreseeable future as “Both Digital Terrestrial (DTT) such as the Government's NTA Star TV Station and Direct to Home (DHT) services such as DSTV, are expected to see considerable growth in coming years” (https://oxfordnusinessgroup.com)

Another advantage also expected from Digital Broadcasting is that it is environment friendly. According to Amaefule (2013), “Digital television reduces greenhouse-gas emission due to a massive-almost ten-fold reduction in the power consumption of broadcasting transmitters". It also has the advantage of generating less noise or ghosting.

Another advantage expected from digital broadcasting is the consistency of data flow over long distances as it is resistant to signal interference. One of the problems of analogue broadcasting is that it is prone to multipath interference and the need to constantly retune the radio because of problems with the signal. This is one problem expected to be solved by digital broadcasting.

Another accruable advantage that is expected from digital switch-over is data casting. This means the

television will have the ability to transmit data in addition to pictures and sound. Thus, members of the public can make use of interactive web links for e-mail, online ordering, instructional materials, stock market price, etc. This is because digital television sets would perform like computers and telephone handsets by providing access to the internet and storing data.

Though digital switch-over is expected to lead to job cut in the broadcast houses, it will also on a positive note have a decisive impact on the economy. Because of Nigeria's population, it will make Nigeria the largest digital television market in Africa. This will also improve music, film and drama production and create a lot of employment. It will also give ordinary Nigerians, almost at a cheap rate, the type of television broadcasting experience presently enjoyed by the rich who can pay for it.

One of the areas in which digital broadcasting will be advantageous to the Nigerian society is in the area of advertisement. While describing this advantage, Ekeh (2014), opines: “The migration of television from the traditional television set to the mobile device will portend a whole new world of opportunity to advertisers wishing to reach customers and prospects and to the entire advertising industry itself.”

Osuagwu and Akinboade (2012) sum these expected advantages up as “expanded service, high quality video and audio, greater variety and faster rates of data transmission, consistency of data flows over long distance, more spectrum efficiency, meaning more channels”.

Suggestions on how to Make Digital Switch-Over Effective in Nigeria

Since inception, the digital migration programme has moved forward in fits and starts. "Its policy response has been uneven and frequently, a mixture of inertia and sudden bursts of change.” Idowu ,(2018) As Nigeria has missed several deadlines in the quest for a complete transition from analogue to digital broadcasting, the following suggestions can aid a smooth switch-over:

One of the banes to effective switch-over in Nigeria has been lack of political will, inadequate funding and corruption. The Government should develop the political will to make the switch-over a success. It is disheartening that since 2006 when the switch-over plan started, Nigeria has had different leaders in Government: President Olusegun Obasanjo, President Shehu Musa Yar' Adua, President Goodluck Jonathan and the present government of President Muhammadu Buhari which is already into its eighth year – but the political will to roll out the switch-over has been lacking. The present Government should make switch-over a reality and its name will be etched in gold in the communication history of the country. Also, a firm bench mark and regulation is critical. Without this, there is doubt and no clarity of purpose. We need this for every investor and broadcaster to plan ahead.

The country should revert to the Pre-2015 plan, whereby Government was reportedly working with local firms to manufacture 20m STB and sell at a subsidized rate to Nigerians. “According to the Federal Ministry of Communication, the former Government of President Goodluck Jonathan announced plans to manufacture STB in Nigeria and sell them to citizens at subsidized rates (https://oxfordbusinessgroup.com). This will go a long way in easing the problem of Set-Top- Boxes.

The government also needs to address the electricity problem of the country, as this has been having a negative effect on digital switch-over in Nigeria. Right from the manufacture of Set-Top-Boxes and other technical installations for the switch-over, poor electricity has a way of affecting these. Also, television viewers might miss many of the programmes on terrestrial television due to lack of electricity supply.

There is the need for continuous training of technicians and agents who will be versed in how to set up Set-Top-Boxes and activate them, how to re-tune a television and troubleshooting any problem.

Conclusion

This paper examines Nigeria's quest of switching from analogue to digital broadcasting since December 2007 when the Late President Umaru Musa Yar-Adua approved that the Nigerian Broadcasting Commission should set in motion and pilot Nigeria's digitization programme towards a target date of June 17, 2012. Since then, there have been several unsuccessful attempts at completely transiting from analogue to digital broadcasting in the country. The study x-rays the problems militating against the switch-over and advantages that can accrue from the exercise. With the announcement of a new switch-over template and timetable by the Federal Government, stating that Phase 2 will commence with roll-outs in the most populous states of Lagos, Kano and Rivers, the paper offers recommendations on how to achieve a complete and successful switch-over in the whole country within a short time.

References

Adeniyi, O. (2009). Digital Broadcasting: Migrating implication and Challenges for Nigeria.http://wwwtechnologytime.com.llpost/digital-broadcasting-migration-implication-and challenges-for-Nigeria.

Adeyemi, A. (2019, May 27). Digital switchover may delay till 2021. https://t.guardian.ng

Aginam, E. (2017) Digital switchover.www.daargroup.com/daar-group/latest-news/vanguardngr-2017-digital-switch-over-fresh-breath-of-hope-as-nbc-unfolds-new-strategy-direction.

Asemah, E. S. (2011). *Principles and practice of mass communication*. Great Future.

Diffusion of Innovation Theory. https://www.communicationtheory.org

Diffusion of Innovation Theory. https://sphweb.bumc.bu.edu

Dokpesi, R. (2009). We are changing broadcasting in Nigeria.. http://www.modernghana.com/movie/2594/1/we-are-changing-html.

Ekeh, D. (2014). Nigeria Television at 50: Challenges of Digitization.http: www.bizcommunity.com/article/157/66/40113 html.

Garba, K. A. (2015, June 22). When will Nigeria signs off digital TV Switch-over? https://t.guardian.ng

Idachaba, A. (2018). Digitization *of broadcasting in Nigeria: Policy and implementation*. Black Belt Conzult Ltd.

Idowu, D. (2018, November, 27). Nigeria's digital switchover: Let us move forward. https://www.vanguardngr.com

Igyor, G.A (2009). Digitization and the challenges of broadcasting. *Lecture notes on digitization.* University of Pennsylvania.

Kombol, M.A. (2008). *Digital consideration in television production*. Switches and Pluggz Publishers .

McQuail, D. (2005). *McQuail's mass communication theory*: Sage Publication.

Nigeria switching from analogue to digital broadcasting in television and radio. https://oxfordbusinessgroup.com

Ogunfuwa, I. (2019, October 28). DSO: NBC to begin analogue switch off 2020. https://punchng,com

Omale, E.G., Ekhaerafo, G. E., & Essien, C . F. (2016). Digital terrestrial transmission failure in Nigeria: Implications for sustainable development. Proceedings of the International Conference on Information and Communication Technology and its Application (ICTA 2016). Federal University of Technology, Minna, Nigeria. November, 28-30, 2016. (pp. 151-157).

Osuagwu, P. & Akinboade, L. (2012). Hurdles on Nigeria's road to digital broadcast, as NBC reassures of success. https://www.vanguardngr.com

RUGIPO RESEARCH AND TECHNICAL JOURNAL

DEVELOPMENT AND PERFORMANCE EVALUATION OF AN ELECTRICFRYING MACHINE

Authors
Imoukhuede K.A., Ayodele O.R. and Obanoyen O.N
Mechanical Engineering Department
Rufus Giwa Polytechnic, Owo
e-mail. kademola05@gmail.com, olakunle_ayodele@yahoo.com
and wolex.wolex@gmail.com

Abstract:

The present outburst of epidemic lassa fever has made many Nigerians to be sceptic to the consumption of locally and manually fried garri. Therefore, there is need for the processing of neat, safe and secured garri.In this study, an electric garri frying machine was designed, constructed and evaluated. The garri frying machine consists of the drying chamber, receiving tray, thermostat, heating element, bearing, discharges tray, paddle shaft, frame and fan. The frame was fabricated from (15mm square pipe iron with dimension (730 X 550 X 760)mm. The frying chamber was fabricated from 2.0mm thickness stainless steel with dimensions of radius 175mm and 600mm length comprising of (1500W) electric heater. The moisture contents of cassava mash were measured with a digital moisture meter (PM400) Japan. 10kg of cassava mash samples A, B, C, D, E, Fand G containing 45% initial moisture contents were dried at 10^0C, 20^0C, 30^0C, 40^0C, 50^0C, 60^0C and 70^0C respectively for 90 minutes.This equipment works by transferring heat from the heating element by a process called conduction.This causes a rise in the temperature of the heating chamber, and the heat developed or built in the heat chamber, is employed, to fry the garri.The temperature of frying is regulated by the use of a thermostat, a temperature regulator device which is calibrated to temperature rate of10^0C, 20^0C, 30^0C, 40^0C, 50^0C, 60^0C and 70^0C. The trend of behaviour observed generally revealed that the frying time reduces as the temperature increases. This therefore, helps in eliminating the fire hazard posed by the crude method of frying garri and also prevent arbitrary frying of garri. The equipment has capacity of drying 10kg of dewatered cassava in ash and having a maximum frying temperature of about 70^0c.

Keywords: Moisture Contents, Frying Rate, Local Construction, Garri Fryer, Frying Temperature

Introduction

The design and fabrication of appropriate equipment for a particular unit operation go a long way in determining the success or otherwise of the overall process operation. It is desirable and necessary that each piece of equipment should be designed and constructed to carry out its necessary function. The successful fabrication of any equipment depends on the use of accurate design data, and other information use of suitable material and use of appropriate fabrication technique.

Garri, is one of the important cassava products that have formed major part of the diet of the people in the tropics. It is usually produced by frying in a pot placed over an earthen fix stove. The process of producing garri is very tedious, inconvenient and introduces fire hazard. However, because of the importance of garri in the diet, there is a need to increase its production output and as well as making it more convenient to produce.These factors therefore, necessitate the designing of anelectrically operatedgarri fryer. The technology of garri frying through a dehydrating process is not a straight forward drying process. (Igbeka *et al.,*1972). The product from such an operation would be dried cassava

pulp or granules and not Garri, (Ikechukwu and Maduabum, 2012). And gratification is a simultaneous cooking and dehydrating operation (Igbeka, 1988). The colour and taste of garri can be enhanced by adding a few drops of palm oil (Odigbon and Ahmed, 1984).

The Traditional method of frying garri, which is frequently done on pot, placed over an earthen fix stove is the most widely spread method used in developing countriesbecause of its simplest and cheapest method of producing garri. Some disadvantages of this local method of the production of garri are nuisance of smoke, sweating by the operator, capacity and rate of frying, accident risk, bad working environment, contamination of any type (Machiopa *et al.,* 2002). Frying of the garri is needed for preservation and storages, reduction in the cost of transportation and achieving desired quality of products etc.

According to Bassey(1989), Tongrul and Pehlivan (2004), the application of dryers in developing countries can reduce post-harvest losses and significantly contribute to the availability of fool in these countries. A significant percentage of these losses are related to improper or untimely drying of food stuffs such as cassava tubes, meat fish etc.

Materials and Methods

The electric garri frying machine systems includes the frying chamber and hopper, paddle shaft, frame, receiving tray, discharge handle, heater, thermostat with sensor, insulation material, and the fan.

Frying chamber and hopper:-The frying chamber is where frying takes place and positioned centrally in the cabinet. It is cylindrical in shape made with 2mm thick stainless steel with dimensions of radius 185mm and 600mm length. The garri is fed through the hopper into the frying chamber.

Receiving tray:-This was constructed with Aluminium sheet. The receiving tray is a rectangular box of dimension (720 X 570 X 110) mm as length, breadth and height respectively which is positioned below the frying chamber.

Paddle Shaft:- Four numbers of flat shaped detachable fins were fabricated to stir the garri in the chamber during frying. It was also made out from the stainless steel and attached to the shaft by bolting. It served to agitate the garri thoroughly in the heating chamber. The shaft is made out from a mild steel rod of 40mm diameter with length 800mm was cut out with hack saw blade and turn on a lathe machine. The clearance gap between tip of the fins and interior chamber surface was limited to 1 to 5mm in order to avoid burning.

Frame/cabinet:- The frame is rectangular in shape made of (35 X 35)mm mild steel pipewith dimensions of (630 X 550 X 760)mm.

Fan:- The fan aids in heat distribution by sucking ambient air from the surrounding to the heater housing and discharging heated air to the drying chamber. An axial flow fan with three blades is used to ensure

proper distribution of air to the frying chamber and for effective heat distribution.

Thermostat:- The thermostat is simply the unit that controls the system and maintains constant temperature in the drying chamber.

Electric Heater:- The source of heat was from the electric heater coil of 1500 watts, amperes, 220 volts (single phase supply). The shape size of the heater was spiral coil type. The force convection heat from top of the chamber was drawn with the aid of centrifugal fan and transported to heating chamber to heat the garri.

Description of the Frying Machine

The developed electric garri frying machine operates on the principle of batch drying. The heating chamber is fabricated to accommodate 10kg of cassava mash and made with a stainless steel plate of 2mm thick, 5800mm long and 350mm wide. The stainless steel was taken to the rolling machine to roll in order to form a cylinder. The cylinder formed was then welded to make a concentric circle which later form upper and lower trough of the frying cylinder. After the cassava mash was loaded, the lid closed and heated air of about 10^0C is blown across the cassava mash from the heater housing through electrical heating element and fan. Both heater and fan terminals are connected to electricity. The heat being supplied by the heater is controlled by a thermostat which turns off the machine if inlet temperature exceeds the actual temperature require for frying. There is a shaft joined with the paddles that passes through the centre of the frying chamber with handle for stirring. After frying, the discharge plate is openedto discharge the cassava mash to the receiving tray placed under the frying chamber. The component parts of the electric garri frying machine are: (1) Drying chamber and hopper (2) Thermostat to regulate temperature (3) Fan (4) Paddle shaft with handle (5) Receiving tray (6) Ball bearing and housing (7) Electric heater housing (8) Discharge handle (9) Frame (10) Chimney

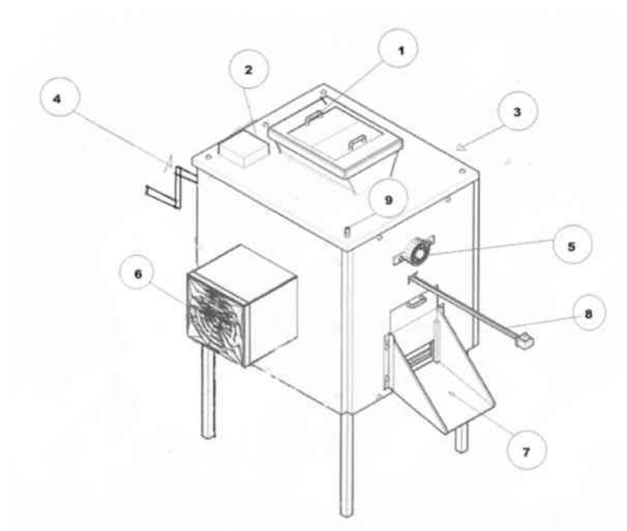


Figure 1.1 Pictorial view of garri frying machine

Design Analysis

In order to develop an efficient electric garri frying machine, the major components were designed based on the following equations.

(a) Design of the hopper size:-

V_h= Volume of hopper.B_h= Base area of hopper and H_h= Height of the hopper.

But B_h =LW .....(2)

Where L=Length of base, W= Width of base and B_h = Base area of hopper

The number of times the mash passes through the hopper is determined by,

N = V/V_h ..... (3)

Where

N = Number of times the mash passes through the hopper

V = Volume of mash that passes through the hopper

V_h = Volume of mash in the hopper.

(b) Design of Frying chamber:-

Volume of frying chamber (V_c) =$\pi {R_c}^2 L_c$.....……(4)

Where:

(V_c) = Volume of frying chamber,L_c= Length of frying chamber, R_c= Radius of frying chamber.

Volume of cassava mash in the cylindrical frying tray:- Assuming the cassava mash in the frying tray is half volume of the tray, then

V_m = ½ V_c…….. (5)

V_m= volume of mash in the tray and V_c = Volume of the tray.

Therefore, the mass of cassava mash in the tray is given by.

M = e/V_c…… (6)

Where

e = density of cassava mash

V_m = volume of mash in the tray.

(c)Design of receiving trough tray.

Volume of receiving trough tray = $L\ x\ B\ x\ H$ ……(7)

Where

L = length of tray (mm)

B = Breadth of tray (mm)

H = Height of tray (mm)

(d) Heat Design:-

The heat required for drying the garri mash is $Q = MC\Delta T$……. (8)

Q = quantity of heat required (Watt), M = mass of cassava mash in the cylinder

C = specific heat capacity of the mash (J/K^0C) and T = temperature range (K).

Time required for the drying can be calculated by

$\frac{\triangle Q}{\triangle t} = K\ A\ (T_2 - T_1)$…….(9)

Where,

$\frac{\triangle Q}{\triangle t}$= Heat rate of transfer, K = thermal conductivity of the mash, A = Area of the cylinder plate, T_1 = Temperature change, T_2 = Ambient temperature and L= Thickness of the mash in the cylinder.

But, $A = 2\pi rh + 2\pi r^2$……10)

Relating the heat rate of transports to the mass of the cassava mash to be dried with time Δt we have, $\frac{\triangle Q}{\triangle t} = \frac{\triangle mLh}{\triangle t}$

Where Lh = latent heat of vapourization.

Δt = time required to dry the mash

Δt = Q/m.

Therefore $\Delta t = \frac{\triangle mLh}{\triangle Q \triangle t}$

(e) Determination of shaft diameter:-

$D_s^3 = \frac{16}{\pi S_s}\sqrt{\{K_b M_b)^2 + (K_t M_t)^2\}}$(Hallet al 1980)…….. (11)

S_s= Allowable combine shear stress for bending and torsional = $40MN/m^2$

K_b=1.5,K_t=1.0 ,M_t=27.1Nm, M_b=104.4Nm (for gradually applied load on rotating shaft).

K_b =combined shock and fatigue factor applied to bending moment.

K_t= combined and fatigue factor applied to torsional moment.

K_t= Combine shock and fatigue factor applied for torsional moment 1.0 to 1.5 for heavy shock to 1.5

S_s=allowable shear stress for type of shaft.

(g) Percentage moisture contents and moisture losses:-

The percentage % moisture content and moisture loss according to Handerson et al (1997) is expressed as

Moisture loss (M.L) = M_d…….... (13)

$$\text{Moisture content (M.C)} = \frac{M_w - M_d}{M_w} \times 100 \quad \text{.................................. (14)}$$

Where

M_w and M_d = Initial and Final moisture content of sample (%) respectively

Performance Evaluation of Electric Garri

In order to evaluate the level of performance of this machine, it was installed in the production unit of a locally producing garri industry in Owo in Ondo State through the permission of the unit authority. The Percentage moisture contents and moisture loss of the samples was conducted by considering the performance parameters of the garri frying machine using the procedure detailed by www.practicalaction.org (2010).

Procedure for experimentation

i. The cassava mash with known initial weight,initial moisture content was poured through the hopper into the heating chamber and covered with the lid.
ii. A digital thermostat with a temperature sensor fixed to the wall of the frying chamber to facilitate temperature regulation was set at required drying temperature of 10^0C, 20^0C, 30^0C, 40^0C, 50^0C, 60^0Cand 70^0C.
iii. The stop watch set to 0 minute and Power button of the garri frying machine is switched ON at constant electricity supplied.
iv. After 10 minutes in operation with thorough stirring, the machine is switched off, the hopper cover is removed and a moisture meter inserted.
v. Moisture content is recorded with a digital moisture meter at four different points around the cassava mashinside the heating chamber at 10minutes interval for a period of 1hour 40minutes.
vi. After drying the discharge pot plate is opened where the fried garri are discharged to the receiving tray placed under the frying chamber.

Results and Discussions

Moisture content and moisture loss of different samples at various drying temperature and time.

Table 1:- Percentage % moisture content and moisture loss of different samples at various heating temperature and time

Time	Sample A	Sample B	Sample C	Sample D	Sample E	Samp
(Min)	10^0C	20^0C	30^0C	40^0C	50^0C	60^0C
0	45.0	45.0	45.0	45	45	45
10	44.0	42.5	42.0	39.0	38.0	37.0
20	35.0	33.0	31.0	30.0	29.0	28.0
30	30.0	27.0	25.0	24.0	23.0	24.0
40	25.0	24.0	23.0	20.0	19.0	18.0
50	11.6	13.1	11.4	9.5	9.0	8.5
60	8.0	5.50	6.5	6.0	5.5	5.0
70	4.5	4.0	4.0	3.5	3.5	3.0
80	4.0	3.0	2.5	2.0	2.0	0.0
90	2.0	0.0	0.0	0.0	0.0	0.0
100	0.0	0.0	0.0	0.0	0.0	0.0

Source: Author's computation, 2022

Where:

Sample A = cassava mash heated at 10^0c

Sample B = cassava mash heated at 20^0c

Sample C = cassava mash heated at 30^0c

Sample D = cassava mash heated at 40^0c

Sample E = cassava mash heated at 50^0c

Sample F = cassava mash heated at 60^0c

Sample G = cassava mash heated at 70^0c

t = Drying time (minutes).

Table 1 shows the percentage moisture contents and moisture losses of different samples of the cassava mash of various temperatures as measured with a digital moisture meter.From the results of moisture content presented in table 1, the moisture contents of all the cassava mash samples (A to G) at 0 minutes (control samples) were 45%. At 90 minutes the moisture content of dried sample A at cassava mash heated at 10^0c was 2% but 3%, 2.5%, 2.3%, 2.0% moisture content dried in sample B, C, D and E were recorded in 80 minutes at temperatures at 20^0c, 30^0c, 40^0c, and 50^0c, respectively. Furthermore at 70 minutes the moisture content of dried cassava mash sample G at 80^0c was 4.5%. However, the percentage average moisture loss are 3.0%, 3.5%, 3.42%, 3.57% and 4.33% obtained from dried cassava mash at 10^0C, 20^0C, 30^0C, 40^0C, 50^0C, 60^0C,and 70^0Crespectively.

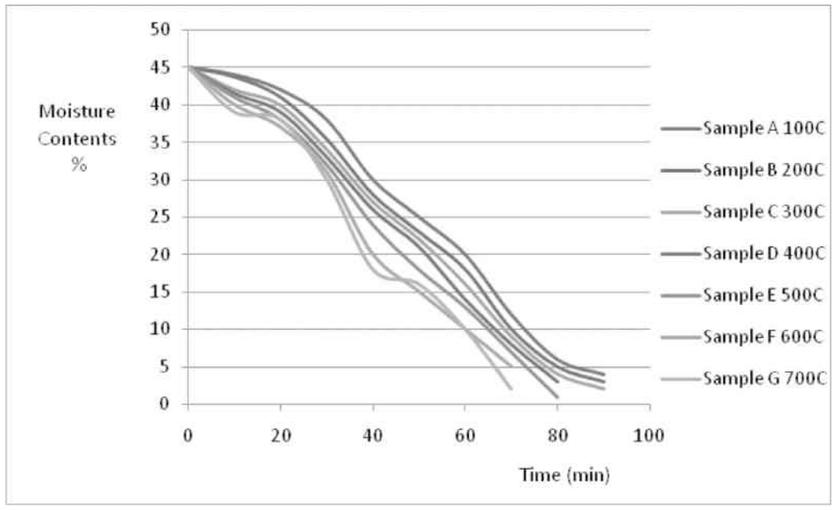


Fig 1.2: Moisture content versus frying time at various temperatures and time

Conclusion

As a means of eliminating the fire hazard posed by the crude method of frying of garri, the temperature of frying is regulated by the use of a thermostat, a temperature regulator device which is calibrated to temperature rate of 10^0C, 20^0C, 30^0C, 40^0C, 50^0C, 60^0C,and 70^0C. (i.e. temperature ranges between 0^0 – 70^0C.This also prevents arbitrary frying of garri. The equipment has capacity of drying 30kg of dewatered cassava pulp, and having a maximum frying temp of about 70^0C.

References

Bassey, M.W. (1989). Development and use of Solar Drying Technologies. *Nigeria Journal of Solar Energy,* Pg 133 -164.

Gupta, J. K and Khumi, R.S (2005). *A Textbook of Machine Design*(14th Revised Ed.). Eurasia Publishing House Ltd New Delhi.

Hall, A. S., Holowenko, A.H & Laughlin, H.G. (1980).*Theory and Problems of Machine Design Schaum's outline series*, MMcGraw- International Book Company Singapore pg 113 - 130.

Handerson, S.M, Perry, R.L.& Young, J.H. (1997).*Principles of process Engineering*(4th Ed.). ASAE, Michigan U.S.A. pg 280 – 283.

Igbeka, J.C (1988).Feasibility study on the establishment of a cottage level garri processing industry.

Igbeka, J.C.,Jory, M.&Griffon, D. (1982).Selective mechanization for cassava processing. *Journal of Agricultural Mechanization Asia, Africa and Latin America*, pg 45 – 50.

Ikechukwu, G.A. & Maduabum, A.W.(2012). *Improved Mechanised GarriFrying Technology for Sustainable Economic Development in Nigeria of engineersand computer scientists*. Hall, Inc. New York.

Madiopa, A., Jones, S.&Akalengasaka, J.D. (2002). A Solar Air Heater with Composition Absorber System for food dehydration, Renewable energy, 27-37.

Odigbohare, E. D.& Ahmed, S.F. (1984). Design of a continuous process gari frying machine NIJOTECH Nigeria Volume 8, pg 25 -33.

w.w.w.practical action org (2010). Drying of food Accessed 14th May 2010.

www Engineering.com (2010). Thermal Conductivity of some materials Accessed 15th March, 2010.

RUGIPO RESEARCH AND TECHNICAL JOURNAL

ANTIMICROBIAL AND LARVICIDAL ASSAY OF *COLA MILENII* LEAF EXTRACTS ON *ANOPHELES STEPHENSI* (LISTON)

Authors
***Adewumi B.L., Oyetayo A.M., Elehinafe T.R. and Osaloni A.R.**
Department of Science Laboratory Technology,
Faculty of Applied Science,
Rufus Giwa Polytechnic, Owo.
Email: adewumiblanre@gmail.com

Abstract:

This study investigated Monkey monkey cola (Cola millenii) lethanolic leaf extract which was screened for both antimicrobial and larvicidal activities. The activity of the leaf extracts against selected clinically isolated pathogens were 13.33 mm in Staphylococcus aureus, 12.67 mm in Bacillus subtilis, 14.00 mm in Escherichia coli and 13.00 mm in Salmonella typhi at highest concentration (50 mg/ml) for the bacteria used while 7.00 mm was the highest zone of inhibition recorded in Candida albican. The minimum inhibitory concentrations (MIC) of the leaf extract were 7.5mg/ml for S. aureus and E. coli, while 10 mg/ml was observed for B. subtilis, S. typhi and C. albican respectively. Furthermore, the leaf extracts had a significant lethal effect on mosquito larva at the lowest concentration recording a media lethal concentration (LC_{50}) of 1.71 ppm. Phytocoil and phytospray produced from the leaf extracts of C. millenii gave promising results in the control of the malaria parasite vector.

Keywords: *Cola millenii,* Ethanolic leaf extracts, Antimicrobial, Larvicidal, Minimum inhibitory concentrations, Lethal concentration

Introduction

A medicinal plant is any plant which one or more of its parts contain substances that can be used for therapeutic purposes or serve as a precursor for the synthesis of useful drugs. These complex chemical substances generally occur as secondary plant metabolites in these plants and are useful to humanity (Ganiyat *et al.*, 2010).

After prolonged exposure to an insecticide over several generations, mosquitoes like other insects may develop resistance, a capacity to survive contact with an insecticide. Since mosquitoes can have many generations per year, high level of resistance can arise very quickly. Resistance for mosquitoes to some insecticides has been documented with just within few years after the insecticides used for indoor (Trape *et al*., 2011). Residual spraying was a major impediment during the global malaria eradication campaign. Judicious use of insecticides for mosquito control can limit the development and spread of their resistance. Detection of developing resistance in mosquitoes is possible, so control programs are well advised to conduct surveillance for this potential problem (Ansari *et al.*, 2005).

Mosquito control is an important component of malaria control strategy, elimination of malaria in an area does not require the elimination of all anopheles mosquitoes. For instance, in North America and Europe, although the vector anopheles mosquitoes are still present, the parasite has been culminated (Sachs and Malaney, 2002). Some socioeconomic improvements once combined with vector reduction efforts and effective treatment, led to the elimination of malaria without complete eliminations of the vector (Trape *et al*., 2011). Some important measures in mosquito control to be followed are: discourage the vector egg-laying, prevent development of the eggs into larvae and adults, kill the adult mosquito

dwelling, prevent mosquitoes from biting human beings and deny them blood meals (Fradin and Day, 2002).

Joseph *et al.* (2017) described only *Cola nitida* and *Cola acuminata* as the Nigeria economic Cola species out of the over 50 species recorded in West Africa. *Cola millenii* is also well recognized in the Nigeria Cola market (Akinnibosun and Adewumi, 2019). These alkaloids can dispel sleep, thirst and hunger. Thise research aimed to subject ethanolic leaf extracts of *C. millenii* to standard scientific scrutiny in relation to its antimicrobial activity spectrum and larvicidal properties.

Materials aAnd Methods

Collection and Preparation of leaves extracts

The monkey cola (*Cola millenii*) leaves was collected fresh from the farm centre at Owo, Ondo State and was authenticated at the Herbarium Section of the Department of Science Laboratory Technology, Rufus Giwa Polytechnic, Owo where Voucher specimens (XCM-LV001) were deposited before it was transferred to the laboratory for analysis. The sample was air dried under shed for three weeks and then milled into powder using electric grinder. A 100g of the powdered sample was soaked in 300ml, ethanol for 72hr with intermittent stirring using sterile spatula. The plant extracts were then filtered through Whatman No1 filter paper into bijou bottles and then concentrated *in vacuo* using rotary evaporator model. Different concentrations of the extracts were prepared by diluting 0.10, 0.20, 0.30, 0.40 and 0.50g of the extracts in 100ml of 0.01% Tween-20 to obtain concentrations of 10, 20, 30, 40 and 50mg/ml respectively (Opawale *et al.,* 2015).

Antibacterial assay of the leaves extract

A minimum inhibitory concentration (MIC) measured of the antibacterial activities and the agar dilution procedure of García *et al* (2006) was used. Ethanol was used to dissolve the extracts to achieve a concentration of 40 mg/ml. Dilutions of these solutions were prepared to obtain final 8.0 to 0.5 mg/ml concentrations. Cultures of 108 colony-forming units (CFU)/ml contained the inoculum for each organism. The diluted inoculum (1:20) was used as a spot with a calibrated 0.002 ml loop to create an inoculum spot covering a 5–8 mm circle and containing 104 CFU. The dish was incubated at 37°C for 24 hours. The reference norm used was chloramphenicol (2.5–120µg/ml) (Sigma). Duplicate observations were made and findings showed as a minimum plant extract concentration capable of producing maximum colonial growth suppression on agar (minimum inhibitory concentration) (Asmerom *et al*., 2020).

Antifungal assay

The antifungal test was done using Petri dishes with the agar dilution process (Gadhi *et al*., 2001; Lim *et al*., 2020). Stock solution of the extracts were double diluted and yielded amounts of 8.0 to 0.125 mg/ml and of 128 to 1µg/ml, respectively (Asmerom *et al*., 2020). In the test, the final levels of Dimethyl sulfoxide (DMSO) were below 2.0% (v/v). The finale inoculum was mounted on the top of the solidified agar with a loop and incubation was done at 29°C while experiments were performed in triplicates (Akinnibosun and Adewumi, 2018). The first test plates prepared without any test sampling after 24, 48, and 72 hours were tested for the fungal growth, according to the incubation time appropriate for a noticeable growth (García *et al*., 2006).

Mosquito Test organism

The test organism larvae of *Anopheles stephensi* were collected from stagnant water within the student hostel of Rufus Giwa Polytechnic, Owo and were kept in a plastic container until testing for bioassays (Ileke and Ogungbite, 2015). The larvae were used within 30 minutes of collection.

Method of Test for Larvicidal Activity

In the larvicidal assays, third and fourth instars larvae of *Anopheles stephensi* were exposed to test

concentration of 2, 4, 8 and 10ml of extracts in a plastic beaker containing 100ml of distilled water. About 100ml of distilled water was taken in a series of 200 ml plastic beaker. The plant extracts were added to the distilled water in the beakers. A control was also maintained by not adding any known concentration of the plant extract to the distilled water in the beaker. Twenty (20) larvae per concentration were used for all the larvae experiment (Ansari *et al.,* 2005).

Each concentration of the plant extract had three (3) replicates each and was arranged in Complete Randomised Design (CRD). The number of dead larvae was recorded at the end of 24hours respectively. The percentage mortality value was calculated using the formula:

$$\frac{\text{Number of dead larvae X 100}}{\text{Total number of exposed larvae}}$$

Method for production of spray from the plant extract

For the production of the bio-insectide spray, taxopon (150g) was poured into a 2L container and Phenol (500 mL) was added then stirred continuously until all is dissolved without any trace of the taxopon particles, menthol was added to aid the dissolution. About 100 g of *C. millenii* extract was added to the mixture and stirred until the solution homogenized. The mixture was thereafter transferred immediately into virgin spray bottles and capped to avoid escape of the solvent for analysis and compared with control (Ileke and Ogungbite, 2015).

Method for production of coils from the plant extract

For the production of the bio-insectide coil, taxopon (150g) was poured into a 2L container and Phenol (300 mL) was added then stirred continuously until all was dissolved, however, menthol was added to aid the dissolution. *C. millenii* (200 g) was added to the mixture and stirred until the solution homogenized. Cassava starch (500 g) was cooked in boiling water (100 ml) placed in a water bath to form a paste. The paste was stirred into the prepared mixture until a consistent paste is formed. The paste was now made into different form and shapes and were placed in the drying cabinet with the temperature set at 38 ^{0}C to until the shapes reached a constant temperature (Ileke and Ogungbite, 2015). Different samples containing 1 %, 2% and 5 % of the plant extract were produced.

Results

Table 1: Antimicrobial activity of ethanolic extract of *C. millenii* leaf on selected clinically isolated bacteria

Conc. (mg/ml) rganisms	10	20	30	40	50	Control
	Zones of inhibition (mm)					
S. aureus	4.33± 0.02^{a}	6.67±0.00^{ab}	8.33±0.15^{ab}	10.00±0.01^{c}	13.33±0.00^{d}	21.00±0.00^{e}
B. subtilis	3.67± 0.01^{a}	5.33±0.01^{b}	7.33±0.02^{c}	9.67±0.15^{d}	12.67±0.33^{e}	23.67±0.67^{f}
E. coli	4.67±0.58^{a}	6.00±0.00^{a}	8.00±0.00^{b}	11.33±0.02^{c}	14.00±0.00^{d}	21.33±0.57^{e}
S. typhi	3.33±0.33^{a}	5.33±0.10^{b}	7.67±0.04^{c}	10.33±0.18^{d}	13.00±0.00^{e}	23.33±0.33^{f}
albicans	0.00±0.00^{a}	0.00±0.00^{a}	2.67±0.00^{b}	5.17±0.02^{c}	7.00±0.00^{d}	19.67±0.33^{e}

Source: Author's Computation, 2022

Values are Mean ± S.E.M (mm), Values followed by different alphabet along the rows are significantly different at p≤0.05, NI= no inhibition, Chl=Chloramphenicol

The result of the antimicrobial activity of the ethanol extract of the plant leaf is shown in Table 1 where it is revealed that the bacteria test organisms had comparable susceptibility to the leaf extracts across the concentrations used with *E. coli* having the widest inhibition zone of 14.00 mm while *C. albicans* recorded the least inhibition zone of 7.00 mm. The antibacteria activity was significantly high given that crude extract was used. Also, the MIC of the extract range from 7.5 mg/ml against *S. aureus* and *E. coli* to 10 mg/ml in the other test isolates as presented in Table 2.

Table 2: MIC of ethanolic extracts of *C. millenii* leaf against some clinically isolated organisms (mg/ml)

Organism	Leaf
S. aureus	7.5
B. subtilis	10
E. coli	7.5
S. typhi	10
C. albicans	10

Source: Author's computation, 2022

The percentage mortality of the mosquito larvae sujected to different doses of the plant extract is presented in Tale 3. It shows that there was 45 % mortality recorded at 1 ppm and 1000 ppm of the extract achieved 100 % mortality against the larvae. The calculated lethal concentration capable of killing 50 % of the larvae was obtained at 1.71 ppm.

Table 3: Percentage mortality of mosquito larva at different concentrations of the ethanolic leaf extracts of *C. millenii*

Dosage (ppm)	Initial larvae	No. of survivors	No. of deaths	% mortality
1000	20	0	20	100
100	20	3	17	85
10	20	6	14	70
1	20	9	11	45
LC_{50}				**1.71**

Source: Author's computation, 2022

The results of the efficacy of the phytocoil and the phytospray against adult mosquitoes are shown in Table 4 and Table 5 respectively. Only the phytocoil containing 5 % of the extract achieved 100 % destruction of the misquitoes after five hours of exposure. whereas, the commercially available coil (Table 4). However, the phytospray containing 5 % of the plant extract achieved 100 % destruction of the mosquitoes after 20 minutes exposure compared with the control insecticide which achieved similar results almost immediately after exposure.

Table 4: percentage mortality of adult mosquito exposed to phytocoil produced from ethanolic leaf extracts of *Cola millenii* (hrs)

Concentration (%)	1	2	3	4	5
	Hours after treatment (HAT)				
1	15.33±0.01	35.00±0.00	40.33±0.00	40.33±0.00	40.33±0.00
2	20.67±0.00	45.33±0.10	50.67±0.00	51.67±0.00	51.67±0.00
5	42.20±0.00	71.67±0.00	100.00±0.00	100.00±0.00	100.00±0.00
Unexposed	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
Coil	50.00±0.00	95.67±0.00	100.00±0.00	100.00±0.00	100.00±0.00

Source: Author's computation, 2022

Table 5: percentage mortality of adult mosquito exposed to phytospray produced from ethanolic leaf extracts of *Cola millenii* (min)

Concentration (%)	5	10	15	20	30
	Minutes after treatment (MAT)				
1	0.00±0.00	0.00±0.00	10.33±0.00	16.67±0.00	16.67±0.00
2	0.00±0.00	6.67±0.04	16.33±0.00	36.67±0.00	66.67±0.00
5	31.67±0.00	52.67±0.00	84.33±0.00	100.00±0.00	100.00±0.00
Unexposed	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
Baygon	100.00±0.00	100.00±0.00	100.00±0.00	100.00±0.00	100.00±0.00

Source: Author's computation, 2022

Discussion

Many infectious diseases have been known to be treated with herbal remedies throughout the history of mankind and *Cola* species have been reported to possess antimicrobial properties (Odugbemi, 2006). Results from this work support this position. A medicinal plant is any plant which one or more of its parts contain substances that can be used for therapeutic purposes or serve as precursor for the synthesis of useful drugs. Medicinal plants contain biologically active chemical substances (phytochemicals) such as saponins, tannins, flavonoids, alkaloids, and other compounds which have preventive or curative properties (Akinnibosun and Adewumi, 2019). These complex chemical substances generally occur as secondary plant metabolites in these plants and are useful to humanity (Ganiyat *et al.*, 2010).

The ethanolic leaf extracts of *C. millenii* which were investigated for its possible antimicrobial activities and it shows various degrees of activities against the selected pathogenic organisms used. *E. coli* a Gram negative bacterium showed the widest zone of inhibition followed by *Staphylococcus aureus* a gram positive organism which show similar susceptibility to the extracts at all the concentrations used. This is in line with the previous reports on the species of Cola (Reid *et al*., 2005). Furthermore, all the bacterial test isolates were susceptible with comparable zones of inhibition suggesting a possible wide spectrum of activity against different bacteria species while having a rather lower activity against the test yeast.
The minimum inhibitory concentration of an antimicrobial agent is the minimum concentration of the agent that prevents visible growth of the test organism in a broth culture. The organisms showed low MIC to the extracts which suggested that the organisms maybe sensitive to *C. millenii*. The outcome of this study has shown that the leaf extracts of *C. millenii* possess antimicrobial activity. Therefore, it may be exploited for the development of alternative therapy to the synthetic antibiotics which has a plethora of adverse effects. These observations are at variance with the observation of Sonibare *et al.* (2009) who reported 90mg/ml MIC for *A. niger* albeit using leave extracts of *C. millenii*. From these results, a very high concentration of the extracts may be necessary to achieve effects comparable to the control antibiotics.

The larvicidal effect of *C. millenii* extracts on mosquito larva was concentration dependent as higher concentration led to higher mortality of the larvae. These results showed that crude extracts of *C. millenii* had a remarkable effect on the larvae of anopheles mosquito. Although, the effectiveness of the plant extracts was observed to be and concentration dependent. The mosquito larva appeared to be highly susceptible to the leaf extract of the plant with very low LC_{50}. *The high level of larvicidal activity observed in this experiment is in line with the observation of Ileke and Ogungbite (2015) who reported a similar observation in oil and extract of A. boonei. Previously, bioactive agents from plants have been identified to impede* the swimming ability of the larvae and pupae of the insect as suggested by Bhattacharya *et al . (2014)* that botanical oils have a considerable effect on the swimming ability of larvae and pupae of mosquito and reduction in their surviving rate.

Furthermore, the insecticidal potency of the phytocoils produced from the *C. millenii* leaf was very

promising especially at 5% incorporation level as the extracts recorded high insect mortality above 50% within 2 h and 100% mortality after 3 h of application respectively which was comparable to the commercially available insecticide coil which had 50% mortality within 1 h and 100% after 3 h of application. Nevertheless, the *C. millenii* leaf extracts had lower effect on the adult insect as only about 50% were killed after 5 h of exposure at 5% incorporation while lower concentrations were unable to achieve 50% mortality in the mosquitoes (*Ileke and Ogungbite, 2015).*
Moreover, the phytospray formulated from the *C. millenii* leaf extracts was more active against the adult mosquitoes as 2% and 5 % incorporation were able to achieve more than 50% mortality after 30 min exposure. The ethanolic extract of the leaf at 5% incorporation actually achieved 50% mortality in the insects within 10 min of exposure which is very encouraging since it is crude extract and not purified yet. The activity compares favourably with the commercially available insecticide (Baygon) which had an instant killing effect on the mosquitoes. The extract of the leaf had lower insecticidal effect on adult mosquitoes as only 5% incorporation concentration had 50% mortality effect on the mosquitoes after the treatment period while the lower concentrations did not achieve 50% mortality of the insects (Singh and Mittal, 2014).

The killing effect of the *C. millenii* leaf extract on the test mosquitoes might be due to their ability to disrupt the normal respiratory activity of the insects. Insecticides formulated from botanical sources have been reported to have a considerable effect on the normal respiration of insects as many of them have a knack to block the respiratory organ (spiracle) of insects according to Ileke and Ogungbite (2015).

Based on these findings, above, that leaf extracts of *C. millenii* had wide spectrum antimicrobial activities against both gram positive and negative bacteria as well as yeast. The organisms used were more susceptible to the plant extracts at all concentrations. *C. millenii* leaf extracts had significant lethal effect on mosquito larva and insecticidal activity against adult mosquitoes. Effective insecticides may be formulated from *C. millenii* leaf extract. More researches should be done to purify the leaf extracts of *C. millenii* to serve as alternative therapy for curing diseases caused by the susceptible microorganisms in this study. This will reduce dependence on imported synthetic antimicrobial drugs. Consequently,, characterization of the chemical species in *C. millenii* is recommended to ascertain the main active agents inherent in the plant leaf Bioinsecticides from *C. millenii* leaf can be integrated into the strategy for control of mosquitoes, and *Cola millenii* cultivation should be encouraged to serve as a reserve of raw material for possible development into acceptable antimicrobial drug.

References

Akinnibosun, F. I. and & Adewumi, L. B. (2018). Evaluation of phytochemical components of various parts of *Cola millenii* K. Schum. *Ovidius University Annals of Chemistry* 29(1),: 29 – 35.

Akinnibosun, F. I. and & Adewumi, L. B. (2019). Properties and potentials of *Cola milenii* K. Schum.: a review. *Nigerian Research Journal of Engineering and Environmental Sciences* 4(1): 166 – 173.

Ansari, M. A., Mittal, P. K., Razdan, R. K., & Sreehari, U. (2005). Larvicidal and mosquito repellent activities of Pine (*Pinus longifolia*, family: Pinaceae) oil. *Journal of Vector Borne Diseases,* 42:95-99.

Asmerom, D., Kalay, T.H. and & Tafere, G.G. (2020). Antibacterial and Antifungal Activities of the Leaf Exudate of *Aloe megalacantha* Baker. *International Journal of Microbiology*, Article ID

8840857, 6 pages, 2020. Doi.Org/10.1155/2020/8840857.

Bhattacharya, S., Iyer, E.P., Iyer, S.C. and & Cox, D.N. (2014). Cell-type specific transcriptomic profiling to dissect mechanisms of differential dendritogenesis. *Genom. Data* 2: 378--381.

Fradin, M.S. and & J.F. Day. (2002). Comparative efficacy of insect repellent against Mosquito bite. *New England Journal of Medicine*, 347(1): 13-18.

Gadhi, C, Benharref A, Jana, M, Basile, A, Contet-Audonneau, N, & Fortier, B. (2001): Antidermatophic properties of extracts from the leaves of *Aristolochia paucinervis*. pomel. Phytother Res 15: 79–81.

Ganiyat, K. O., Patricia, A.O., Sothka, J., Oguntokun, O. and & Thoda, E. (2010). Phytochemical screening, antimicrobial and antioxidant activities of four Nigerian medicinal plants. *Annuals of Biological Research* 1(2): 114-120.

García, V.M.N., Gabriela, R.L. Gerardo, Z., Margarita, A., Macrina, F., Armando, H. and & Enrique, J. (2006). Antifungal and Antibacterial activity of four selected mexican medicinal plants. *Pharmaceutical Biology*, 44:4, 297-300, DOI: 10.1080/13880200600715837

Ileke, K.D. and & Ogungbite, O.C. (2015). *Alstonia boonei* De Wild oil extract in the management of mosquito (*Anopheles gambiae*), a vector of malaria disease. *Journal of Coastal Life Medicine*, 3(7): 557-563.

Joseph, A.U., Monday, I.A., Edet, A. and & Usenobong, F.U. (2017). Effects of ethanolic extracts of *Cola millenii K.* Schum seed on biochemical and toxicological indices of male wistar albino rats. *Journal of Pharmacognosy and Phytochemistry*, 6(1): 160-166.

Lim, H., Seo, K., Chon, J. and & Song, K. (2020). Antimicrobial Activity of *Hibiscus sabdariffa* L. (Roselle) Powder against Food-Borne Pathogens Present in Dairy Products: Preliminary Study. *Journal of Dairy Science and Biotechnology* 38:1, pages 37-44.

Odugbemi, T. (2006): Outlines and Pictures of Medicinal plants from Nigeria. University of Lagos.

Ogundipe, O. O., Moody, J. O., Houghton, P. J, and & Odelola HA (2001). Bioactive chemical constituents from *Alchornea laxiflora* (Benth.) Pax and Hoffman. *J. Ethnopharmacol*., 74: 275-280.

Opawale, B.O., Oyetayo, A.M. and & Agbaje, R.B. (2015). Phytochemical Screening, Antifungal and Cytotoxic Activities of *Trichilia heudelotii* Planc (Harm). International Journal of Sciences: Basic and Applied Research (IJSBAR), volVol. 24, Issue. 6, pp. 267-276.

Reid, K. A., Jager, A. K., Light, M. E., Mulholland, D. A. and & Staden, J. V. (2005): Phytochemical and Pharmacological Screening of Sterculiaceae species and Isolation of antibacterial Compounds. *J. Ethnophamacol*. **97 (2):** 285-291.

Sachs, J. and & Malaney, P. (2002). The economic and social burden of malaria. *Nature, 415:*680 – 685.

Singh R. R. and & Mittal, S. (2014). Improvement of local subgrade soil for road constuction by the use of coconut coir fiber. *IJRET; International Journal of Research in Engineering and Technology*, 3:5.

Sonibare, M.A., Soladoye, M.O., Oyedokun, O.E. and & Sonibare, O.O. (2009). Phytochemical and antimicrobial studies of four species of Cola Schott and Endl. (Sterculiaceae). *Afri J Trad Med.*, 6(4): 518-528.

Trape, J. F., Tall, A., Diagne, N., Ndiath, O., Ly, A. B., Faye, J., Dieye-Ba, F., Roucher, C., Bouganali, C. and Badiane, A. (2011). Malaria morbidity and pyrethroid resistance after the introduction of insecticide-treated bednets and artemisinin-based combination therapies: a longitudinal study. *Lancet Infectious Diseases, 11*, 925 – 932.