West Africa Built Environment Research (WABER) Conference 2015

10-12 August 2015
University of Ghana
Accra, Ghana

Proceedings of the WABER 2015 Conference (Volume 1)

Editors
Samuel Laryea
Roine Leiringer
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*NEA ONNIM NO SUA A, OHU*

Symbol of knowledge, life-long education and continued quest for knowledge
FOREWORD

It is a pleasure to welcome you to our 6th WABER Conference taking place at the University of Ghana in Legon, Accra. Thank you for coming, and a very warm welcome to Accra and the beautiful campus of the University of Ghana. I know some of you have travelled long distances to get here. Some of you have also made considerable sacrifices to mobilise the resources required to be here. We appreciate your efforts. We hope the conference meets your expectations and provides you with valuable experience and developmental opportunities for a productive and rewarding career.

We are grateful for the presence of the Minister for Education – Professor Naana Jane Opoku-Agyemang – at the Opening Session of this conference. Thank you for kindly accepting our invitation to come and open the conference for us. We are equally grateful for the presence of the Vice Chancellor of University of Ghana – Professor Ernest Aryeeetey – whose leadership and distinguished academic career serves as an inspiration to many. Professor Aryeeetey leads a University which has recently been ranked by Thompson Reuters as the 10th best university on the African continent. We are proud to host our conference here and thank you for accepting our invitation to come and give a Welcome address. Thank you also to our other special guests – particularly leaders of academic institutions and industry – for joining us. The presence of industry practitioners and leaders of the built environment professions provides an opportunity for us to critically explore practical solutions to existing problems in our built environment like flooding, fire, building collapse, poor construction, health and safety of workers, environmental pollution, land management, development control, impact of construction on the environment, inclusive design, waste management, traffic on our roads and congestion in our cities. We believe that such interactions provide a much needed opportunity to start to bridge the proverbial gap between academia and industry.

The WABER Conference keeps growing each year. For this, I would like to thank our delegates and partners. Thank you for the contributions you have made to the life and success of this conference. As some of you know, this conference began in 2008 as an initiative of the School of Construction Management and Engineering at University of Reading. Over the years, colleagues including Prof. Will Hughes, Dr Roine Leiringer, Dr Chris Harty, Dr Sena Auyepong, Dr Emmanuel Essah, Prof. George Ofori and myself have formed a solid foundation for the development of the conference, which so far has proven to be successful. We have sustained the success through the provision and facilitation of appropriate academic infrastructure and leadership. Most importantly, the academic recognition and continued support we receive from delegates has been the key to our development. Indeed, the most important people in the growth of WABER are the conference delegates, and we take great pride in the high number of repeat participants.

Let me focus now on this year’s conference and our activities.

The delegates at this year’s conference come from 64 different academic institutions spread across eight different countries. There is a real opportunity here for rich exchange of academic, social and cultural ideas. Please take every opportunity to interact, exchange ideas and develop collaborations with colleagues from other institutions.

From an initial submission of 165 abstracts, we eventually accepted 92 papers for presentation at this year’s conference. Congratulations to the authors of accepted papers. Thank you for the hard work put into doing the research and writing the papers. The papers being presented at this year’s conference are written by authors from six main academic backgrounds and disciplines namely: architecture, building, construction management, estate / property management, quantity surveying, and urban and regional planning. As such, the conference truly reflects an international gathering of built environment academics. We also have some mainstream academics and industry practitioners here who will contribute to the richness and quality of deliberations.
More than 50 reviewers from 12 different countries were involved in the peer review process for this conference. I would like to express sincere gratitude to each reviewer for the great job done. Without the dedication and expertise of our referees, this conference will not be as successful as it is. So thank you to all reviewers for your contributions to the success of this conference. I particularly wish to thank Dr Wisdom Kwawu, Dr Roine Leiringer and Prof Will Hughes for your significant contributions in this regard.

It is important to appreciate the roles and efforts of the following people for significant contributions made towards the successful organization of the conference: Florence Laryea (for among other things, formatting and typesetting the papers in this conference proceedings), Dr Sana Agyepong, Jonathan Ntsiful, Dr Emmanuel Essah, and colleagues at Scatterlings Conference and Events. It is always a mammoth task to mount an event of this nature successfully.

Our keynote speakers who have travelled long distances to come and share their time, knowledge and expertise with us deserve our profound gratitude: Professor George Ofori (National University of Singapore); Professor Koshy Varghese (Indian Institute of Technology, Madras); Dr Roine Leiringer (University of Hong Kong); and Dr Ron Watermeyer (Infrastructure Options Pty Ltd, South Africa).

I finally wish to thank our sponsors and partners who support us in diverse ways. In particular, John Rixs Construction and EPP Books Services / Zenith University College.

We aspire to provide a vehicle for the advancement of built environment research in Africa; and create opportunity for built environment academics, particularly those in the early stage of their career, to develop their research work and skills through constructive interaction with experienced international academics. Therefore, the future of this conference needs to be properly architectured and sustained through innovative ideas, academic enterprise and leadership. The WABER conference values are knowledge, interaction, people and leadership. We have developed with a clear sense of purpose since 2008 and made significant impact on the research landscape in West Africa. We plan to continue our growth by serving the built environment community in our region. Plans for the publication of our African Journal of Built Environment Research are now firmly established. Two issues will be published within the next year. We are awaiting feedback on our application for indexing of the WABER Conference proceedings in the Thomson Reuters Conference Proceedings Citation Index. A positive outcome will facilitate greater scientific recognition of our work and dissemination of our research outputs in global databases like Scopus and the Web of Science collection. Our activities going forward will include: facilitating access to scientific literature, providing opportunity for experienced/leading international academics from elsewhere to interact with the built environment community in Africa, providing a forum for quality scientific engagement and interactions, facilitating the development of research skills and publications among built environment academics particularly those in the early stages of their careers, supporting the development of researchers in our academic institutions, and creating opportunity for people in different institutions to connect for exchange of ideas and collaborative work.

I thank you once again for coming to this conference. Enjoy it, engage in the exchange of ideas, build new relationships for the future, and have a safe journey back home. We wish you all the best in your endeavours and hope to see you again in the future.

Samuel Laryea, PhD
Chairman of WABER Conference, Associate Professor at Wits University School of Construction Economics and Management, Fellow of the Higher Education Academy
August 2015
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Our authors develop their papers in line with the principles of academic freedom. However, they are also responsible for good academic practice when conducting and reporting scientific research. It is the responsibility of authors to abide by the norms of academic ethics and integrity. WABER accepts no liability for copyright infringements or inappropriate use of material in any paper published.

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DECLARATION

PEER REVIEW AND SCIENTIFIC PUBLISHING POLICY STATEMENT

10th August 2015

TO WHOM IT MAY CONCERN

I confirm that all papers in the WABER Conference Proceedings have been through a peer review process involving initial screening of abstracts, review of full papers by at least two referees, reporting of comments to authors, revision of papers by authors, and re-evaluation of re-submitted papers by the Scientific Committee to ensure quality of content.

It is the policy of the West Africa Built Environment Research (WABER) Conference that all papers must go through a systematic scientific and peer review process involving examination by at least two referees who are knowledgeable in the field. A paper is only accepted for publication in the conference proceedings based on the recommendation of the reviewers and the Scientific Committee.


Papers in the WABER Conference Proceedings are published open access on the conference website to facilitate public access to the research papers and the wider dissemination of scientific knowledge.

Yours Sincerely,

Samuel Laryea, PhD
University of the Witwatersrand, Johannesburg, South Africa
Chairman of WABER Conference
REVIEW PANEL

We would like to express gratitude to the following people who conducted thorough scientific reviews of more than 100 papers submitted for WABER Conference 2015 and provided authors with constructive comments.

Dr Wisdom Kwawu, University of the Witwatersrand, South Africa  
Dr Roine Leiringer, The University of Hong Kong, Hong Kong  
Prof Will Hughes, University of Reading, UK  
Prof George Ofori, National University of Singapore, Singapore  
Dr Eziyi Ibem, Covenant University, Nigeria  
Dr Patrick Manu, University of the West of England, UK  
Dr Martin Tuuli, Loughborough University, UK  
Dr Kola Akinsomi, University of the Witwatersrand, South Africa  
Dr Fidelis Emuze, Central University of Technology, South Africa  
Dr Taibat Lawanson, University of Lagos, Nigeria  
Dr Abimbola Windapo, University of Cape Town, South Africa  
Dr Obinna Ozumba, University of the Witwatersrand, South Africa  
Dr Emmanuel Essah, University of Reading, UK  
Dr Olurotimi Kemiki, Federal University of Technology, Minna, Nigeria  
Dr Alex Opoku, South Bank University, UK  
Dr Stefan Gottlieb, Aalborg University, Denmark  
Dr Peter Raisbeck, University of Melbourne, Australia  
Dr Dominic Ahiaga-Dagbui, Robert Gordon University, Scotland  
Solomon Babatunde, Northumbria University, UK  
Dr Simon SD Smith, University of Edinburgh, Scotland  
Dr Daxuan Zhao - A-Star Science and Technology, Singapore  
Dr Li Qing, Singapore  
Dr Koech Cheruiyot, Gauteng City Regional Observatory, South Africa  
Dr Douw Boshoff - University of Pretoria, South Africa  
Dr Haruna Moda Musa, Manchester Metropolitan University, UK  
Dr Aaron Anvuur, Loughborough University, UK  
Martin Löwstedt, Chalmers University of Technology, Sweden  
Dr Johan Nyström, The Swedish National Road and Transport Research Institute, Sweden  
Vivien Chow, The University of Hong Kong, Hong Kong  
Dr Ajibade Aibinu, University of Melbourne, Australia  
Ebo Inkoom, The University of Hong Kong, Hong Kong  
Paula Cardellino, Universidad ORT Uruguay, Uruguay  
Kofi Agyekum, KNUST, Kumasi, Ghana  
Sarfo Mensah, Kumasi Polytechnic, Ghana  
Dr Chika Udeaja, Northumbria University, UK  
Dr Bernard Baiden, KNUST, Kumasi, Ghana  
Dr Naa Adjeley Ashiboe Mensah Doamekpor, KNUST, Kumasi  
Mr J. G. K. Abankwa, Central University College, Ghana  
Dr Kulomri J. Adogbo, Ahmadu Bello University, Nigeria
SCIENTIFIC COMMITTEE

Dr Roine Leiringer, University of Hong Kong, Hong Kong
Prof George Ofori, National University of Singapore, Singapore
Prof Will Hughes, University of Reading, UK
Dr. Eziyi O. Iben, Covenant University, Nigeria
Dr Ola Uduku, Edinburgh College of Art School of Architecture, Scotland
Dr Patrick Manu, University of the West of England, UK
A/Prof Immaculata Nwokoro, University of Lagos, Nigeria
Dr Taibat Lawanson, University of Lagos, Nigeria
Dr Abimbola Windapo, University of Cape Town, South Africa
Dr Martin Tuuli, Loughborough University, UK
Prof Koshy Varghese, Indian Institute of Technology, Madras, India
Dr Ahmed Doko, Ahmadu Bello University, Nigeria
Prof Kwabena A. Anaman, University of Ghana, Legon, Ghana
Dr Kulomri J. Adogbo, Ahmadu Bello University, Nigeria
Prof Stella Zubairu, Federal University of Technology, Minna, Nigeria
Dr Emmanuel Essah, University of Reading, UK
Prof D. R. Ogunsemi, Federal University of Technology, Akure, Nigeria
Dr Oluotimi Kemiki, Federal University of Technology, Minna, Nigeria
Prof Chimay Anumba, Penn State University, USA
Dr Alex Opoku, South Bank University, UK
Dr Noah Karley, Anglia Ruskin University, UK
Dr Cynthia Adeokun, Colman Architects Ltd., London, UK
Prof Kabir Bala, Ahmadu Bello University, Nigeria
Mr Sarfo Mensah, Kumasi Polytechnic, Ghana
Dr Stefan Gottlieb, Aalborg University, Denmark
Paula Cardellino, Universidad ORT Uruguay, Uruguay
Dr Obinna Ozumba, University of the Witwatersrand, South Africa
Dr Jasper Mbachu, Massey University, New Zealand
Dr Wisdom Kwawu, University of the Witwatersrand, South Africa
Dr Dominic Ahiaga-Dagbui, Robert Gordon University, Scotland
Dr Ajibade Aibinu, University of Melbourne, Australia
Dr Aaron Anvuur, Loughborough University, UK
Dr Kola Akinsomi, University of the Witwatersrand, South Africa
Dr Sena Agyepong, Ashesi University College, Ghana
A/Prof Samuel Laryea, University of the Witwatersrand, South Africa
WABER COMMITTEE

The West Africa Built Environment Research (WABER) Committee comprises of the following persons:

A/Prof Samuel Laryea, University of the Witwatersrand, South Africa
Dr Sena A. Agyepong, Ashesi University College, Ghana
Dr Emmanuel Essah, University of Reading, UK
Dr Taibat Lawanson, University of Lagos, Nigeria
Dr Cynthia Adeokun, Colman Architects Ltd., London, UK
Prof Anny Nathaniel Aniekwu, University of Benin, Nigeria
Prof Kabir Bala, Ahmadu Bello University, Nigeria
Mr Afolabi Dania, University of Reading, UK
Mr Damilola Ekundayo, Oxford Brookes University, UK
Mr Michael K. Frimpong, MOKOF Consulting Ltd, Accra, Ghana
Dr Eziyi Ibem, Covenant University, Nigeria
Dr Ahmed Doko Ibrahim, Ahmadu Bello University, Nigeria
Prof George Intsiful, KNUST, Kumasi, Ghana
Dr Noah Karley, Anglia Ruskin University, UK
Dr Wisdom Kwawu, University of the Witwatersrand, South Africa
Dr Roine Leiringer, University of Hong Kong, Hong Kong
Dr Patrick Manu, University of the West of England, UK
Dr Jasper Mbachu, Massey University, New Zealand
Dr Gabriel Nani, KNUST, Kumasi, Ghana
A/Prof Immaculata Nwokoro, University of Lagos, Nigeria
Prof D. R. Ogunsemi, Federal University of Technology, Akure, Nigeria
Dr Martin Tuuli, Loughborough University, UK
Prof Stella Zubairu, Federal University of Technology, Minna, Nigeria

The main responsibility of the WABER Committee is to provide the infrastructure and academic leadership for developing the WABER conference.
SPONSORS AND PARTNERS

Thank you to all sponsors and partners of the WABER Conference.

More information about our sponsors and partners can be found on our website www.waberconference.com / waberconf.com
PRIZES TO BE AWARDED AT THE WABER 2015 CONFERENCE

• Best Research Paper

This prize is awarded to recognize the author(s) of an original piece of research which contributes a better understanding of the research question/problem investigated and demonstrates a high degree of scientific quality and innovative thought. This prize was created to acknowledge the continuing importance of high quality research to academic institutions, a researcher’s reputation and the development of the built environment field.

• Best Industry-Related Research

This prize is awarded to recognize an industry-related research paper which tackles a significant subject of relevance to construction practitioners and provides conclusions that are likely to help in resolving / improving a problem in practice. The paper should contain impactful research that is both scientifically rigorous and practically relevant.

• Best Presentation

This prize is awarded to recognize the presentation which is the most coherent, clearly enunciated, well-paced, easy to understand, and effective. The award is given on the basis of quality of the presentation and not the written paper. It recognizes the best presentation based on communication of the content of a paper and the ability of the speaker to deliver an impactful, authoritative and engaging presentation. The award looks to encourage researchers to put as much effort as possible into the presentation of their work.

• Gibrine Adam Promising Young Scholar Award

This prize is awarded to recognize and encourage truly exceptional young researchers. The recipient should be a young academic who demonstrates promise, such that he/she is likely to become established as a research leader. The prize is provided by Mr Gibrine Adam – President of Zenith University College and CEO of EPP Books Services – who has made significant contributions to the education sector through his educational establishments and philanthropic work. Awarding this prize each year will serve as an important inspiration for young African built environment academics.
PROFILE OF KEYNOTE SPEAKERS

Thank you to our keynote speakers for accepting our invitation to come and interact with delegates at the WABER Conference 2015. A brief profile of each keynote speaker is given in this section.

Dr Roine Leiringer, University of Hong Kong

Dr Roine Leiringer has been part of the WABER Conference since its inception and has made significant contributions to the conference development. He has participated in all our conferences since the start and been our custodian for research quality. Roine reviews at least 10 of the papers submitted for each year's conference and contributes to editing of the conference proceedings. Through this constructive engagement, he is able to identify the challenging areas for authors when it comes to navigating the contours of good scientific research and paper writing. This unique position offers him the understanding and platform to share ideas with delegates on issues of research quality and development from an international, as well as context-specific, perspective.

Bio

Dr Roine Leiringer is an Associate Professor in the Department of Real Estate and Construction at The University of Hong Kong. He holds an MSc in Civil Engineering and a PhD in Industrial Economics and Management from KTH Royal Institute of Technology, Sweden. In 2010 he was awarded the academic grade Docent at Chalmers University of Technology, Sweden. In research, Roine is committed to critical perspectives. Early research interests were in the areas of Public-Private Partnerships and innovation. Recently much of his research has been in the following four areas:
- 'service-led construction projects', investigating the strategic implications for firms shifting from product manufacturing to being providers of through-life service offerings;
- The impact of government policy and reform initiatives on firms and actors active in the creation of the built environment;
- Sustainability, in particular how individuals in construction organisations are incentivized (or not) to incorporate sustainability into their daily work;
- Client capabilities – what capabilities do public sector clients need in order to effectively procure and manage their capital projects?

Roine is: co-editor of Construction Management and Economics; a former committee member (Secretary) of the Construction Researchers on Economics and Organisation in the Nordic region (CREON) Network; past joint coordinator of CIB Task Group 84 on 'Construction Reform'; and co-founder and co-director of the West Africa Built Environment Research (WABER) conference series. He is currently a Professor Visitante at Universidad ORT Uruguay (Montevideo, Uruguay).

Professor George Ofori, National University of Singapore

In the league of built environment academics, Professor George Ofori is a leader with several international accomplishments. Professor Ofori will speak on "Developing your academic career" and "A research agenda for the built environment". Both topics are relevant for every academic in the built environment field. He is available for the first two days of the conference to engage with delegates and exchange ideas with particularly early career academics wishing to develop successful academic and research careers.

Bio

Prof. George Ofori, B.Sc., M.Sc., Ph.D., D.Sc. is a Professor in the Department of Building at National University of Singapore. He is married with four children. Formerly, Senior Quantity Surveyor, G.A. Takyi and Partners,
Accra, Ghana; Senior Lecturer, 1983-91 and Associate Professor, 1991-99, National University of Singapore. Prof. Ofori has been Head of Department of Building (2002-05), Co-ordinator, Working Commission 107 of International Council for Research and Innovation in Building and Construction (CIB) on Construction in Developing Countries (1997-2007), Consultant to international agencies and governments on construction industry development, and construction management and economics since 1978, undertaking assignments in various countries including Botswana, Ghana, Malawi, Singapore, South Africa, Swaziland and Tanzania. Prof. Ofori is especially interested in the improvement of the construction industries of developing countries.

Professor Koshy Varghese, Indian Institute Of Technology, Madras

Prof Koshy Varghese is a leading international academic in the area of ICT in Construction. His keynote address will provide insights on applications of ICT in large construction projects in India and elsewhere in the world to integrate the processes of planning, design, construction and operation. Koshy will be available throughout the conference to share ideas with delegates on current developments in ICT and automation in construction. He will also be part of our research skills workshop where he will contribute to discussions on quantitative/technology research in construction and also how qualitative methods can complement quantitative techniques to strengthen research contributions.

Bio

Prof. Koshy Varghese is a Professor of Building Technology and Construction Management at the Department of Civil Engineering, Indian Institute of Technology Madras, India. He earned his Doctoral Degree from the University of Texas at Austin, USA with a specialization in Computer Integrated Construction and is currently a member of the editorial board of several journals in the area. Prof. Koshy Varghese is a recipient of the prestigious American Society of Civil Engineers (ASCE) best paper award for
Journal of Computing in Civil Engineering for 2011. He was conferred the Tucker-Hasagawa award for 2012 by International Association for Automation and Robotics in Construction (IAARC) for his contributions to Automation in Construction. The Project Management Institute (PMI) awarded him the Distinguished Scholar Award for 2012 for his research and practice based activities in the area of Project Management. He is currently the President of the International Association for Automation and Robotics in Construction.

Dr Ron Watermeyer, Director of Infrastructure Options (Pty) Ltd and Chair of ISO/TC 59/SC 18 Construction procurement

The design and adoption of innovative procurement systems in infrastructure delivery is a necessity in today’s complex and challenging construction environment. Dr Watermeyer will speak on current developments and recent examples of projects involving design and adoption of alternative and innovative procurement systems. The keynote will outline how intended outcomes and value for money can be achieved through procurement strategy.

Bio

Dr Ron Watermeyer’s qualifications include: DEng, CEng, PrEng, PrCM, PrCPM, FSAICE, FIStructE, FICE, FSAA. He is a renowned international expert on construction procurement and has been at the forefront of many development initiatives in South Africa since the early 1990s including the reinterpretation of building regulations, the classification of sites in terms of geotechnical characteristics and building practice, changing construction methods, technologies and practices to facilitate socio-economic development imperatives and the development of construction procurement procedures and practices. His work on procurement has formed the basis for not only South African standards for construction procurement but also the recently published ISO 10845 family of standards. He has in recent years piloted the implementation of target contracts and framework agreements for the
delivery of civil engineering and building projects within the public sector. He has also led the development of documented procurement and delivery management system for a number of South African public sector bodies. He served as the South African Institution of Civil Engineering's 101st President in 2004. In 2009 he obtained a senior doctorate (Doctor of Engineering) from the University of the Witwatersrand for his engineering development work which has significantly contributed to the delivery of infrastructure for the advancement of a changing South African society. In 2010 he was awarded the Institution of Civil Engineer's International medal for his contribution over time in the delivery of enabling engineering mechanisms for the UN Millennium Development Goals. He has published more than 70 papers and articles on various aspects on the delivery of infrastructure.
# PROGRAMME FOR WABER CONFERENCE 2015

**DAY 1**  
**10.08.15**

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<th>Time</th>
<th>Session</th>
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<td>07:30-09:00</td>
<td><strong>REGISTRATION</strong></td>
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<td>09:00-10:00</td>
<td><strong>OPENING SESSION</strong> (MAIN AUDITORIUM)</td>
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<td>09:00-09:10</td>
<td>Welcome and Introduction of Guests – Samuel Laryea, Chairman of WABER Conference</td>
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<td>09:10-09:20</td>
<td>Remarks by Chairman of Opening Session – Prof. Ernest Aryeetey, Vice Chancellor of University of Ghana</td>
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<td>09:20-09:45</td>
<td>Conference Opening Speech by the Guest of Honour – Prof. Naana Jane Opoku-Agyemang, Honourable Minister for Education &amp; Former Vice Chancellor of the University of Cape Coast, Ghana</td>
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<td>09:45-09:50</td>
<td>Recognition of Mr Gibrine Adam for contributions to education</td>
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<td>09:50-10:00</td>
<td>Vote of thanks and WABER 2015 Group Photograph</td>
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<td>10:00-10:20</td>
<td><strong>SOCIALISING BREAK</strong></td>
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<td>10:20-10:45</td>
<td><strong>KEYNOTE ADDRESS</strong></td>
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<td>A research agenda for the built environment – Prof George Ofori, National University of Singapore, Singapore</td>
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<td>10:45-10:55</td>
<td>Q&amp;A</td>
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<td>11:00-13:15</td>
<td><strong>PARALLEL SESSION</strong></td>
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<td><strong>STREAM 1 (MAIN AUDITORIUM)</strong></td>
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<td><strong>STREAM 2 (SEMINAR ROOM)</strong></td>
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<td>Chair</td>
<td>Dr Roine Leiringer, University of Hong Kong, Hong Kong</td>
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<td>Dr Frederick Addo-Abedi, Kaff University College, Ghana</td>
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<td>11:00-11:10</td>
<td>Enhancing architecture in Nigeria through research: bridging the gap between academic and practice-led research - Elizabeth T. Dassah and Z.</td>
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<td>User satisfaction with space flexibility in offices of selected tertiary institutions in Niger State, Nigeria - Olatunde Poloranmi Adedayo, Anthony Ikechukwu</td>
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<td>11:10-11:20</td>
<td>Facilities management for African urban marketplaces: attitudes toward waste management</td>
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<td>11:20-11:30</td>
<td>Q&amp;A</td>
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<td>11:50-12:00</td>
<td>Q&amp;A</td>
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<tr>
<td>12:00-12:15</td>
<td>REFRESMENTS BREAK</td>
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<tr>
<td>12:25-12:35</td>
<td>Q&amp;A</td>
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<td>12:55-13:05</td>
<td>Architects and interdisciplinary research: reflections from ethnographic and measured fieldwork - Joy Joshua Maina</td>
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<td>13:05-13:15</td>
<td>Q&amp;A</td>
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<td>13:15-14:00</td>
<td>LUNCH</td>
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<td>14:00-14:30</td>
<td><strong>KEYNOTE ADDRESS</strong>&lt;br&gt;Information and Communication Technology in Construction – Prof Koshy Varghese, Indian Institute of Technology, Madras, India</td>
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<td>14:30-14:40</td>
<td>Q&amp;A</td>
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<tr>
<td>14:45-15:45</td>
<td><strong>PARALLEL SESSION</strong>&lt;br&gt;STREAM 1 (MAIN AUDITORIUM)：&lt;br&gt;Chair： Dr Sena Agyepong, Ashesi University College, Ghana&lt;br&gt;14:45-14:55：Prudence practice among construction project managers in Nigeria - Wasiu Adeniran Bello and Emmanuel Andenyang&lt;br&gt;14:55-15:05：Due process practice on construction projects in Lagos State, Nigeria - Oluwaseyi Ajayi and Bamidele Mafimidiwo&lt;br&gt;15:05-15:15：Q&amp;A                                                                                   &lt;br&gt;STREAM 2 (SEMINAR ROOM)：&lt;br&gt;Chair： Dr Wisdom Kwawu, University of the Witwatersrand, South Africa&lt;br&gt;14:45-14:55：Exploring health and safety practices on some Nigerian construction sites - Baba Shehu Waziri, Mansur Hamma-adama and Bukar Kadai&lt;br&gt;14:55-15:05：Appraisal of health and safety management practices of Nigerian construction SMEs - Abdullateef A. Shittu, Ahmed D. Ibrahim, Yahaya M. Ibrahim and Kulomri J. Adogbo&lt;br&gt;15:05-15:15：Q&amp;A</td>
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<td>15:35-15:45</td>
<td>Q&amp;A</td>
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<td>15:45-16:00</td>
<td>BREAK</td>
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<td>16:00-17:30</td>
<td><strong>RESEARCH SKILLS WORKSHOP</strong>&lt;br&gt;Methodologies for collecting and analysing quantitative data – Facilitated by Dr Martin Tuuli and Dr Aaron Anvuur (Loughborough University, UK)</td>
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<td>Developing an academic career: what should you do, and how should you do it? – Prof George Ofori, National University of Singapore, Singapore</td>
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**STREAM 1 (MAIN AUDITORIUM)**

- **Chair** Prof Kwabena Anaman, University of Ghana, Legon
- **09:45-09:55** Factors responsible for mortgage default in Nigeria: a comparative study of commercial banks and primary mortgage institutions - Moses Idowu Atilola, Wasiu Oyewale Shittu and Olaitan Ayodeji Olowoleru
- **09:55-10:05** Effects of global financial crises on financial performance of selected indigenous construction firms in Katsina State, Nigeria - Sani Yar'adua Ibrahim and Dikko Kado
- **10:05-10:15** Analysis of budgets for physical infrastructure for public secondary schools - D. O. Mac-Barango and I. Mbamali
- **10:15-10:25** Budgetary allocation to the housing sector and the price of some building materials - D. O. Mac-Barango and Abdullateef A. Shittu
- **10:25-10:35** Thematic analysis of challenges faced by small and medium construction companies in accessing credit in South Africa - Balogun O.A, Agumba J.N and Ansary N

**STREAM 2 (SEMINAR ROOM)**

- **Chair** Dr Emmanuel A. Essah, University of Reading, UK
- **09:45-09:55** Bridging the urban-rural gap: key to sustainable development in Akure - Oluwayomi Akinrinmade and Odunwole Sogbon
- **09:55-10:05** Highest and best use ideology for sustainable development of residential lands in metropolitan Lagos, Nigeria - Michael Adedayo Adebayo
- **10:05-10:15** Impact of residential property development patterns on sustainable environment in Akure, Nigeria - Bamidele M. Ogunleye
- **10:15-10:25** Role of professional builder in achieving sustainable built environment in Nigeria - D. Dahiru, A. D. AbdulAzeez, K. Bala
- **10:25-10:35** Perceived of Estate Surveyors and Valuers on users’ preference for green building in Lagos, Nigeria - Markson Opeyemi Komolafe and Matthew Oluwole Oyewole

**Q&A**

- **09:30-09:40**
- **10:15-10:25**
- **10:35-10:45**
- **10:45-10:55**
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<td>What are the elements of good research supervision? What are the critical points of the process and what strategies can be used for dealing with the critical points? This session will involve exchange of ideas and experiences on successful practices (Prof Koshy Varghese, Prof Kwabena Anaman, and Prof George Ofori will contribute to the interactions in this session)</td>
<td>How do you make a contribution to knowledge for the purpose of achieving a PhD? How do you develop from the PhD to becoming a recognised academic? This session on doctoral research and postdoctoral activities will be led by contributions from Dr Roine Leiringer, Dr Martin Tuuli and Dr Aaron Anvuur</td>
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<td>Chair Dr Kulomri J. Adogbo, Ahmadu Bello University, Nigeria</td>
<td>Chair Dr Clinton Aigbavboa, University of Johannesburg, South Africa</td>
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<td>Methods to assess the effectiveness of naturally ventilated classrooms in Gauteng, South Africa - E.A. Essah and W. Kwawu</td>
<td>Management of multi-tenanted properties in Abeokuta - Ibrahim T. Akogun</td>
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<td>15:15-15:25</td>
<td>Combating the impact of collapse of building structures in Lagos Island, Lagos State, Nigeria - Oladimeji Iyanda</td>
<td>Analysis of spatial inequality and urban poverty traps in Akure - Odunwole Sogbon</td>
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### Assessing the effects of unauthorized buildings in the Sekondi-Takoradi metropolis, Ghana - Matthew K. Somiah, Joe Frederick Cobbinah and P. Kwaw

Performance of private sector participation in solid waste collection: a polycentric planning perspective - Samson Akinola

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<td>Dr Martin M. Tuuli, Loughborough University, UK</td>
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<td>09:45-09:55</td>
<td>Forecasting the duration for small span bridge construction projects using the Artificial Neural Network (ANN) - Isaac Mensah, Theophilus Adjei-Kumi, Gabriel Nani, Anthony K. Danso</td>
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<td>09:55-10:05</td>
<td>Strategies to facilitate building information modelling adoption in the South African construction industry - George Kekana, Clinton Aigbavboa and Wellington Thwala</td>
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<td>Q&amp;A</td>
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<td>10:15-10:25</td>
<td>Project quality management practices in Effect of crushed ceramics waste partially replaced</td>
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<td>Construction professionals' perception on the prospect of adopting E.M.S ISO 14001 in Nigerian construction industry - Abdulkarim Mohammed Iliyasu and Muawiyya Abubakar</td>
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<td>Pareto analysis on the total quality management (TQM) status of Nigerian design firms - Dikko Kado and Kabir Bala</td>
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<td>Factors affecting the application of total quality management approach in building maintenance practices - A.D. AbdulAzeez, A. Abbas, D. Dahiru, M. Abubakar</td>
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<td>Motivational factors of employee-consultant in Nigerian construction industry - Abubakar Darda’u Abdulazeez, Emmanuel Chukwuemeka Osuji, Dauda Dahiru and Dalhatu Abdussalam</td>
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<td>Perspectives of construction business marketing strategies: exploring the inherent challenges of marketing strategies of SME contracting firms in Ghana - Owusu-Manu, D., Badu, E. and Darko, A.</td>
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**Topics Covered**

- Multinational and indigenous construction firms of Nigeria - Umar Saad Mohammed and Dahiru Dauda
- Use of crumb rubber as a partial replacement for fine aggregate in asphalt concrete mixes - Abdulfatai Adinoyi Murana, Lawal Sani and Sani Abdulrahman Tolani
- Evaluation of clay roof tiles produced with saw-dust, cassava starch and makuba - Aliyu Lawal Muhammad and M. I. Khalil
- Ecological self-compacting concrete using gum arabic as a plasticizer - P.W. Zakka, O.F. Job and N.A. Anigbogu
- Use of cocoa bean shells ash (CBSA) as a stabilizer in soil bricks production - John Kobina Fynn, Emmanuel Aseidu, Peter P. Valley, Patrick Zievie and Kennedy Appiadu-Boakye
- Effect of African Locust Bean Waste Water on Soil Bricks for Masonry walling - Patrick Zievie, Peter P. Valley, Emmanuel Aseidu and Kennedy Appiadu-Boakye
- Use of fine aggregate in hot mix asphalt - Abdulfatai Adinoyi Murana, Lawal Sani and Sani Abdulrahman Tolani
- Use of crumb rubber as a partial replacement for fine aggregate in asphalt concrete mixes - Abdulfatai Adinoyi Murana, Lawal Sani and Sani Abdulrahman Tolani
- Use of fine aggregate in hot mix asphalt - Abdulfatai Adinoyi Murana, Lawal Sani and Sani Abdulrahman Tolani
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<td>Dr Cynthia Adeokun, Colman Architects Ltd, UK</td>
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<td>Putting research into practice: exploring the inherent challenges of research uptake in the built environment faculties in Ghana - Owusu-Manu, D., Badu, E., Agyekum, K. and Akom, J.B.</td>
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<td>Management policies for accessible environment in senior high schools - Stephen Dwirah, Richmond Opoku, Loretta Asabea Obuobi, Tagritaa Pascal Saafaa, Francis Agyekum-Boateng, Eric Paul Tudzi</td>
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<td>Promoting education on inclusive design of the built environment at KNUST - Anthony Kwame Danso and Eric Paul Tudzi</td>
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<td>Virtual reality and the built environment curriculum - Muhammad Zia-ul-haq Muhammad and Mansir Dodo</td>
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SECTION 1: KEYNOTES
A RESEARCH AGENDA FOR THE BUILT ENVIRONMENT

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The built environment sector comprises the construction industry and the allied groupings of enterprises in the same value chain which plans for, finances, designs, constructs, owns, sells or rents, operates and manages, and eventually demolishes the physical components of the built environment. This sector plays a key role in the social and economic development of any country as it establishes the physical means for the process of development. The tasks the built environment sector will be required to tackle will continue to be complex. Appropriate materials, technologies, tools and methods, equipment, practices and procedures need to be continuously developed. Further research should be undertaken to provide the industry with the background knowledge, discoveries and the ways and means of successfully delivering on the tasks put to it.

How can researchers know what to research? The aim is to discuss a research agenda for the built environment. It is also the intention to explore new ways of working on research subjects in the built environment sector. In this regard, the main theme is: “going beyond current issues to make connections and make a difference”.

Some fundamental questions on the nature of the built environment are considered in order to establish the objects of research on the sector. First, what and why the sector produces are analysed. Second, the participants in the process, the methods adopted and the environment in which these activities take place are considered. This is followed by a discussion of how the sector’s performance is assessed. Third, the nature of the operating environment of the sector is explored. Finally, what the future holds, and what researchers must do are explored.

The research agendas of some countries are discussed, starting with the national strategic development agendas, then considering the national construction industry programmes these strategies give rise to, and then the research agendas for the built environment sector and parts of it. This is followed by consideration of an existing global research agenda for built environment sector.

What should research in the built environment sector aim to achieve? What should it seek to work on? Research agendas for segments of the built environment sector are suggested. These are followed by a discussion of the new approaches to research. Examples of “finding and making connections”; and “looking beyond” are outlined. The outline of the

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The proposed research agenda is considered. The agenda should set out the framework for research that should be forward looking and path breaking; it should tackle new topics with new approaches and methods. It should encourage work on topics that deal with real problems to find solutions that will make a difference and improve quality of life.

It is proposed that a national research road map be prepared. This should be context based, with a firm foundation, realistic but aspirational. It should be prepared by the national industry development agency, umbrella industry organizations and academic representatives. There should also be an action plan and monitoring arrangements. National awards and other forms of recognition would be suitable motivators. Finally, a poem sets out the main issues.

Keywords: built environment, research agenda
DEVELOPING A SUCCESSFUL ACADEMIC CAREER: WHAT SHOULD YOU DO, AND HOW SHOULD YOU DO IT?

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The university academic staff member is well qualified and is employed to teach and undertake research. The academic is a teacher and a scholar, and is recognized as being engaged in a profession. Thus, the academic is highly regarded in society. What are the reciprocal responsibilities of the academic? As an academic, what do you intend to achieve in your career? Should you be satisfied with your current level of output and achievement? How can you continue to improve your performance? What is your role? What can you expect from your institution; and what are you entitled to expect? Do you have a responsibility to contribute to the development of knowledge in your field? Do you think you have a responsibility to society?

The aim is to discuss the career development of an academic. Issues covered include motivations for, and benefits of, the continuous development of an academic. A fundamental consideration of the nature of an academic and an analysis of what the academic does is followed by discussion of how the performance of the academic is assessed. The following questions are discussed: Who is an academic? Is the academic a professional? Why is academic development important – to the individual; to the institution; and to society? How is the career development of an academic undertaken? Is it a deliberate process, or does it materialize on its own over time? What should the academic do? How can one measure one’s progress in one’s development as an academic? What help can one have, in one’s institution and elsewhere? Is there an end point (a limit) to the development of an academic?

As “institutions of higher learning”, universities must meet very high expectations and demands from society in terms of the graduates they produce, and the solutions they help to find to the prevailing and future pressing needs of the society. Moreover, the universities are operating in an increasingly more demanding and competitive environment. One of the factors for ranking universities is the perception of peers of the reputation of the particular university. This is invariably derived from the perceived quality of the academic staff members of the university. Further questions arise: does an academic have the responsibility to contribute to the enhancement of the reputation of the university? How can the academic’s aspirations be aligned with the institution’s policy goals? What should the institution do to guide and support the effort of the academic to improve the academic’s performance?

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Some advice is given to the individual, the department and the university. It is suggested that the individual academic should assume the responsibility for the continuous development of the academic's career. The elements of good practice in doing this are discussed. The help that is available for this particular aspect of the academic's life is highlighted. Examples of universities and individual cases are presented. Elements of the career development of one prominent academic are outlined. The implications of the professionalism of the academic are used to frame the discussion of the way forward. The questions considered include: should the service orientation be a watchword of the academic? What about altruism? Should there be a code of ethics that, among others, oblige the academic to continue to improve in performance, and make the maximum contribution to society?

Keywords: academic career, academic development, academic responsibility, successful academic
INFORMATION AND COMMUNICATION TECHNOLOGY IN CONSTRUCTION

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Information and Communication Technology (ICT) advances have disrupted the conventional ways of working in several industries at a global scale. From the 1970's, the impact of computing technologies have steadily been increasing in all activities of Architecture, Engineering and Construction (AEC) Industry. From the initial focus on numerical computing, the technology today has become essential for a wide range of activities such as communication, visualization, planning and field data collection. The construction industry has been slower than most other industries in the adopting, harnessing and deploying of ICT. This has been attributed to the structure of the industry as well as its conservative approach. There is a need to improve the understanding of technology adoption models in the construction industry in order to enable the projects to derive value out of investing in technologies.

This talk will address several aspects of ICT applicability and adoption by the AEC industry through two case studies. The first case study will discuss technology adoption process on a project where a large owner in collaboration with the nominated general contractor adopted building information modeling with the expectation of reducing project duration. The process of evolving the BIM execution strategy and the resulting implementation as well as the outcomes and lessons learned will be presented.

The second case-study will present the adoption of a wide range of digital technologies being utilized for metro rail construction. Some of the largest construction projects in the world today are metro rail projects. These include the Cross-Rail project in London, several projects in the Middle East and over fifty on-going metro rail projects in India and China. Successful metro rail planning and construction requires collaboration of a wide range of disciplines- from Archeologists to Urban Planners. In addition to sophisticated engineering technologies for under and over ground construction, the utilization of digital technologies to model and integrate the information needs of various disciplines has had a major impact on several of the metro rail projects. The talk will discuss the technologies, adoption mechanisms, success and challenges faced in developing an integrated digital technology platform for one of the largest projects in India.

Keywords: BIM, information technology, ICT applicability, computing technology, technology adoption, visualization

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SOME OBSERVATIONS ON ‘DOING’ AND ‘WRITING’ QUALITY RESEARCH

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This presentation is based on observations made acting as a reviewer and theme leader for five consecutive WABER conferences. The presentation will strive to go from the generic to the specific in dealing with a variety of issues that are important both in doing research and in writing for publication. Due to the nature of the exercise the treatment of the issues is by no means exhaustive. Indeed, each topic is worthy of a presentation/paper of its own. Furthermore, it is important to note that ‘research quality’ is a very subjective concept. Views vary depending on the philosophical underpinnings and research methods applied. However, commonly it is assessed on the basis of all aspects of study design; and is a judgment regarding the match between the methods and questions, selection of subjects, measurement of outcomes, and protection against bias. Thus, the objective here is not to draw strict conclusions regarding what is right and what is wrong as this is simply not possible; and even if it was it would not be desirable. Instead, focus is on highlighting the need to actively strive for research quality and how this then can be transferred into publications.

To start, the ever growing importance of publishing will be briefly discussed. The point will be made that, on the international arena, academic reputational credibility is increasingly dependent on journal rankings and citation indicators. For universities, in general, citations and journal rankings are now used as an index of institutional quality and as a means to establish prestige. The ‘value’ and ‘quality’ of a publication is measured against the perceived quality of the journal it is published in, the number of citations it gets, and a variety of time related indexes. It follows that, publications in high ranking outlets and citations accrued by academic units are significantly related to rankings of their academic quality. The main drivers for this – in my opinion rather sad scenario – including university rankings, promotions, competition for funding, national research assessment exercises etc. will be briefly touched upon. While it is clear that not all these drivers have a direct influence on academics in the African context, I will argue that they have an indirect impact as they influence the international journals in which African-based researchers strive to publish. Following on from this the argument is then progressed to look at how to find an appropriate journal to publish in, and how the type and quality of the research undertaken dictates this choice.

The presentation then takes a brief detour to outline the very different ways of doing and thinking about research, i.e. paradigms. This is necessary as the methods and techniques mobilised in research bring with them certain assumptions about how the world works, and about what knowledge you can produce to describe it. I will argue that understanding

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this is essential. While not something that has to be made explicit in writing, a good understanding of ontology, epistemology and methodology significantly increases the chances of producing rigorous research, and in turn, well-argued papers. Some terms that will be discussed are: Ontology – basic assumptions about the nature of reality. Any way of understanding the world, or some part of it, makes assumptions about what kinds of things do or can exist in that domain, and what might be their conditions of existence and relations of dependency (for example persons, institutions, relations, norms, practices, structures, roles, and so on). Such an inventory of kinds of being and their relations is an ‘ontology’. Epistemology – basic assumptions about what we can know about reality, and about the relationship between knowledge and reality. Put slightly differently, it deals with the problem of knowledge: what knowledge consists of, how we know what we think we know, and what grounds we have for thinking that it is possible to have knowledge of anything. Methodology - specifies how the researcher may go about practically studying whatever he / she believes can be known. Methodology is focused on the specific ways — the methods — that we can use to try to understand the world better. Paradigm - overarching perspective concerning appropriate research practice, based on ontological and epistemological assumptions.

Our ontological and epistemological leanings have fundamental implications on how we use theory and our choice of research method(s). In very simple terms, theory can be seen as a way of looking at a field that is intended to have explanatory and/or predictive implications. Generally speaking there are three different ways of viewing theory in the social sciences: (i) Theory as generalisations about, and classifications of, the social world. The scope of generalisation varies from theorising about a particular range of phenomena to more abstract and general theories about society as a whole; (ii) Theory as a set of statements that should be translated into empirical, measurable, or observable propositions, and systematically tested; (iii) Theory as explaining phenomena, identifying causal mechanisms and processes which, although they cannot be observed directly, can be seen in their effects. All three are perfectly acceptable and the view taken quite clearly relates to ontological and epistemological considerations. I will argue that it is these considerations that dictate which theories could be used together and which that cannot. This is known as theoretical proximity and theoretical compatibility. Crudely put, theories are based on a series of assumptions and claims of how things are connected and they cannot, therefore, be combined indiscriminately. Examples will be shown to illustrate this point. Of great importance here is the explication of the theoretical constructs. These are conceptual abstractions of phenomena that cannot be directly observed, such as ‘trust’ and ‘capability’. Achieving construct clarity is, therefore, a necessity for the successful collection and analysis of data. This is where many research endeavours fall short.

Similarly related to ontological and epistemological considerations is the choice and explication of the research methodology. The presentation will deal with two key issues in regards to methodology. The first is the misuse of the term and the tendency to use ‘methodology’ as a pretentious substitute for method. This misuse of the term obscures an important conceptual distinction between the tools of scientific investigation (properly ‘methods’) and the principles that determine how such tools are deployed and interpreted. The second issue, which is of greater substantial
importance, is that of methodological slurring. This is sometimes made explicit in the papers; e.g. when an author claims to be adopting an interpretivist approach, but goes on to use positivist methods (the misuse of the Yin case study method is a very common example of this). Other times it is not made explicit, but it is nonetheless clear that there is little congruence between the research question (i.e., the researcher's assumptions about the nature of reality and how one might know reality) and the methods used to address the question. Methodological slurring leads to poor research and resultant papers will not get accepted in any of the better journals. Note that this does not mean that it is wrong to combine quantitative and qualitative methods. On the contrary, such research can be very powerful if done properly.

From these broad observations, attention will then turn to more specific observations on paper writing and issues that keep appearing in most papers. The first of these has to do with the introduction and framing of the paper. In general this relates to the problematisation of the research and the literature review. This is a very important part of the paper that seemingly is not given the amount of attention it deserves. What is commonly missed is that the introduction needs to effectively introduce the paper. When writing an introduction the following sequence is useful: a short introductory statement of the contextual grounding (i.e. what does this paper deal with? - this could be a brief background statement etc.); what is the issue or problem within this context that the paper will address, and why is this interesting and worthy of research; what does the paper set out to do (i.e. what is the purpose of the paper and what might the reader gain from reading it); how is the paper structured (i.e. what specific issues, approaches, theories etc. are going to be introduced). Specific attention will be given to the question of how to explicate what is usually called ‘the knowledge gap’. It is my firm belief that this should not take the form of showing/arguing that no one has done this particular kind of research before. There could be very good reasons for why it has not been done...! Rather it is necessary to show how the research actually adds to the current knowledge base. So, instead of arguing that no one has applied this particular method/theory to this particular problem before, the author should present a justification for why it is useful to do so. This is a slightly different, but substantially stronger, argument.

The second observation has to do with the analysis and discussion. This is the most challenging part of the paper and requires critical thinking skills. Too often this section is reduced to presenting numerical data and the results of statistical tests, or a series of excerpts from interviews. Sometimes this is justified, but more often than not what is lacking is engagement with theory and the literature. This is the section in which ‘value’ should be added, and it should form the basis for new knowledge claims. Hence, rather than just presenting the data, authors should try and think about the following: Respond to the research question / problem you set out in the introduction; what have you found out; what arguments are you making – are they obvious; what is the logic behind the argument – how does the data get you there; relate both to the data and back to the literature positioning/theory. A good front-end makes the analysis and discussion much easier to write.

A third, more specific, observation concerns the use of factor analysis and Structural Equation Modelling (SEM). There is nothing wrong with using
these techniques, if done properly. However, far too often this is not the case. My main argument here is that this particular research method is not well suited for exploratory studies. Indeed, it was developed to test theory rather than develop it. Somehow over time the method has been adapted from its original purpose of testing the relationships between theoretical constructs/factors in specific settings to instead explore the relative importance of factors elicited from the literature in said settings. The latter approach has a number of inherent weaknesses. First is the process of ‘extracting’ factors from existing literature. This requires a rigorous and systematic literature review (the question is always going to be if you have missed any factors...). It also requires a solid understanding of the issues discussed above (e.g. theoretical compatibility and construct clarity). In short, the factors cannot be adopted indiscriminately regardless of whether they are commonly found in the literature or not! Much of the construction related ‘success factor’ literature is largely reductionist and unreflective – you do not want to add to this. Second, even sophisticated statistical manipulation does not counter a relatively simplistic data set (e.g. ranking of perceived importance by a select few respondents). Here much more care needs to be taken to sampling and the common tendency for authors to conflate perceptions and actions. Asking respondents what they think about specific issues is fine, but this is not the same thing as observing / measuring what they do. Too many papers make claims about actual practices when all that the authors have done is asked people’s opinions. For example, a ranking of the most important processes in house building in a certain country says nothing about how and when these processes play out.

The final observation relates to the country (or regional) context. This goes beyond the question of whether or not to add this information to the title. There are two key concerns here. The first is if the particular context is important or not. This varies depending on how the research is justified and the kind of knowledge claims that are made. Simply applying research developed elsewhere to the case of your own country does not extend our collective knowledge. There needs to be some basis on which to conclude that your country is a special case to which existing knowledge cannot be applied! Second, if the context is important it needs to be treated as such. This means giving it appropriate space in the first half of the paper (i.e. giving it due attention in the literature review) and also weaving it into the analysis and discussion.

Keywords: paper writing, research quality, theory
DESIGN AND ADOPTION OF INNOVATIVE PROCUREMENT SYSTEMS IN INFRASTRUCTURE DELIVERY

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Procurement systems needs to be designed around a set of objectives. An objective that is common to both the public and private sector is value for money. Whenever procurement outcomes fail to deliver value for money, or are perceived to have failed to do so, those responsible for the procurement are held to account.

Value for money may generally be regarded as the optimal use of resources to achieve intended outcomes. It needs to be assessed during the planning, implementation and close out phases with a focus on economy, efficiency and effectiveness, respectively. Objectives and expected outcomes framed during the planning phase frames the value for money proposition that needs to be implemented. During the close out of a project the projected outcomes are compared against the actual outcomes. This confirms the “effectiveness” of the project in delivering value for money. Any deficit between what was planned and what was achieved puts value for money for a project at risk.

It is well understood that optimism bias and strategic misrepresentation may compromise the projected project outcomes and be the root cause for failing to obtain value for money on projects. A key question is what proactive action can be taken during implementation (efficiency) to minimise any gaps between achieved and projected outcomes irrespective?

This paper examines the fundamental differences between the general goods, general services and delivery of infrastructure. It thereafter reviews the approaches to the soliciting of tenders and the awarding of contracts and the conditions of contract which are most likely to enable value for money to be delivered during implementation. It also examines the question of procurement strategy and tactics and issues of governance and project management, all of which can improve efficiencies during implementation and as such contribute to the achievement of the value for money proposition established during the planning phase of projects. It also describes the culture change that is necessary to deliver value for money during implementation.

Keywords: value for money, procurement, delivery management, infrastructure

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INTRODUCTION

Procurement is the process which creates, manages and fulfils contracts (ISO 10845-1:2010). A system is a set of interrelated or interacting elements (ISO 9000:2005). It is an established way of doing things that provides order and a platform for the methodical planning of a way of proceeding. Systems are underpinned by processes (sets of interrelating activities which transform inputs into outputs (ISO 9000:2005)), procedures (specified ways to carry out an activity or process (ISO 9000:2005)) and methods (documented, systematically-ordered collections of rules or approaches (ISO 10845-1:2010)).

A procurement system comprises (Watermeyer, 2011a):

- rules and guidelines governing procedures and methods;
- procurement documents which include terms and conditions, procedures and requirements;
- governance and quality arrangements to manage and control procurement; and
- organisational policies which deal with issues such as:
  - the usage and application of particular procurement procedures;
  - requirements for recording, reporting and management of risk;
  - procedures for dealing with specific procurement issues;
  - the usage of procurement to promote social and developmental objectives; and
  - the assignment of responsibilities for the performance of activities associated with the various processes.

Different components of a procurement system are designed around specific objectives. Graellis (2011) identifies 9 such goals, namely competition, integrity, transparency, efficiency of the procurement systems, customer satisfaction, best value for money, wealth distribution, risk avoidance and uniformity of rules. Some of these objectives are closely related, some are instrumental to one another, while some are in open conflict and not all of them are desirable. Furthermore, some of these objectives relate only to public procurement system.

An objective that is common to both the public and private sector is value for money. Taxpayers, shareholders, financiers and project sponsors all have a desire to see value for money being realised in the procurement of infrastructure. Whenever procurement outcomes fail, or are perceived to have failed, to achieve, those responsible for the procurement are held to account.

This paper examines the components of procurement system for the delivery of infrastructure (fixed assets which are acquired, constructed or which results from construction operations) that is better able to deliver value for money whilst minimising the scope for corruption.

VALUE FOR MONEY IN THE CONTEXT OF INFRASTRUCTURE DELIVERY

The concept of value for money needs to be understood in the context of infrastructure delivery. Value for money may generally be regarded as the optimal use of resources to achieve intended outcomes. The UK National Audit office currently define it as “the optimum combination of whole-life cost and quality (or fitness for purpose) to meet the user’s requirement.” Underlying value
for money is an explicit commitment to ensure that the best results possible are obtained from the money spent or maximum benefit is derived from the resources available. It is a means for developing a better understanding (and better articulation) of costs and results so that more informed, evidence-based choices can be made. Value for money needs to be assessed during the delivery cycle using the so-called three “Es” – economy, efficiency and effectiveness at the end of the planning, implementation and close out stages of a project, respectively (see Figure 1). An overarching fourth “E” also needs to be considered when delivering infrastructure, namely equity (Watermeyer, 2013).

Figure 1: Results chain framework (after Watermeyer, 2013)

Infrastructure delivery needs to be managed and controlled in a logical, methodical and auditable manner. The starting point in the development of any delivery management system is to identify the information which needs to be developed and accepted by the client or implementer at a particular point in the delivery process to enable a project to be advanced i.e. at a control point (or gate). The stages in the delivery of construction works can then be defined as the activities that need to take place between such points. These stages enable the work flow (sequence of connected activities) toward the attainment of an end of stage deliverable to be developed and culminate in gates (control points) which can be used to provide assurance that the proposed works remains within agreed mandates, aligns with the purpose for which it was conceived, and can progress successfully from one stage to the next (Watermeyer, 2012a). The results chain framework illustrated in Figure 2 needs to be linked to the stages of infrastructure delivery. Figure 3 links the three basic “Es” associated with value for money to the typical stages of the life cycle for the delivery of infrastructure.
The critical starting point in delivering value for money through projects is to screen and select projects during the project initiation stage which are aligned with strategic needs or business opportunities (see stage 0 in Figure 3). Objectives and expected outcomes for given inputs as well as parameters such as the time lines, cost and levels of uncertainty at the end of the planning phase (stage 4). This frames the value for money proposition that needs to be
implemented at the point in time that a decision is taken to proceed with the implementation of a project. It establishes “economy” and identifies opportunities for “equity” when design concepts or solutions have been sufficiently developed to establish the feasibility of the works or to select a particular conceptual approach to pursue. It is also the point where the scope of a project is frozen. Should the works not prove to be viable as conceptualised (e.g. insufficient budget, unacceptable risk profile, geotechnical / environmental / community constraints, poor return on investment etc.), the project is either consciously modified in order to satisfy “economy” considerations before proceeding with implementation or is terminated as indicated in Figure 2.

During the close out of a project (stage 9) the projected outcomes are compared against the actual outcomes. This confirms the “effectiveness” of the project in delivering value for money. This typically involves the comparing of the scope, schedule and cost plan and, where relevant, the performance as documented at the start and the end of the implementation phases, respectively. Value for money will occur when what is achieved equals or exceeds what was expected. Any deficit between what was planned and what was achieved puts value for money for a project at risk. An assumption can, however, be made that if the implementer exercises due care and reasonableness during implementation, value for money will be achieved. Put differently, if due care and reasonableness is exercised during implementation and what is achieved is nevertheless less than what was expected, the difference lies not in the efficiency of implementation but in the inherent project risks materialising or shortcomings in framing the value for money proposition at the start of the project. It is a well-researched fact that risk is inherent in all projects and not all risks can be accurately forecasted or controlled during project planning and implementation (Loosemore et al, 2006).

**REASONS FOR INFRASTRUCTURE PROJECTS FAILING TO DELIVER VALUE FOR MONEY**

The value for money proposition at the time that a decision is taken to proceed with the implementation of an infrastructure project is based on sets of assumptions and the available data. It is therefore important to understand the context within which the value for money proposition is established, particularly that relating to cost.

The degree of project definition as measured by the percentage of design completed at the end of stage 4 can be estimated from the fee apportionments for stages contained in the guideline fees such as those published by the South African councils for the architectural and engineering professions and The Royal Architectural Institute of Canada (Watermeyer, 2014). It is somewhere between about 12 and 40%, depending upon the nature of the works that are being designed and the level of effort and detail put into the end of stage 4 deliverables as some of the work which is normally included in the stage 5 deliverables may be included in the stage 4 deliverables. As an illustrative example, the US Department of Energy uses the classification of estimates indicated in Table 1 to enable the quality of the cost estimate to be appropriately considered through the evolution of a project. Class 3, 2 and 1 estimates typically occur towards the end of Stages 4, 5 and 6, respectively. As a result, the decision to proceed with a project may be based on a class 3 estimate with a -20 to + 30% accuracy where the degree of project definition is between 10 and 40%.
Table 1: Generic Cost Estimate Classifications and Primary Characteristics (US Department of Energy, 2011)

<table>
<thead>
<tr>
<th>Estimate Class</th>
<th>Degree of project definition (expressed as % of complete definition)</th>
<th>Typical purpose of estimate</th>
<th>Methodology</th>
<th>Expected accuracy range (typical variation in low and high ranges)*</th>
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<tbody>
<tr>
<td>Class 5</td>
<td>0% to 2%</td>
<td>Concept screening</td>
<td>Capacity factored parametric models, judgment or analogy</td>
<td>-20 to -50% +30 to +100%</td>
</tr>
<tr>
<td>Class 4</td>
<td>1% to 15%</td>
<td>Study or Feasibility</td>
<td>Equipment factored or parametric models</td>
<td>-15 to -30% +20 to +50%</td>
</tr>
<tr>
<td>Class 3</td>
<td>10% to 40%</td>
<td>Budget, Authorization, or Control</td>
<td>Semi-detailed unit costs with assembly level line items</td>
<td>-10 to -20% +10 to +30%</td>
</tr>
<tr>
<td>Class 2</td>
<td>30% to 70%</td>
<td>Control or Bid/Tender</td>
<td>Detailed unit costs with forced detailed take-off</td>
<td>-5 to -15% +5 to +20%</td>
</tr>
<tr>
<td>Class 1</td>
<td>70% to 100%</td>
<td>Check Estimate or Bid/Tender</td>
<td>Detailed unit cost with detailed take-off</td>
<td>-3 to -10% +3 to +15%</td>
</tr>
</tbody>
</table>

* The state of process technology and the availability of applicable reference cost data affect the range markedly. The ± value represents the typical percentage variation of actual costs from the cost estimate after application of contingency (typically at a 50% level of confidence) for given scope.

The value for money proposition upon which the “economy” of a project is based during the planning phase, which ends with a decision being made to proceed with a project at the end of stage 4, may need to be viewed with some caution as it may be tainted by (Flyvbjerg et al, 2003):

- optimism bias - the human mind’s cognitive bias in presenting the future in a positive light; and
- strategic misrepresentation – behaviour that deliberately underestimates costs and overestimates benefits for strategic advantage usually in response to incentives during the budget process.

Implementation sits between the bookends of “economy” and “effectiveness” in the results chain framework shown in Figure 1 i.e. between Stages 4 and 9. It needs to be executed “efficiently” in order to minimise time delays, scope creep and unproductive costs and to mitigate the effects of uncertainty on objectives (risks) so as to maintain the value for money proposition formulated at the outset of the project.

Optimism bias and strategic misrepresentation are in the main confined to the planning (economy) stages of a project which ends with a decision being made to proceed with a project and relate to the quality of the information upon which a decision is made. The key question that begs asking is what proactive action can be taken during implementation (efficiency) to minimise any gaps between achieved and projected outcomes irrespective of whether or not optimism bias and strategic misrepresentation is present at the time that a decision was taken to implement a project?

**DIFFERENCES IN THE PROCUREMENT OF GENERAL GOODS AND SERVICES AND THE DELIVERY OF INFRASTRUCTURE**
The starting point in the design of a procurement system for infrastructure delivery which is better able to deliver value for money is to recognise that there are differences between procurement processes for general goods and services and that for the delivery of infrastructure (Watermeyer et al, 2013). Procurement that is unrelated to the delivery of infrastructure typically relates to goods and services that are standard, well-defined and readily scoped and specified. Once purchased, goods invariably need to be taken into storage prior to being issued to employees. Services most often involve routine, repetitive services with well understood interim and final deliverables which do not require strategic inputs or require decisions to be made regarding the fitness for purpose of the service outputs.

In contrast, procurement relating to the construction, supply, renovation, rehabilitation or alteration of infrastructure (delivery of infrastructure) covers a wide and diverse range of goods and services, which are required to provide or alter the condition of fixed assets on a site. Accordingly, the procurement process for the delivery of infrastructure involves the initial and subsequent recurring updating of planning processes at a portfolio level flowing out of an assessment of public sector service delivery requirements or business needs. Thereafter it involves planning at a project level and the procurement and management of a network of suppliers, including subcontractors to produce a product on a site (see Figure 3). There is no need to store and issue materials or equipment unless these are issued to employees responsible for the maintenance or operation of infrastructure, or are issued free of charge to contractors for incorporation into the works.

Figure 3: Differences between the procurement of general goods, general services and delivery of infrastructure (after Watermeyer et al, 2013)

There are also differences in the approach to the procurement. General goods and services typically deal with direct acquisitions which involve standard, well
defined and scoped services, off-the-shelf items and readily available commodities. The business need is commonly achieved through the production of a specification, which then forms a requisition for the procurement of goods or services. An immediate choice can generally be made in terms of the cost of goods or services satisfying specified requirements. Limited management inputs are required in administering the contracts.

Infrastructure delivery differs in that there cannot be the direct acquisition of infrastructure. Each project has a supply chain which needs to be managed and programmed to ensure that the project is completed within budget, to the required quality and in the time available. Many risks relate to the "unforeseen" which may occur during the performance of the contract. This could for example include unusual weather conditions, changes in owner or end user requirements, ground conditions being different to what was expected, market failure to provide materials, sector wide strikes, community unrest or accidental damage to existing infrastructure. Unlike general goods and services, there can be significant changes in the contract price from the time that a contract is awarded to the time that a contract is completed. Key persons responsible for managing a contract, particularly in complex works, have a major impact on the outcome of these changes. The procurement of plant and equipment within infrastructure projects is also different as requirements are frequently established in terms of desired performance. As a result, a range of goods and services (or combinations thereof), with different characteristics, reliability, availability of spares, costs, time for delivery, etc., may satisfy such requirements.

RULES AND GUIDELINES GOVERNING PROCEDURES AND METHODS

It is common practice to regulate public procurement through some form of legislation. This can take place through the embedding of procurement rules in legislation or the establishment of high level requirements in legislation and requiring procurement to be executed in terms of a national or international standards (Watermeyer, 2004 and 2011b). Such systems are commonly designed around competition and transparency objectives. The promotion of competition is seen as a way to guarantee that goods and services are procured under the best market conditions. Competition as such is seen as an instrument for ensuring value for money. Guaranteeing free and open competition has become a general legal principle and a main objective in pursuing public interest (Graellis, 2011). Transparency which can be regarded as the timely, easily understood access to information, is seen to guarantee fair, equitable and non-discriminatory procedures. It is seen to protect the integrity of the process and the interest of the organization, stakeholders and the public.

The United Nations Commission on International Trade Law’s (UNCITRAL) Model Law on Public Procurement (2011) contains procedures and principles aimed at achieving value for money and avoiding abuses in the procurement process. The text promotes objectivity, fairness, participation and competition and integrity towards these goals. Transparency is also a key principle, allowing visible compliance with the procedures and principles to be confirmed. These model laws envisage that regulations are required to enable the laws to be implemented and that detailed operating procedures be developed to facilitate implementation.
<table>
<thead>
<tr>
<th>Procedure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negotiation procedure</td>
<td>A tender offer is solicited from a single tenderer.</td>
</tr>
<tr>
<td>Competitive selection procedure</td>
<td>Any procurement procedure in which the contract is normally awarded to the contractor who submits the lowest financial offer or obtains the highest number of tender evaluation points.</td>
</tr>
<tr>
<td>Nomination procedure</td>
<td>Tenderers that satisfy prescribed criteria are entered into an electronic database and are invited to submit tender offers based on search criteria and, if relevant, their position on the database, whereupon they are repositioned on the database.</td>
</tr>
<tr>
<td>Open procedure</td>
<td>Tenderers may submit tender offers in response to an advertisement to do so.</td>
</tr>
<tr>
<td>Quotation procedure</td>
<td>A call for expressions of interest is advertised and thereafter only those tenderers who have expressed interest, satisfy objective criteria and who are selected to submit tender offers, are invited to do so.</td>
</tr>
<tr>
<td>Quotation procedure using the two-stage system</td>
<td>Tenderers submit technical and financial proposals in two envelopes. The financial proposal is only opened should the technical proposal be found to satisfy requirements.</td>
</tr>
<tr>
<td>Proposal procedure using the two-envelope system</td>
<td>Tenderers submit technical and financial proposals in two envelopes. The financial proposal is only opened should the technical proposal be found to satisfy requirements.</td>
</tr>
<tr>
<td>Proposal procedure using the two-stage system</td>
<td>Non-financial proposals are called for. Tender offers are then invited from those tenderers that submit acceptable proposals based on revised procurement documents. Alternatively, a contract is negotiated with the tenderer scoring the highest number of evaluation points.</td>
</tr>
<tr>
<td>Shopping procedure</td>
<td>Written or verbal offers are solicited from three sources. The goods are purchased from the source providing the lowest financial offer once it is confirmed in writing.</td>
</tr>
<tr>
<td>Competitive negotiation procedure</td>
<td>A procurement procedure which reduces the number of tenderers competing for the contract through a series of negotiations until the remaining tenderers are invited to submit final offers.</td>
</tr>
<tr>
<td>Restricted competitive negotiations</td>
<td>A call for expressions of interest is advertised and thereafter only those tenderers who have expressed interest, satisfy objective criteria and who are selected to submit tender offers, are invited to do so. The employer evaluates the offers and determines who may enter into competitive negotiations.</td>
</tr>
<tr>
<td>Open competitive negotiations</td>
<td>Tenderers may submit tender offers in response to an advertisement by the employer to do so. The employer evaluates the offers and determines who may enter into competitive negotiations.</td>
</tr>
<tr>
<td>Electronic auction procedure</td>
<td>Tender submissions are initially evaluated using stated methods and criteria. All tenderers who submit responsive tenders are invited simultaneously by electronic means to submit new evaluation parameters and have their evaluation scored, without having their identity made known to other tenderers. Tenderers may amend their offers up until such time as the auction is closed.</td>
</tr>
</tbody>
</table>

The ISO 10845 family of standards are designed around both primary and secondary procurement objectives, namely that the procurement system is fair, equitable, transparent, competitive and cost effective and that it may incorporate measures to promote objectives associated with a secondary procurement policy subject to qualified tenderers not being excluded and deliverables or evaluation criteria being measurable, quantifiable and monitored for compliance. These systems are substantively the same as those contained in section 217 of the Constitution of the Republic of South Africa, 1996.

The adoption of ISO 10845 family of standards offers a solid foundation for a procurement system as it provides a framework for best practice and obviates the need for the developing of detailed operating procedures. This family of standards establishes:
processes, procedures and methods as well as rules for the application of a wide range of methods and procedures (see Tables 2 and 3) that are used in soliciting tenders and awarding contracts;

Table 3: Standard tender evaluation methods (after ISO 10845)

<table>
<thead>
<tr>
<th>Method</th>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method 1: Financial offer</td>
<td>Tender offers are ranked from the most favourable to the least favourable comparative offer. The highest ranked tenderer is recommended for the award of the contract.</td>
</tr>
<tr>
<td>Method 2: Financial offer and quality</td>
<td>Quality criteria are scored in the evaluation of tender offers. All offers failing to score the minimum number of points for quality are eliminated. Financial offers are scored and combined with points for quality in terms of a disclosed weighting. The tenderer with the highest number of tender evaluation points is recommended for the award of the contract.</td>
</tr>
<tr>
<td>Method 3: Financial offer and preferences</td>
<td>Tenderers who claim a preference and satisfy the preferencing criteria are assigned a preference score. Financial offers are scored and combined with points for preference in terms of a disclosed weighting. The tenderer with the highest number of tender evaluation points is recommended for the award of the contract.</td>
</tr>
<tr>
<td>Method 4: Financial offer, quality and preferences</td>
<td>Quality, preferences and financial offers are scored as for methods 2 and 3. All three of these scores are combined in terms of a disclosed weighting. The tenderer with the highest number of tender evaluation points is recommended for the award of the contract.</td>
</tr>
</tbody>
</table>

The ISO 10845 family of standards establishes a way of doing things that provides order and a platform for the methodical planning of a way of proceeding. These standards collectively provide a platform to achieve fair competition, reduce the possibilities for abuse and improve predictability in procurement outcomes and in so doing facilitate the attainment of value for money during the solicitation processes including that relating to “equity”. This family of standards does not, however, provide standard forms of contract (a contract between two parties with standard terms that do not allow for negotiation) as such documents can be drafted around significantly different objectives and principles e.g. master
– servant relationship or collaboration between two experts, risk sharing or risk transfer, independent or integrated design, short term relationships based on one sided gain or long-term relationships focused on maximising efficiency and shared value, etc.

Table 4: Procurement documents (after ISO 10845)

<table>
<thead>
<tr>
<th>Component</th>
<th>Division</th>
<th>Function and broad outline of contents</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Expression of interest</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E1: Submission procedures</td>
<td>E1.1: Notice and invitation to submit an expression of interest</td>
<td>Alerts respondents to submit their credentials in order to be admitted to an electronic database or to be invited to submit tenders should they satisfy the stated criteria.</td>
</tr>
<tr>
<td></td>
<td>E1.2: Submission data</td>
<td>Establishes the rules from the time a call for an expression of interest is advertised to the time that any submission is evaluated.</td>
</tr>
<tr>
<td>E2: Returnable documents</td>
<td>E2.1: List of returnable documents</td>
<td>Ensures that everything the employer requires a respondent to include in his submission is included in, or returned with, such a submission.</td>
</tr>
<tr>
<td></td>
<td>E2.2: Submission schedules</td>
<td>Contains documents that the respondent is required to complete for the purpose of evaluating submissions.</td>
</tr>
<tr>
<td>E3: Indicative scope of work</td>
<td>E3: Indicative scope of work</td>
<td>Indicates to respondents what the contract is likely to entail so that they can make an informed decision as to whether or not they wish to respond and, if so, to structure their submission around the likely demands of the project.</td>
</tr>
<tr>
<td><strong>Tender document</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1: Tendering procedures</td>
<td>T1.1Tender notice and invitation to tender</td>
<td>Alerts tenderers to the nature of the goods, services and engineering and construction works required by the employer and should contain sufficient information to enable them to respond appropriately.</td>
</tr>
<tr>
<td></td>
<td>T1.2 Tender data</td>
<td>Establishes the rules from the time that tenders are invited to the time that a tender is awarded.</td>
</tr>
<tr>
<td>T2: Returnable documents</td>
<td>T2.1 List of returnable documents</td>
<td>Ensures that everything the employer requires a tenderer to submit with his tender is included in, or returned with, his tender submission.</td>
</tr>
<tr>
<td></td>
<td>T2.2 Returnable schedules</td>
<td>Contains documents that the tenderer is required to complete for the purpose of evaluating tenders and other schedules which upon acceptance become part of the subsequent contract.</td>
</tr>
<tr>
<td><strong>Contract documentation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1: Agreements and contract data</td>
<td>C1.1 Form of offer and acceptance</td>
<td>Formalizes the legal process of offer and acceptance</td>
</tr>
<tr>
<td></td>
<td>C1.2 Contract data</td>
<td>Identifies the applicable conditions of contract and associated contract-specific data that collectively describe the risks, liabilities and obligations of the contracting parties and the procedures for the administration of the contract.</td>
</tr>
<tr>
<td>C2: Pricing data</td>
<td>C2.1 Pricing assumptions</td>
<td>Provides the criteria and assumptions which it is assumed (in the contract) that the tenderer has taken into account when developing his prices, or target in the case of target and cost reimbursable contracts.</td>
</tr>
<tr>
<td></td>
<td>C2.2 Pricing schedules / Activity schedule / Bill of quantities</td>
<td>Records the contractor’s prices for providing goods, services or engineering and construction works which are described in the scope of work section of the contract.</td>
</tr>
<tr>
<td>C3: Scope of Work</td>
<td>Scope of work</td>
<td>Specifies and describes the goods, services, or engineering and construction works which shall be provided and any other requirements and constraints relating to the manner in which the contract work shall be performed</td>
</tr>
<tr>
<td>C4: Site information#</td>
<td>Site information</td>
<td>Describes the site as at the time of tender to enable the tenderer to price his tender and to decide upon his method of working and programming and risks.</td>
</tr>
</tbody>
</table>
There are, however, two international families of standard contracts, namely those published by the International Federation of Consulting Engineers (FIDIC) and the Institution of Civil Engineers (NEC3). These standard forms of contract cover a range of contract types, contracting strategies (design by employer, design and construct, develop and construct and management contracts) and pricing strategies (see Table 6).

### Table 5: Targeting strategies

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluation points</td>
<td>Give a weighting to social and economic (development) policy objectives along with the usual commercial criteria, such as quality, which are scored at the short listing stage or the admission to a data base</td>
</tr>
<tr>
<td></td>
<td>Give a weighting to social and economic policy objectives along with price and where relevant, quality, during the evaluation of tenders</td>
</tr>
<tr>
<td>Incentives for KPI's</td>
<td>Make incentive payments to contractors should they achieve a specified target (key performance indicator) associated with a social or economic goal in the performance of a contract</td>
</tr>
<tr>
<td>Mandatory subcontracting</td>
<td>Require contractors to invite competitive tenders from targeted enterprises for specified portions of the works in terms of a specified procedure and specific forms of subcontract. Upon the award of the contract, the subcontractor becomes a domestic subcontractor</td>
</tr>
<tr>
<td>Contractual obligations</td>
<td>Make policy objectives a contractual condition, e.g.</td>
</tr>
<tr>
<td></td>
<td>• A fixed percentage of the work is required to be subcontracted out to enterprises that have prescribed characteristics, or a joint venture shall be entered into</td>
</tr>
<tr>
<td></td>
<td>• Parts of the works are to be executed using employment intensive methods.</td>
</tr>
</tbody>
</table>

The FIDIC and NEC3 forms of contract cover engineering and construction works and professional services. The NEC3 forms of contract, however, also cover supply, term service and framework contracts. The FIDIC forms of contract are based on the traditional approach to drafting and administering contracts, assessing variations to the contract and effecting payment to contractors in terms of standard price-based pricing strategies (lump sum or bill of quantities). The NEC3 forms of contract on the other hand, facilitate the implementation of sound project and risk management principles and practices in a flexible manner. They also offer a wide range of price-based (activity schedule, price list and bill of quantities) and cost-based pricing strategies (time based contract, cost reimbursable contract, target contract and management contract) and options to manage risk. They are drafted on a relational contracting basis, based on the belief that collaboration and teamwork across the whole supply chain optimises the likely project outcomes and are therefore based on “discussion at the time” rather than “argument later.” They contain clear procedures with defined time limits for actions to be taken, and provide for effective control of change, speedy agreement of time, quality and cost impacts of change, improved forecasting of end costs and end dates. They assess compensation events (events for which the employer is at risk) which entitle the contractor to more money on the basis of cost, as defined in terms of the contract, uplifted by any percentages for overheads and profit or fees agreed at the time when the contract is concluded for work already done, or a forecast for the work not yet done (Watermeyer, 2012b). The wide range of options, which can be tailored for particular circumstance, enable the selection of pricing structures that align payments to results and permit a more balanced sharing of performance risk. They are also well aligned to the Society of Construction and Law’s Delay and Disruption Protocol.
(Watermeyer, 2014). The NEC3 family of contracts has according great potential to realise value for money during the execution of a contract.

**PROCUREMENT STRATEGY AND TACTICS**

Strategy in infrastructure delivery may be considered as the skilful planning and management of the delivery process. It involves a carefully devised plan of action which needs to be implemented. It is all about taking appropriate decisions in relation to available options and prevailing circumstances in order to achieve optimal outcomes. Procurement strategy (see Figure 4) reflects the choices made in determining what is to be delivered through a particular contract, the procurement and contracting arrangements and how secondary (or developmental) procurement objectives are to be promoted during the implementation phase of an infrastructure project (Watermeyer, 2012b).

**Table 6: Price-based and cost-based pricing strategies for engineering and construction contracts (Watermeyer, 2012b)**

<table>
<thead>
<tr>
<th>Pricing strategy</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Price based</strong></td>
<td></td>
</tr>
<tr>
<td>Lump sum</td>
<td>Contract in which a contractor is paid a lump sum to perform the works. (Interim payments which reflect the progress made towards the completion of the works may be made)</td>
</tr>
<tr>
<td>Bill of quantities</td>
<td>Contract in which a bill of quantities lists the items of work and the estimated/measured quantities and rates associated with each item to allow contractors to be paid, at regular intervals, an amount equal to the agreed rate for the work multiplied by the quantity of work actually completed</td>
</tr>
<tr>
<td>Price list / price schedule</td>
<td>Contract in which a contractor is paid the price for each lump sum item in the Price List / Schedule that has been completed and, where a quantity is stated in the Price List / Schedule, an amount calculated by multiplying the quantity which the contractor has completed by the rate</td>
</tr>
<tr>
<td>Activity schedule</td>
<td>Contract in which the contractor breaks the scope of work down into activities which are linked to a programme, method statements and resources and prices each activity as a lump sum, which he is paid on completion of the activity. The total of the activity prices is the lump sum price for the contract work.</td>
</tr>
<tr>
<td><strong>Cost based</strong></td>
<td></td>
</tr>
<tr>
<td>Cost reimbursable</td>
<td>Contract in which the contractor is paid for his actual expenditure plus a percentage or fee</td>
</tr>
<tr>
<td>Target cost</td>
<td>Cost reimbursable contract in which a target price is estimated and on completion of the works the difference between the target price and the actual cost is apportioned between the employer and contractor on an agreed basis</td>
</tr>
<tr>
<td>Management contract</td>
<td>Contract in which the contractor is paid the amounts paid to subcontractors plus a percentage fee</td>
</tr>
</tbody>
</table>

As indicated in Table 1, the decision to proceed with an infrastructure project is typically taken when between 10 and 40% of the design is complete. It is therefore important to adopt procurement strategies in the implementation of project which enable projects to be delivered on time and within budget. It is also important to integrate design with construction through strategies such as early contractor involvement, design and construct or develop and construct and to manage contracts proactively so that wastage is minimised and the risks associated with budget and schedule overruns are managed.

Procurement tactics are required to implement procurement strategies. Such tactics relate to the setting up of the procurement documents to solicit tender offers and to enter into contracts i.e. the formulation of submission data, tender
data, contract data, the pricing and the scope of work associated with a contract or order issued in terms of a framework contract (see Table 4). Choices are informed by a number of considerations such as the selection of a contractor who is most likely to deliver best value through the performance of the contract, life cycle costs, the availability of spares, operation and maintenance requirements, the nature of the desired relationship with the contractor, the manner in which delays and disruptions are to be managed, the allocation of risk to the party that is best able to bear it, risk mitigation measures etc. Procurement strategy and tactics have the potential to contribute to “efficiency” during implementation and to reduce the gap between achieved and projected outcomes. On the other hand, the inability to manage risk, interference and scope creep will result in what is planned not being achieved.

Figure 4: Components of a procurement strategy (Watermeyer, 2012b)

The range of options provided in the ISO 10845 family of standards and the NEC3 family of contracts provides a solid platform for the development of procurement strategies for the delivery of a portfolio of projects or a single contract. They also provide a wide range of tactics which can be incorporate in procurement documents associated with a particular procurement.

A strategic and tactical approach to procurement can be used not only to manage risk but also to incentivise performance. Such an approach can also be linked to collaborative working through framework agreements (Watermeyer, 2012).

A strategic approach to procurement above the project level to balance competing objectives and priorities rather than viewing each project in isolation, should be undertaken during stage 2 (strategic resourcing) shown in Figure 2. If left to the contract level, the opportunity for trade-offs will be lost and are likely to have a lesser impact on project outcomes.

PROJECT MANAGEMENT AND GOVERNANCE

Management can be defined (BS13500) as “the act of bringing people together to accomplish goals and objectives using available resources in an efficient, effective and risk aware manner” and governance as “the system by which the whole organisation is directed, controlled and held accountable to achieve its core purpose over the long term.” Management is about “getting the job done” whereas governance is about “ensuring that the right purpose is pursued in the right
way”. Governance is the framework by which an organization is directed, controlled and held accountable to achieve its core purpose over the long term. Project governance which includes those areas of organizational governance that are specifically related to project activities, provides a comprehensive, consistent method of controlling the project and ensuring its success.

ISO 21500 (2012) describes project management as “the application of methods, tools, techniques and competencies to a project which can be applied to a project as a whole or to an individual phase or to both.” This standard identifies process groups (initiating, planning, implementation, controlling and closing) and subject groups (integration, stakeholder, scope, resource, time, cost, risk, quality, procurement and communication).

The indicative impact of a number of key factors over the life cycle of a project is illustrated in Figure 5. The implementation of infrastructure projects need to be carefully managed. There is also a need to put in place controls within the procurement and delivery management process to provide all those involved in all levels of management with access to information to perform their work and those involved in the governance system to take decisions regarding their readiness to bear the risk (effect of uncertainty on objectives) after risk treatment in order to achieve objectives.

![Figure 5: Indicative impact of key variables on the delivery of infrastructure over time](image)

Those engaged in infrastructure delivery needs to determine and manage numerous interrelated and interacting processes. To do so effectively, it is necessary that processes be identified and appropriately defined and documented to ensure the effective planning, operation and control of such processes. Furthermore, responsibilities for activities need to be assigned, procedures need to be implemented, and measures need to be put in place to ensure effective control so that the required results are obtained. As such a control framework needs to be developed to link processes and activities to a series of control points around which decisions can be based on the documented outputs of a process.

The starting point is to determine and document the work flow for processes associated with infrastructure procurement and delivery management as well as their sequence and interaction. Thereafter, procedures associated with the
performance of activities need to be documented and responsibilities assigned to persons with competence (demonstrated ability to apply knowledge and skills) to perform such activities. Controls (check points within a process or a gate) also need to be put in place to ensure both the operation and control of these processes to ensure the effectiveness of these processes based on the conceptual thinking presented in Figure 6. Resources and information need to be made available to support the operation and monitoring of these processes. Finally records which provide evidence of conformity to requirements need to be identified, stored, protected and retained in a readily retrievable manner.

The stages and gates indicated in Figure 2 provide a control framework for delivery management which facilitates not only the management of quality but also provides the basis for auditing. This control framework provides the basis for ensuring that projects progress in such a manner that they remain within agreed mandates, align with the purpose for which they were conceived and can progress successfully from one gate to another (Watermeyer et al, 2013).

ISO 10845 describes six generic processes and the activities associated with each process. It does not, however, provide a control framework for the implementation of this standard. Figure 6 outlines a control framework for procurement which is aligned with the provisions of ISO 10845.

Figure 5: Concepts relating to conformity based on ISO 9000, Quality management systems – fundamentals and vocabulary

NOTE Audits are used to determine the extent to which requirements are fulfilled
The University of the Witwatersrand, Johannesburg, embarked upon a major capital expansion programme on its various campuses during 2007. Those responsible for implementing the programme adopted procurement procedures and methods which formed the basis for the ISO 10845 standards and made use of the NEC3 family of contracts. They pursued a strategic approach to procurement and developed control frameworks along the lines of that described in this paper, based on the philosophy of collaboration, shared risk and integrated project teams. They adopted a range of packaging strategies including framework agreements with early contractor involvement, used contracting strategies including design by employer, design and construct and develop and construct and engaged in procurement procedures ranging from open tenders to restricted competitive negotiations. They also embarked upon the development of control frameworks along the lines of that described in this paper.

Figure 6: Control framework for a procurement system based on ISO 10845

Laryea and Watermeyer (2014) fully describes the outcomes of the delivery of the portfolio of projects over a period of 6 years (2008-2013) comprising more than 40 projects with a budget of around R1,5 billion Rand (approximately 150m USD). The average difference the final amount paid to contracts at the completion of the project and the price when the contractor was instructed to execute the contract has been less than 6% including scope creep. Most projects were delivered on time and within budget. This is not the norm in South Africa or for that matter in developing countries. For example, Hawkins and McKittrick (2012) in their
report on the pilot countries in Construction Sector Transparency Initiative (CoST) programme found that in the 145 projects sampled in eight countries, 31% exhibited poor management of time and cost with at least 55% being over budget and 8% being more than 100% over budget.

The design of the procurement system and the approach to managing projects at the University of the Witwatersrand facilitated the culture change outlined in Table 7 which played a major role in the successful project outcomes.

Table 7: Culture change required to improve project outcomes (Watermeyer, 2012a)

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master-servant relationship of adversity (“them and us”)</td>
<td>Collaboration towards shared goals (integrated project team approach)</td>
</tr>
<tr>
<td>Fragmentation of design and construct</td>
<td>Integration of design and construct</td>
</tr>
<tr>
<td>Constructability and cost model determined by the design team and quantity surveyor / cost consultant only</td>
<td>Constructability and cost model developed with contractor’s insights</td>
</tr>
<tr>
<td>Short-term “hit-and-run” relationships focused on one-sided gain</td>
<td>Long-term relationships focused on maximising efficiency and shared value</td>
</tr>
<tr>
<td>Risks are allowed to take their course</td>
<td>Active risk management and mitigation</td>
</tr>
<tr>
<td>Develop the project in response to a stakeholder wish list</td>
<td>Deliver the optimal project within the budget available</td>
</tr>
<tr>
<td>“Pay as you go” delivery culture</td>
<td>Discipline of continuous budget control</td>
</tr>
<tr>
<td>Pay for what is designed</td>
<td>Deliver infrastructure within an agreed budget</td>
</tr>
<tr>
<td>Rigid, bespoke, ill defined and disjointed procurement system</td>
<td>Flexible, predictable, integrated, documented and auditable procurement system</td>
</tr>
<tr>
<td>Poorly structured procurement documents based on bespoke or local standards and forms of contract with reliance placed on local knowledge</td>
<td>Structured procurement documents based on international / national standards and forms of contract with minimal customisation / amendments and clear and unambiguous requirements</td>
</tr>
<tr>
<td>Meetings focused on past - what has been done, who is responsible, claims. etc.</td>
<td>Meetings focused on “How can we finish project within time and budget available?”</td>
</tr>
<tr>
<td>Project management focussed on contract administration</td>
<td>Decisions converge on the achievement of the client’s objectives</td>
</tr>
<tr>
<td>Standard delivery stages prescribe the contracting arrangements and are unrelated to a portfolio of projects</td>
<td>Delivery is managed and controlled through stages which permit the full range of contracting arrangements and commence at a portfolio level</td>
</tr>
<tr>
<td>Ill defined end of stage deliverables and acceptance procedures</td>
<td>Well defined end of stage deliverables and acceptance procedures which enable informed decisions to be made</td>
</tr>
<tr>
<td>Design and construction developed in isolation from operation and asset management considerations</td>
<td>Design and construction aligned with operation and asset management requirements</td>
</tr>
<tr>
<td>Procurement strategy focussed on selection of form of contract as all other choices are predetermined</td>
<td>Selected packaging, contracting, pricing and targeting strategy and procurement procedure aligned with project objectives</td>
</tr>
<tr>
<td>One project one contract</td>
<td>Works packaged appropriately to achieve objectives and efficiencies</td>
</tr>
<tr>
<td>Project delivery take place within predetermined parameters without any conscious thought to objectives</td>
<td>Projects deliver on documented primary and secondary (developmental) objectives in a measureable and quantifiable manner</td>
</tr>
</tbody>
</table>
CONCLUSIONS

Much can be done to minimise the gap between achieved and projected outcomes during the implementation of an infrastructure project in order to realise value for money. The starting point is to recognise that there are significant differences between the procurement system for general goods and services and that for infrastructure.

A procurement system that is most likely to deliver value for money during implementation is one which is based on:

- the adoption of procurement standards such as the ISO 10845 family of standards for soliciting tenders and awarding contracts, which are based on fair, equitable, transparent, competitive and cost effective system objective, permit the promotion of socio-economic objectives and provide a wide range of methods and procedures; and

- standard forms of contract such as the NEC3 family of contract which facilitate collaborative working, offer an open book approach to the cost of change and the application of pricing structures that align payments to results, provide cost based and price based pricing strategies and are sufficiently flexible to provide a balanced sharing of performance risk on a project by project basis.

The adoptions of a standard such as ISO 10845 and forms of contract such as the NEC3 may not necessarily enable value for money to be achieved. Procurement systems should be linked to a strategic approach to procurement. Procurement strategy should be developed preferably at a portfolio level. Procurement tactics need to be implemented at a contract level. Good governance and project management linked to suitable control frameworks for infrastructure delivery and procurement can also make a significant contribution to the effectiveness of project implementation.

The design and adoption of an innovative procurement system needs to be underpinned by a culture change in order to deliver optimal outcomes.

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SECTION 2: VOLUME 1 CONFERENCE PAPERS
A COMPARISON OF LIGHTWEIGHT AND HEAVYWEIGHT CONSTRUCTION INCORPORATING PHASE CHANGE MATERIALS FOR OFFICE BUILDINGS IN A COMPOSITE HOT CLIMATE

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²,3School of Architecture Planning and Landscape, Newcastle University, United Kingdom

A comparison of lightweight and heavyweight construction types incorporating Phase Change Materials (PCM) in office building fabric is conducted. The aim is to compare between the energy conservation and cooling capabilities of the two construction types in office buildings in the composite hot humid/hot dry climate found in a large part of Nigeria. PCMs are incorporated into the building fabric of a hypothetic building in a composite hot humid/hot dry climate in order to conserve electricity. A building energy calculation software called EnergyPlus is used to model and simulate the performance of the lightweight and heavyweight partitioned buildings. The predicted electricity consumption and thermal comfort performance between the two construction types are compared by keeping all variables in the models constant except the construction type. Previous analyses of PCM incorporated in the building fabric of heavyweight type of construction made of sandcrete block partitions indicate that the combination of large heat capacity of the heavyweight building to store heat during the day and high night time temperatures cause thermal discomfort in the building. In this study, a lightweight construction made of Gypsum board for partitions is considered. The context of power outage in developing countries is also considered in the analyses through the use of a novel cooling strategy termed Cyclic cooling. Cyclic cooling is the cooling of the interiors long enough to maintain comfort for a maximum duration within the working hours. Results predicted by EnergyPlus show an almost 2-fold improvement in electricity consumption in the lightweight partitioned building when compared to the heavyweight partitioned building. This is due to the added thermal mass in heavyweight construction that traps unwanted heat within the building.

Keywords: electricity conservation, EnergyPlus, hot climate, phase change material, thermal comfort

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INTRODUCTION

The World Bank estimates that the per capita electricity consumption in Nigeria is 120.5kWh. This is a 23-fold difference compared global average of 2803 kWh in 2009. Although the installed capacity of the existing power stations in Nigeria is 5906MW, the maximum load ever recorded is 4,000MW. For a country of approximately 170 million people as of 2013(World Bank, 2015), this indeed is grossly inadequate to meet electricity demand. Figures released by the Federal Ministry of Power in Nigeria (Punch Newspaper, 2015) showed that the country’s peak generation as of October 15, 2014 was 3,513.5MW, against a peak demand of 12,800MW. The country is currently generating about 2,500MW. A study on energy efficiency in Nigerian buildings (Uyigue 2009) has shown that 99% of the respondents who participated have unplanned periods of power outage every day. Therefore, conserving energy is required to reduce the dependence on the failing central supply and also reducing rising energy costs.

Table 1 Properties of a good PCM

<table>
<thead>
<tr>
<th>Thermo-physical properties</th>
<th>Suitable phase-transition temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High latent heat of transition</td>
</tr>
<tr>
<td></td>
<td>High conductivity</td>
</tr>
<tr>
<td></td>
<td>High density</td>
</tr>
<tr>
<td></td>
<td>Small volume change</td>
</tr>
<tr>
<td></td>
<td>Low vapour pressure</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chemical properties</th>
<th>No super-cooling: Self nucleation means they crystallize with little or no super-cooling and usually non-corrosiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Favourable phase equilibrium: Congruent melting means melt and freeze repeatedly without phase segregation and consequent degradation of their latent heat of fusion</td>
</tr>
<tr>
<td></td>
<td>Sufficient crystallization rate</td>
</tr>
<tr>
<td></td>
<td>Long-term chemical stability</td>
</tr>
<tr>
<td></td>
<td>Compatibility with materials of construction</td>
</tr>
<tr>
<td></td>
<td>No toxicity</td>
</tr>
<tr>
<td></td>
<td>No fire hazard</td>
</tr>
</tbody>
</table>

CMs are used as energy conservation mechanisms in buildings. The use of PCM as an energy conservation mechanism affects the cooling load directly therefore targeting this end-use will provide substantial energy savings. PCMs as described by Kuznik et al. (2008) are materials having the capacity to store latent heat energy, as well as sensible energy. As the temperature increases, the material changes phase from a solid to a liquid. As this physical reaction is endothermic, the PCM absorbs heat. Similarly, when the temperature decreases, the material changes phase from a liquid to a solid. As this reaction is exothermic, the PCM releases heat. In ideal situations, PCMs should have the thermos-physical and chemical properties shown in Table 1 (Batagarawa A., 2013) depending on the
climatic or operational context. The thermo-physical properties affecting the performance of PCM include heat capacity, conductivity and density, which are all affected by the thickness of the PCM building component.

The thermo-physical properties of a PCM is studied within the context of office buildings in Abuja-Nigeria in a previous study (Batagarawa A., 2013). Abuja falls within the composite hot dry/ hot humid climate found in a large part of Nigeria. The properties studied include transition temperature, thickness and conductivity based on the assumption that the chemical properties are within acceptable margins. Results predicted that transition temperature of 24°C, thickness of 10mm and conductivity of 1.5w/m²/k conserves most electricity while keeping the occupants in comfort leading to a saving of 13,904kWh of overall electricity per annum. The results further indicate that although the electricity consumption of the building with no PCM on lightweight partitions uses less electricity, the thermal comfort achieved is improved by 10%. This suggests that the added thermal mass in heavyweight construction traps unwanted heat within the building which night temperatures are too high to dissipate, therefore lightweight construction may be better suited with PCM technology in this climatic context.

In other studies of PCM, a reduction of about 3°C has been recorded with the use of PCM in peak conditions in the continental climate of Weimar, Germany (Voelker, 2008) and energy conservation of about 15% in Mediterranean climate of Spain (Castell et al., 2010). A study (Lim and Jae-Han, 2013) investigated the energy saving potentials in lightweight buildings by analyzing the thermal load characteristics. Results show that the annual cooling load decreased by 1.05%, the peak cooling load decreased by 1.30% and the highest indoor temperature dropped by 0.50 °C. When the night ventilation was applied to the building HVAC system for better passive cooling performance, the annual cooling load decreased by 9.28%.

All three studies are in lightweight buildings however, the cooling operating strategies under operation are natural ventilation and adequate mechanical cooling. Also, the lightweight buildings studied are located in climates other than composite hot humid/ hot dry climate leaving a gap in literature covering innovative cooling strategies for PCM incorporated buildings in composite hot climates using lightweight construction.

Another study (Woods and Richardson, 2008) has quantified the surface temperature and energy storage of construction wallboard and concrete with and without PCM. PCM reduces the maximum surface temperature, increases the diurnal energy storage and decreases the penetration depth for all values of the mass parameters. As well as improving performance, the PCM significantly reduces the thickness of mass required therefore, the thermal mass potential of typical wallboard used in conjunction with PCM rivals that of a heavyweight concrete construction.

The aim of this study is to compare between the energy conservation and cooling capabilities of lightweight and heavyweight construction
incorporating Phase Change Materials (PCM) for Office buildings in the composite hot humid/hot dry climate found in a large part of Nigeria.

METHODOLOGY

The study utilised a quasi-experimental approach for a parametric analysis using computer simulations. The parametric analysis is expressed in terms of dependent and independent variables in form of an experiment. The independent variables examined are lightweight and heavyweight construction. The two dependent variable adopted to evaluate thermal comfort are; dry-bulb air temperature in Degree Celsius; and electricity conservation in kilo Watt hours (kWh).

A hypothetical base-case building is modelled and analysed by the software DesignBuilder and EnergyPlus respectively (DesignBuilder, 2011; EnergyPlus, 2011). DesignBuilder is used as a graphical user interface for the text based simulation engine of EnergyPlus. EnergyPlus is a whole building energy simulation program used to model energy flows in buildings. It is used as a predictive tool; to simulate the energy and thermal performance of a building with a change in a design variable. In EnergyPlus, the modelled building is imported as an .idf file generated by DesignBuilder.

A validation exercise of the user’s ability and the capability of the software was conducted by comparing predicted results of a simulation conducted by the author and those from a published experiment (Batagarawa A., 2013). The variables and performance of a laboratory tested model by Kuznik et. al. (2009) having PCM in the building fabric are used to create a validation model and the results compared. The comparison gives an acceptable agreement of results with a root mean square error of 10.4%.

The base-case

The base-case is a hypothetical building generated with variables extracted from primary and secondary sources. Sources of variables making the base-case are shown in Table 2. The primary source is data collected from energy audits in 15 office buildings in Nigeria (Batagarawa, 2011).

The sampling of the selected buildings is purposive based on the building type, cooling method, occupancy and climate. The building type adopted is office buildings utilizing mix-mode cooling and single use occupancy in a climate experienced by a large portion of Nigeria. Other criteria that affected the sampling include availability of records and access. The secondary sources are through Nigerian building code (Nigeria Building Code, 2006) and a literature search of a bio-climatic approach to building design in hot climates.

Firstly, the data collected from the field include external and partition walls, glazing, floors, roof and schedules as shown in Table 2, Section 1. Secondly, within the National Building Code the specifications that affect the scope of this study used in designing the base-case are shown in Table
2, Section 2. Finally, the Bio-climatic variables in Table 2, Section 3 are optimized for energy conservation in a previous paper by Batagarawa (2012). They are geometry, orientation, glazing, shading, airtightness and insulation.

Table 2 Base-case variables (U-values calculated based on CIBSE methodology)

<table>
<thead>
<tr>
<th>Fieldwork data</th>
<th>Nigerian building code</th>
<th>Bio-climatic design options from literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate: Abuja- composite hot and humid/ hot and dry</td>
<td>Lighting</td>
<td>Geometry: Rectangular and square planned</td>
</tr>
<tr>
<td>Occupancy: 162 employees- 10.3 m2/occupant, Floors: 4</td>
<td>Rooms with external glazing must exceed 64 lux for natural daylighting. Lighting level for office buildings specify about 500 lux [22 and [23].</td>
<td>Orientation: North-south, east-west</td>
</tr>
<tr>
<td>Wall to window ratio: 25%</td>
<td>Ventilation</td>
<td>Glazing: Single glazing with analysis between; clear; bronze tinted; reflective and bronze tinted; and double glazing.</td>
</tr>
<tr>
<td>Building use: Office</td>
<td>Naturally ventilated rooms require more than 4% o floor area external access. Mechanical ventilation supply: 10 L/s/person.</td>
<td>Shading: No shading, venetian internal shading and external window hoods</td>
</tr>
<tr>
<td>Internal heat gains (Appliances, people): 18W/m²</td>
<td>Room dimensions</td>
<td>Airtightness: Poor and good</td>
</tr>
<tr>
<td>Lighting intensity: 4W/m²</td>
<td>Ceiling height must exceed 2.4m unless; it's a sloping roof and dropped ceiling in which case it may as low as 1.5m and 2.2m respectively.</td>
<td>Insulation: North-south, east-west, all sides</td>
</tr>
<tr>
<td>Building volume: 6174 m³</td>
<td>A habitable room must have any one dimension exceeding 3m and 10.8 m²; Distance from property line to building should be 6m or above.</td>
<td></td>
</tr>
<tr>
<td>External wall: 225* 225* 450mm external sandcrete walling units, U-value 1.4 W/m²K.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Partition wall: 150* 225* 450mm internal sandcrete walling units, U-value 1.4 W/m²K.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roofing: Aluminum clad gable roofs with dropped ceilings made of chip wood. U-value is 0.38 W/m²K.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ground floor: concrete slabs, U-value 4.4 W/m²K. 6.7 W/m²K for other floors.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schedules: 9 hours from 8am-5pm, some 4hrs on Saturday, once a month.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The location used for the simulations is Abuja, the capital city of Nigeria. The climate experienced in Abuja falls within a composite hot and humid/ hot and dry climate classification that is experienced in a (Ogunsote, 1991). The city experiences three weather conditions annually. A warm, humid wet season beginning from April and ends in October; and a dry season from November to March. In between the two, there is a brief interlude of Harmattan; a harsh, dusty wind blowing from the desert. Daytime temperatures reach as high as 30°C and night time lows can dip to 12°C. The mean daylight-hours is 12hrs, mean annual precipitation is 1221mm and mean annual temperature range is 24-28°C based on a Neutrality temperature of 26°C. Neutrality temperature using the formula by de Dear and Brager (1998) in Equation 1.

\[ T_n = 17.8 + 0.38(T_{zep}) \]

**Equation 1**

Error! Reference source not found. shows the base-case configuration and the results predicted are based on simulation of a test case, being the 2nd floor of the 4 storey base-case. In an attempt to isolate the effect of other building envelope variables such as the roof solar gain and ground
floor heat flux, the 2nd floor was chosen to test the electricity consumption per square area as recommended by Wang et al. (1999). Thermal energy storage requires large surface areas (Ortiz et al., 2010) and therefore walls - which provide the largest surface area compared to ceilings and floors - are used as the test building components in the study.

**PCM configuration in light-weight and heavy-weight construction**

To model construction type for simulation in EnergyPlus, each type of envelope system is assigned one or more layers of materials based on the actual construction, and each surface is assigned its respective construction, outside boundary condition, and relative geometry (Shrestha et al., 2011). The PCM heavyweight wall modelled is shown in Figure 1 and Table 3. It consists of a 10mm PCM Layer, an internal render of 25mm, a sandcrete block layer of 225mm and an external render of 25mm. On the other hand, the lightweight partitions are made of two gypsum board layers with an air layer in the middle as shown in Figure 2 and Table 4.
Table 3 Heavyweight construction for PCM partitions

<table>
<thead>
<tr>
<th>Layer</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>A PCM Layer</td>
<td>10mm</td>
</tr>
<tr>
<td>B Internal render</td>
<td>25mm</td>
</tr>
<tr>
<td>C Sandcrete block layer</td>
<td>225mm</td>
</tr>
<tr>
<td>D External render</td>
<td>25mm</td>
</tr>
</tbody>
</table>

On the other hand, the lightweight partitions are made of two gypsum board layers with an air layer in the middle as shown in Figure 5 and Table 6.

Figure 2 Lightweight construction for PCM partitions

Table 4 Lightweight construction for PCM partitions

<table>
<thead>
<tr>
<th>Building material</th>
<th>Thickness [m]</th>
<th>Conductivity [W/m K]</th>
<th>Density [kg/m³]</th>
<th>Specific Heat [J/kg-K]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gypsum board</td>
<td>0.025</td>
<td>0.25</td>
<td>900</td>
<td>1000</td>
</tr>
<tr>
<td>Air</td>
<td>0.01</td>
<td>0.3</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>PCM</td>
<td>0.01</td>
<td>0.5</td>
<td>800</td>
<td>2000</td>
</tr>
</tbody>
</table>

The heavyweight wall to total surface area is 2:5 in the case of total heavyweight building while the lightweight partition to total surface area ratio is 1:4 in the case with the combination heavyweight external walls and lightweight partitions. This is further discussed under the Analysis.
section. The case with PCM in its fabric is modelled with PCM of transition temperature 24°C, thickness of 10mm and conductivity of 1.5W/m K, employing an algorithm.

**Climatic variables for modelling and simulation**

EnergyPlus requires climatic data to run valid simulations based in a given location. These climatic data are added as separate weather file input before running the simulations. The weather file used in this research has been synthesized by Meteonorm (2012) for Abuja, Nigeria, in hourly times steps over a year. The option of cooling in EnergyPlus chosen is ‘Ideal load air system’ which is set to turn on when the temperature goes above 24°C.

**Other design variables for modelling and simulation**

Conduction Finite Difference that has been proven to satisfactorily simulate PCM behaviour (Clarke, 2001; Tetlow and Riffat, 2011). Density and latent heat of fusion of the hypothetical PCM are held constant based on assumptions formed from literature at 800kg/m³ and 120 kJ /kg respectively. The effective heat capacity $C_{eff}$ is calculated by the from Darkwa and O’Callaghan (Darkwa and O’Callaghan, 2006):

$$C_{eff} = C_s + a e^{-\frac{(T-T_m)}{b}}$$

Where $C_s$ is specific heat capacity, $a$ is the total amount of latent heat, $T$ is the coefficient of solar radiation, $T_m$ is transition temperature and $b$ is the width of phase change zone. This formulation is used in the absence of a real PCM material tested for actual effective heat capacity, $C_{eff}$. Other assumptions employed for the modelling and simulation of PCMs are:

- Density for PCM in both solid and liquid states is the same.
- When cooled from the fully molten state, the PCM does not follow the melt curve during solidification. However, it does appear to follow the melt curve when cooling from a partially melted state. There is no provision in EnergyPlus 6.0 to specify two enthalpy curves; one for transitional and one for freezing. Therefore, the PCM transitional data was used to calculate the enthalpy of the PCM-mixed cellulose.
- EnergyPlus assumes one-directional heat conduction which may overlook the effect of thermal bridging in the whole building analysis.
ANALYSIS
To compare the performance of PCM in lightweight and heavyweight construction, nine results are simulated for the duration of a year in an annual simulation. In addition, analyses on the hottest and coldest days in March and August respectively with PCM in lightweight partitions and the heavyweight shell are predicted.

Annual simulation
Hourly dry-bulb air temperatures over a year for the space ‘second floor north’ in the hypothetical base-case building are predicted under natural ventilation, full mechanical and cyclic cooling strategies for both heavyweight and lightweight constructions as shown in Table 5. The process of cyclic cooling is mechanical cooling of 5 hours from 8am-2pm. The nine simulations cover a combination of the four cases used as the basis of comparison:

1. The case of heavyweight building having external and partition walls (Figure 1)
2. The case with the combination heavyweight external walls (Figure 1) and lightweight partitions (Figure 2)
3. The case of heavyweight building without PCM
4. The case with the combination heavyweight external walls and lightweight partitions without PCM

Design-day Simulations
These simulations are conducted to analysis the two hottest and coldest days both heavyweight and lightweight PCM constructions that are is cyclically cooled during the day.

RESULTS AND DISCUSSION
To compare the performance of PCM in lightweight and heavyweight construction, two categories of analysis are conducted; an annual simulation; and design-day simulation.

Annual simulation
The aim of this simulation is to compare between the annual performance of a space that is constructed with either lightweight or heavyweight type of construction, and in addition, the effect of PCM on each. The indicators used are electricity consumption and annual hours of discomfort. Hourly dry-bulb air temperature over a year for the space ‘second floor north’ in
the hypothetical base-case building are predicted under a combination of construction types and cooling strategies as shown in Table 5. There are four simulations presented; the first two cover the case with no PCM while the last two cover the case with PCM. Within each case, a comparison is made between heavyweight and lightweight construction types.

Simulation 1 predicts an electricity consumption of 162,009 kWh and annual discomfort hours of 48,2% of annual working hours. Simulation 2 predicts an electricity consumption of 78,826 kWh and annual discomfort hours of 600,26% of annual working hours. Simulation 3 predicts an electricity consumption of 179,096 kWh and annual discomfort hours of 384,16% of annual working hours. Simulation 4 predicts an electricity consumption of 86,612 kWh and annual discomfort hours of 549,23% of annual working hours.

The highest electricity consumption corresponds to Simulation 3, the heavyweight partitioned building with PCM. The lowest electricity consumption on the other hand, corresponds with Simulation 2, the lightweight partitioned building also with no PCM. The predictions suggest lightweight partitioning outperforms heavyweight, with an almost 2-fold improvement in energy conservation. This is due to the larger capacity of the heavyweight building to store heat during the day. Night time temperatures are too high to effectively cool down the building, causing an increase in the cooling required to keep the building occupants warm in the mornings.

| Table 5 Results of comparison between lightweight and heavyweight PCM construction |
|--------------------------------------|------------------|------------------|------------------|------------------|
|                                      | Heavyweight | Lightweight | Heavyweight | Lightweight |
| Simulations                          | 1           | 2             | 3             | 4             |
| Yearly hours of discomfort (2340)    | 48          | 600           | 384           | 549           |
| Discomfort per annum %               | 2%          | 26%           | 16%           | 23%           |
| Electricity consumption per annum (kWh) | 162,009   | 78,826       | 179,096       | 86,612       |
| Difference in consumption from base-case | 30,991    | 114,174      | 13,904        | 106,388      |
| Difference in consumption from base-case % | 16%       | 59%           | 7%            | 55%           |
Further analysis on the incorporation of PCM in all walls or only in internal partitions are shown in Table 6. The simulation of the case with PCM only in partition walls predicts an electricity consumption of 83,396kWh and annual discomfort hours of 370, 16% of annual working hours. There is an additional 10% hours of thermal comfort when PCM is only added to the partitions. However electricity consumption is also higher by 4,570kWh. This is because the added thermal mass in heavyweight construction traps unwanted heat within the building and lightweight partitions lose and gain heat faster.

**Design-day Simulations**

The aim is to explore in more detail, the effect of PCM depending on climatic conditions. The hottest and coldest days, based on weather data are used. The two days are referred to as design days and correspond to 21st of March and 4th of August, respectively. The results of the analysis on the 2 hottest and coldest days with the base case that has PCM in lightweight partitions or the heavyweight shell is shown in Figure 3.

**Table 6 Comparing performance between PCM incorporated in all walls and partitions**

<table>
<thead>
<tr>
<th></th>
<th>PCM on all walls</th>
<th>PCM only on partitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yearly hours of discomfort (2340)</td>
<td>600</td>
<td>370</td>
</tr>
<tr>
<td>Discomfort per annum%</td>
<td>26%</td>
<td>16%</td>
</tr>
<tr>
<td>Electricity consumption per annum (kWh)</td>
<td>78,826</td>
<td>83,396</td>
</tr>
</tbody>
</table>

Figure 3 Difference in thermal performance between heavy-weight and light-weight construction type for design days
Table 7 Comparing the thermal performance between heavyweight and lightweight construction type for design days

<table>
<thead>
<tr>
<th>Hours</th>
<th>Air-temperature in Heavyweight</th>
<th>Air-temperature in Lightweight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>August</td>
<td>March</td>
</tr>
<tr>
<td>1</td>
<td>24.9</td>
<td>31.1</td>
</tr>
<tr>
<td>2</td>
<td>24.8</td>
<td>31</td>
</tr>
<tr>
<td>3</td>
<td>24.8</td>
<td>30.8</td>
</tr>
<tr>
<td>4</td>
<td>24.7</td>
<td>30.6</td>
</tr>
<tr>
<td>5</td>
<td>24.7</td>
<td>30.5</td>
</tr>
<tr>
<td>6</td>
<td>24.7</td>
<td>30.4</td>
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<tr>
<td>7</td>
<td>24.7</td>
<td>30.2</td>
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<tr>
<td>8</td>
<td>24.7</td>
<td>30.2</td>
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<tr>
<td>9</td>
<td>23.4</td>
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<td>10</td>
<td>23.4</td>
<td>25.5</td>
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<td>23.4</td>
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<tr>
<td>12</td>
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<td>24.5</td>
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<td>14</td>
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<td>18</td>
<td>24.8</td>
<td>30.8</td>
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<tr>
<td>19</td>
<td>24.7</td>
<td>30.8</td>
</tr>
<tr>
<td>20</td>
<td>24.7</td>
<td>30.7</td>
</tr>
<tr>
<td>21</td>
<td>24.7</td>
<td>30.7</td>
</tr>
<tr>
<td>22</td>
<td>24.6</td>
<td>30.6</td>
</tr>
<tr>
<td>23</td>
<td>24.6</td>
<td>30.6</td>
</tr>
<tr>
<td>24</td>
<td>24.6</td>
<td>30.5</td>
</tr>
</tbody>
</table>
In heavyweight construction type, the maximum air temperature predicted in March is 31.1°C while in August is 24.9°C. In lightweight construction type, the maximum air temperature predicted in March is 29.1°C while in August is 26.7°C. The maximum temperatures predicted for heavyweight construction are higher than in lightweight. In heavyweight construction type, the minimum air temperature predicted in March is 25.3°C while in August is 23.4°C. In lightweight construction type, the minimum air temperature predicted in March is 24.7°C while in August is 23.7°C. The minimum temperatures predicted for lightweight construction are also lower than that of heavyweight. For a heat dominated climate, these results indicate the advantage of using PCM for cooling spaces.

**CONCLUSIONS**

This study compares the energy conservation and thermal performance of lightweight and heavyweight construction incorporating Phase Change Materials (PCM) for Office buildings in composite climates. Abuja, the capital city of Nigeria is chosen as the location modelled for a hypothetical base case using DesignBuilder as a graphics user interface and EnergyPlus as a simulation engine to run the parametric analyses. To compare the performance of PCM in lightweight and heavyweight construction, two categories of analysis are conducted; an annual simulation; and design-day simulation.

In the annual simulation analysis, the highest electricity consumption occurs in the heavyweight construction type while the lowest electricity consumption occurs in the lightweight construction type. The predictions suggest lightweight partitioning outperforms heavyweight, with an almost 2-fold improvement in energy conservation. This is due to the larger capacity of the heavyweight building to store heat during the day and night time temperatures are too high to effectively cool down the building, causing an increase in the cooling required to keep the building occupants warm in the mornings. However, the results also predicts that the presence of PCM caused an increase in electricity consumption and discomfort.

To further study the use of PCM in lightweight internal partitions ONLY as opposed to all walls, a simulation is conducted. The results predict that spaces could become cooler, dragging temperatures from outside to within the comfort range by an average of 3°C and up to 6°C in March. There is an increase of temperature of 1°C to 1.6°C in the month of August but nonetheless, the temperatures remain within the comfort range. The results indicate that PCM technology may be better suited when incorporated within lightweight construction of internal partitions and not
external walls in this climate. In design day analysis, the maximum temperatures predicted for heavyweight construction are higher than in lightweight. The minimum temperatures predicted for lightweight construction are also lower than that of heavyweight. For a heat dominated climate, these results indicate the advantage of using PCM for cooling spaces.

LIMITATIONS AND RECOMMENDATIONS

It should be noted that these results are applicable only for the test-case presented in this research. The internal partitioning and spatial planning of the base case are determined by a combination of variables, further limiting the generalizability of results. Future research is required to evaluate the generalizability of these results to similar buildings and in other climates.

REFERENCES


AN ASSESSMENT OF THE CONFORMITY OF HOUSING STANDARDS IN THE RISING URBAN DEVELOPMENT IN KADUNA STATE

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2Department of Architecture, Kaduna State University, Nigeria
3Department of Urban Development and Control Unit, Federal Capital Territory, Abuja-Nigeria

The growing rate of urbanization in Nigeria is drawing global attention. New settlements are fast emerging in many cities. A quick look from a distance calls for concern raising questions needing answers on policies relating to urban development process; do they exist in our nation? How much of it is being conformed to? This study seeks to find out the environmental conditions of the new settlements in conjunction with town planning standards vis-a-viz its effects on the community. The study assessed the conformity of housing standards at plot level and the level of provision of community facilities. The study collected data through structured questionnaire and interviews with the stakeholders of these settlements. Two sets of questionnaires (totalling 225 copies) were distributed to sort for information from developers, government agencies and occupants of Gonin gora Sabon Tasha, Mararaban Rido, Graceland and Kabama. The data collected were analyzed using SPSS tools such as averages, ratios and percentages. The results show that at plot level some of the settlements are not planed, standards are forsaking and setback are not observed, The communities involved suffer untold hardship due to lack of community facilities. The reason for this as revealed by the study is because the sale of land is control by individuals or families instead of government. The buyers now build to their financial capability, which in most cases do not adhere to standards criteria thereby making the areas mere modern slums. The study recommended that to achieve sustainable development, government should buy off land from individuals, plan and provide infrastructure, amenities and needed facilities in a layout (if they cannot build for the citizens), before selling plots of land to individuals to develop.

Keywords: community, facilities, housing standard, settlements

INTRODUCTION

There are glaring evidences that the growing rate of urbanization in Nigeria is not without concomitant problems of planning, adequate
provision of basic amenities and infrastructures. There are more new settlements emerging in many cities in Nigeria in the past decade than probably were since independent in 1960. For instance, in Kaduna State the results of 2000 and 2003 crises led to the polarization of the metropolis. Christians from the northern part are now migrating to the south. The recent insurgency by Boko haram in the northern states has further worsened the situation because many people are now moving to the perceived safety zones and these zones are experiencing population pressure every day and due to this according to Zaki et al (2013) accommodation is now provided mostly in form of inadequate houses lacking in major amenities necessary for comfortable living.

The aim of urban settlement according to Agbola (2005) is “providing a more satisfying environment in which urban inhabitants can live, work and pursue their goals that would enhance human dignity and lead to the attainment of a richer and fuller life”.

A quick look at these new settlements portray them as emergency area where so many people build houses in so limited spaces with nearly no regards for established housing standards. This results to over-crowding, bad drainage system, jeopardizing the safety and health being of the people living in the area.

The dynamics of the Nigerian city growth according to Obono (2002) have been accompanied by enormous deficiencies in modern basic facilities such as potable water, hospitals, roads, electricity, market and recreational areas, among other municipal and community facilities.

In the developed western world it takes them many decades to go through urbanization process, gradual emergence of economic, social and political systems to tackles the problems of transformations, ironically it is not so in Nigeria’s situations. The patterns of urbanization or urban development are occurring very rapidly, which according to Agbola (2005) is occurring against a background of higher population growth but less developed economic, social and political systems.

In the year 1992, the Nigerian urban and Regional Planning Act No.88 (URP Act No. 88) was promulgated by the federal government of Nigeria which clearly defines the roles of the three tiers of government in the planning process aiming at overhauling the old laws. The URP Act No.88 stipulates a wide range of plans and scope of serious for professional planners to contribute to the planning of human settlements. Unfortunately it has been observed by scholars at different times, Falade (2003) and Agbola (2006) that no government at all levels in Nigeria has fully implement all tenets of the Act.

It is more than two decades now after the passage of this law, the many dividends of good planning that are expected to come from it are yet to be seen.

The Act was amended by Act 18 of 1999 that ushered in new millennium developments, which include the creation of an independent ministry for
Housing and Urban Development resulting from the two in one 2002 government policy on Housing an Urban Development. The policy was seen as a lucid exposition of all that is bad and ugly on and about Nigerian cities and urban agglomerations with well thought out strategies on how to make the cities work again.

Surprisingly, new settlements have continued emerging at a rapidly and at a greater rate than the capacity and capability of urban managers thereby creating modern slums which the inhabitants call homes. Although, urbanization in Nigeria has been in existence since 18th century, it has been observed by Suleiman (2003) that it was largely under colonial rule that the major cities and urban systems that exist today were defined. Most of the cities grew modestly in population and size. However, today through political changes and administrative development of the country, many of the towns and cities have continued to grow at a rate faster than the capacities of the initially installed facilities.

Thus, linkages exist between deficient infrastructure and poor health outcomes of urban residents. Arimah (2002) posited that “major implication of the pattern of towns and cities development concern the head to provide adequate infrastructure”.

This study presupposed there are existing standards and building codes guiding housing delivery in urban settlements whether they are old or new. It therefore worked on the hypothesis that: “most of the Nigeria’s urban settlements especially the new ones are modern slums”. So the underpinning problems associated with lack of city-wide administration in the system of cities governance, the non-effective and efficient urban governance in Nigeria, how and who should govern the towns and cities development as found in the norms of developed countries urban administration were not the concern of this study.

The primary concern of this study is to find out:

• Are these settlements developed in line with standard criterion or they are just slums?
• Are there existing policies relating to urban development process?
• How much of these are being conformed to in the built environment?
• What are the effects of non-conformity experiences by these communities?
• What should government do to solve the problems for the sustainability of the built environment and future urban settlements?

To provide answers to these questions the study carried out an investigation of the environmental conditions of some of the new settlements and assessed their conformity to housing standards development at plot level and urban development planning process at community facilities level.
The reason for this is to ensure that standard houses are built, political requirement and aesthetics are met and community facilities that ensure health and safeties of the inhabitants are provided.

Housing standards, according to Zaki (2012) states that they established rules and norms of behaviors by the government rather than individual or private groups with regards to housing which is necessary to maintain the man-shelter-environment relationship at a save level.

Table 1: General Planning and site requirements

<table>
<thead>
<tr>
<th>Category of Plot</th>
<th>Maximum plot coverage as % of the total plot area</th>
<th>Minimum set back (M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>%</td>
<td>Front, Back, Side</td>
</tr>
<tr>
<td>Low density</td>
<td>35%</td>
<td>-</td>
</tr>
<tr>
<td>Medium density</td>
<td>40%</td>
<td>5.0, 3.0, 3.0</td>
</tr>
<tr>
<td>High density</td>
<td>50%</td>
<td>4.5, 2.5, 3.0</td>
</tr>
</tbody>
</table>

Source: Kaduna State Urban Planning Development Authority (KASUPDA)

The above defined building lines and stipulates that no structure such as porch veranda, steps and so on shall project beyond the specified building lines. For ventilation and health related reasons it is stipulated that where two buildings are to be built on the same plot or site the distance between the two buildings should not be less than the mean of the heights of the two buildings. The maximum height of hedge fence or walls around plots shall not be more than 1.5m in front and 2.0m at the back. Where any hedge, fence or walls parts appears to the authority to be likely to obstruct the view of a passage at road traffic the authority should ensure it is altered.

Types of Standards

The first step in a review like this is to consider the various types of standards which standards are meant to perform in shelter provision. In general according to (UNHSP, 2009), three broad groups of functions can be identified, which provide a basis for classifying the standards themselves. First, there are space standards, which specify not only the amount of space to be made available in shelter provision but also the rights of individuals to that space and the manner in which it is to be used. More specifically; these standards define the level of intensity at which the activity of shelter provision can be conducted. The units in which standards are expressed vary, and include minimum lot sizes, number of buildings per unit area, building bulk per unit area, number of persons per room (occupancy ratio) or number of persons per acre (density).

Second, there are technologies or performance standards which define the quality of environment, particularly in terms of the quality of construction, the type of materials that must be used, the quality of services that can be offered, or tolerable levels of toxicity. Building bye-laws, codes of
construction, and regulations on water, fire, noise, waste and industrial effluent all belong to this category.

Third, there are threshold and range standards. These define the lower and upper limits of the size of population, area of distance to be serviced by a particular amenity or community facility. They include standards regarding the per capita supply of water, the desirable number of potential patients per hospital bed, or the amount of recreation land required to serve a specific number of people. Range standards define the maximum area serviced by a facility, whilst threshold standards define the respective minima.

Looking at the later on the basis for examining the environmental aspects of shelter provision, it has been argued by some scholars that this typology of standards is not completely useful as it stands, and needs to slightly modify. Therefore in reviewing the standards for shelter provision in the developing regions of the world, according to (Olayemi, 2000) the following threefold division is, therefore, offered:

1) Space – use and density standards
2) Health and sanitation standards
3) Community facilities and services standards.

Based on these stipulated criteria the study assessed the provisions obtainable in Kaduna state urban development.

**Table 2: Kaduna State Housing Standards**

<table>
<thead>
<tr>
<th>Categories of Plot</th>
<th>Plot Size</th>
<th>Plot Coverage</th>
<th>Setback of Boundary</th>
<th>Back to Road centre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential High Density</td>
<td>30m x 15m (100 x 50)ft</td>
<td>50%</td>
<td>1.80m</td>
<td>12m</td>
</tr>
<tr>
<td>Medium Density</td>
<td>30m x 20m (100 x 75)ft</td>
<td>40%</td>
<td>2.50m</td>
<td>15m</td>
</tr>
<tr>
<td>Low Density (GRA)</td>
<td>30m x 40m (100 x 150)ft</td>
<td>35%</td>
<td>3.5m</td>
<td>15m</td>
</tr>
</tbody>
</table>

Source: Kaduna State Urban Planning Development Authority (KASUPDA)

**METHODOLOGY**

The study carried out an in-depth literature review about the subject area upon which two (2) sets of structured questionnaire were designed and distributed to the developers and public agencies on one hand; and residents in five settlements within Kaduna State in the western political zone of Nigeria on the other. Interviews were held with community leaders and some government officials. This was done to seek their various opinions on the perceived established policies and standards and what effect the lack of or it provision has on the environment and the inhabitants. In all 238 questionnaire were distributed of which 100 copies were distributed to developers and government agencies; 95 copies were returned and analyzed. For the residents the sample distribution was
determined from a representative sample for population greater than 10,000. The following standard formula was used to determine the sample size (IWSD, 2003 in MacDonald, 2006)

\[ n = \frac{Z^2pq}{d^2} \]

Where:

- \( n \) = the desired sample
- \( Z \) = the standard deviate, usually set 1.96 which correspond to the 95 percent confidence level
- \( p \) = the proportion in the target population estimated to have particular characteristic (normally set between 0.1 and 1.05)
- \( q = 1 - p \)
- \( d \) = degree of accuracy desired usually set at 0.05

**Table 3: Questionnaire Distribution**

<table>
<thead>
<tr>
<th>Categories</th>
<th>Total Number</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developers</td>
<td>50</td>
<td>49</td>
</tr>
<tr>
<td>Public Authorities (PA)</td>
<td>50</td>
<td>46</td>
</tr>
<tr>
<td>Residents</td>
<td>138</td>
<td>138</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>230</strong></td>
<td><strong>223</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Coverage</th>
<th>Total Number</th>
<th>Returned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kabama Zaria</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Grace land Zaria</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Sabon Tasha Kaduna</td>
<td>45</td>
<td>45</td>
</tr>
<tr>
<td>Mararaban Rido Kaduna</td>
<td>38</td>
<td>38</td>
</tr>
<tr>
<td>Gonin Gora Kaduna</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>138</strong></td>
<td><strong>138</strong></td>
</tr>
</tbody>
</table>

For the study area, the household population was estimated to be 314,066 (FRN, 2009, NPC 1998; Based on average of 5 per household of census 1991). Therefore the proportion of the population that was tested was 32.406.6 which is 10% of the whole population. Therefore \( P = 0.1 \)

Sample size \( n = (1.96)^2 \times 0.1 \times 0.9 = 138.2976 \)

(0.05)^2

The study therefore randomly administered 138 questionnaires to the residents of the study areas on the ratio of 1:5 houses. The 138 copies were correctly filled and returned.

Developers consists of contractors and consultants of construction firms who are responsible for actualizing the construction work; the public authorities (PA) are government health officers, local government building department agents, town planners and housing authorities (in this case Kaduna State Urban Planning Development Authority – KASUPDA) who
are responsible for ensuring the conformity to housing standards and adherence to building codes.

Considering the analysis of the data, the strength and weaknesses of data triangulation are: Standing on the fact that triangulation is a borrowed term from the study of experimental methods and refers to any attempt to investigate a phenomenon using more than one method; and that it was developed to counteract the threats emanating in the validity that each experimental method contained. The strength of the data triangulation is that effective data analysis was done through triangulation. This is based on the fact that each experimental method is ‘best’ for certain applications, scenarios and populations, but none is best for all. Using them will combine their respective advantages. The weakness lies in the fact that all information may be mixed up in data analysis as researchers are seldom skilful in the two methods and cost of using multiple methods may be expensive. Some of the variables that are impediment to triangulation are response rates, size and complexity of survey, sensitive questions, implementation time, etc.

RESULTS

Table 4: Ranking of Facilities Perceived to be provided in a Decent Settlement

<table>
<thead>
<tr>
<th>Facilities</th>
<th>N0</th>
<th>Mean</th>
<th>Std Deviation</th>
<th>Std Error</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>138</td>
<td>2.60</td>
<td>.595</td>
<td>.051</td>
<td>2nd</td>
</tr>
<tr>
<td>Roads</td>
<td>138</td>
<td>2.74</td>
<td>.441</td>
<td>.038</td>
<td>1st</td>
</tr>
<tr>
<td>Recreation</td>
<td>138</td>
<td>1.72</td>
<td>.551</td>
<td>.047</td>
<td>7th</td>
</tr>
<tr>
<td>Drainage</td>
<td>138</td>
<td>2.25</td>
<td>.465</td>
<td>.040</td>
<td>3rd</td>
</tr>
<tr>
<td>Hospital</td>
<td>138</td>
<td>2.08</td>
<td>.568</td>
<td>.048</td>
<td>4th</td>
</tr>
<tr>
<td>Set Back</td>
<td>138</td>
<td>1.47</td>
<td>.707</td>
<td>.060</td>
<td>9th</td>
</tr>
<tr>
<td>Sewage</td>
<td>138</td>
<td>1.13</td>
<td>.338</td>
<td>.029</td>
<td>10th</td>
</tr>
<tr>
<td>Market</td>
<td>138</td>
<td>1.48</td>
<td>.642</td>
<td>.055</td>
<td>8th</td>
</tr>
<tr>
<td>Schools</td>
<td>138</td>
<td>2.08</td>
<td>.695</td>
<td>.059</td>
<td>4th</td>
</tr>
<tr>
<td>Electricity</td>
<td>138</td>
<td>1.84</td>
<td>.697</td>
<td>.059</td>
<td>6th</td>
</tr>
</tbody>
</table>

Table 5: Ranking of the existing Facilities provided for the settlements

<table>
<thead>
<tr>
<th>Facilities</th>
<th>N0</th>
<th>Mean</th>
<th>Std Deviation</th>
<th>Std Error</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>138</td>
<td>2.44</td>
<td>.705</td>
<td>.060</td>
<td>3rd</td>
</tr>
<tr>
<td>Roads Network</td>
<td>138</td>
<td>2.27</td>
<td>.700</td>
<td>.060</td>
<td>5th</td>
</tr>
<tr>
<td>Water</td>
<td>138</td>
<td>2.27</td>
<td>.760</td>
<td>.065</td>
<td>6th</td>
</tr>
<tr>
<td>Recreational facilities</td>
<td>138</td>
<td>2.46</td>
<td>.641</td>
<td>.055</td>
<td>2nd</td>
</tr>
<tr>
<td>Schools</td>
<td>138</td>
<td>2.70</td>
<td>.459</td>
<td>.039</td>
<td>1st</td>
</tr>
<tr>
<td>Market</td>
<td>138</td>
<td>1.96</td>
<td>.671</td>
<td>.057</td>
<td>9th</td>
</tr>
<tr>
<td>Set Back</td>
<td>138</td>
<td>2.09</td>
<td>.714</td>
<td>.061</td>
<td>8th</td>
</tr>
<tr>
<td>Drainage</td>
<td>138</td>
<td>2.17</td>
<td>.868</td>
<td>.074</td>
<td>7th</td>
</tr>
<tr>
<td>Hospital</td>
<td>138</td>
<td>2.34</td>
<td>.560</td>
<td>.048</td>
<td>4th</td>
</tr>
<tr>
<td>Sewage</td>
<td>138</td>
<td>1.48</td>
<td>.642</td>
<td>.055</td>
<td>10th</td>
</tr>
</tbody>
</table>
Environmental assessment was done within the constraints of a lack of information as such the study saw the measures as being practical. Therefore, the study took a practical measurement of setback of the areas of study and the results presented as follows:

**Table 6: Averages of plot coverage and setback obtainable in the areas**

<table>
<thead>
<tr>
<th>Location</th>
<th>Plot Coverage (average)</th>
<th>Setback of Boundary (average)</th>
<th>Back to Road centre (average)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kabama Zaria</td>
<td>76 %</td>
<td>1.2 m</td>
<td>10.0m</td>
</tr>
<tr>
<td>Grace Land Zaria</td>
<td>84 %</td>
<td>1.0 m</td>
<td>6.0m</td>
</tr>
<tr>
<td>Sabon/Tasha Kaduna</td>
<td>87 %</td>
<td>0.9 m</td>
<td>6.0m</td>
</tr>
<tr>
<td>Mararaban/Rido Kaduna</td>
<td>85 %</td>
<td>0.9 m</td>
<td>5.7m</td>
</tr>
<tr>
<td>Gonin Gora Kaduna</td>
<td>90 %</td>
<td>0.9 m</td>
<td>6.0m</td>
</tr>
</tbody>
</table>

**Table 7: GA Perception of who should be responsible for implementation of policies**

<table>
<thead>
<tr>
<th>Description</th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land owners (sellers)</td>
<td>10</td>
<td>21.8</td>
</tr>
<tr>
<td>Village Heads</td>
<td>07</td>
<td>15.2</td>
</tr>
<tr>
<td>Developers</td>
<td>03</td>
<td>6.5</td>
</tr>
<tr>
<td>Public authorities (PA)</td>
<td>26</td>
<td>56.5</td>
</tr>
</tbody>
</table>

**FINDINGS AND DISCUSSION**

The literature review shows the standards required of a settlement and community service facilities that should be provided to make any settlement satisfactory. Table 4 shows the residents’ ranking of the facilities, they ranked Road 1st with a mean score of 2.7, water was ranked 2nd with 2.60 mean as main facilities to be provided in a new settlement. The residents also ranked Drainage 3rd and by this they proved the philosophical saying that a city must be adorned with good roads for accessibility, water for life and drainage for the discharge of waste water. Hospitals and Schools were ranked 4th showing that society needs health and education at the same time. Electricity, Recreation, Market, Setback and Sewage were ranked 6th, 7th, 8th, 9th and 10th and the mean scores of 1.84, 1.72, 1.48, 1.47 and 1.13 respectively. When interviewed what informed their ranking decision, the majority of the respondents said they based their ranking on the necessity of life.

**Table 8: Factors Responsible for Poor Implementation of Standards policies**

<table>
<thead>
<tr>
<th>Description</th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stringent policies</td>
<td>10</td>
<td>20.4</td>
</tr>
<tr>
<td>Lack of awareness</td>
<td>02</td>
<td>04.1</td>
</tr>
<tr>
<td>No government presence</td>
<td>06</td>
<td>12.2</td>
</tr>
<tr>
<td>Lack of enforcement by Government agents</td>
<td>31</td>
<td>63.3</td>
</tr>
</tbody>
</table>
Table 5 shows the residents’ ranking of what is provided in their settlement. The analysis of the responses shows school ranked 1st with the mean 2.70, Recreation facilities 2nd with the mean 2.46. This was followed by Electricity 3rd with the mean score 2.44 and Hospital was ranked 4th with the mean 2.34. The result in this table shows that priority is not given to what matters most in the communities even when these facilities are grossly inadequate. What is alarming is the ranking of Roads and Water provision 5th and 6th respectively. The implication of the result with Water, Drainage, Setback and Market being ranked 6th, 7th, 8th and 9th respectively is that no easy accessibility to the areas when it rains because of flooding cause by lack of no drainage. On market days is even worse because trading take place on the pavement called roads, motorists take longer distances to find alternative routes. Water that is the source of life is only provided in Governments Reserved Areas (GRAs) as commonly known. The majority take the alternatives of drilling boreholes if they are capable or digging a well according to their financial power. The ranking of setback shows no conformity which means the areas are mostly congested and unplanned.

Table 6 is a result of plot coverage, boundary setback and back to road centre presenting the average of the total obtained in the areas. The table shows Gonin gora covering up to 90% of the plot, Sabon tasha covers 87%, Mararaban rido 85%, Graceland covers 84% while Kabama covers 76%. This can be noted as a serious noncompliance when compared to the stipulated standards in tables 1 and 2. The implication is that the areas quickly become congested especially with the stipulated setback not being conformed to. What is worth noting is the Kabama, which inspite of being a layout still did not conform to the stipulated standards. This is an indication that as long as building of houses or housing developments is left in the hands of individuals who purchase land for their own use and not the government doing it for the citizens then they will always try to maximize the use of space within the constraint of their financial capability.

Table 7 shows the opinions of the PA who responded to the question ‘who is responsible for the implementation of the building standards policies?’ 56.5 percent indicated that it is the responsibility of PA to ensure compliance, 21.8 percent indicated that it is the land owner who is selling the land. 15.2 percent indicated that it is the village head that should be responsible and only 5.5 percent indicated developers. In an interaction (interview) those that are of the opinion that it be the PA said only government formulates policies and it is the government that has the power to enforce any policies within its jurisdiction. Those that said land owners argued that since it is not government land those selling land should always ensure that plots are demarcated and provision of roads made before selling their land. Those who indicated village heads said that village heads are the government representatives in their communities and they have the authority to implement government’s policies. Those who opined that it should be should be the developers based their
argument on the fact that since developers consist of professional who are no novices to the standards policies they are in the better position to implement policies.

Table 8 show the responses of the developers on what could be the factors responsible for poor implementation of standards policies, 63.3 percent believed it is lack of enforcement by the PA. 20.4 percent indicated that it is due to stringent policies, 12.2 percent indicated that no government present is the reason for poor implementation of policies and 4.1 percent indicated lack of awareness.

CONCLUSION

The literature reveals that there are existing policies, stipulated building codes for standards and established agencies to enforce their implementation. From the analysis of the primary data shown above, the study findings are:

I. At plot level the stipulated setback and building codes standards that make a settlement a healthy environment for people live in and carry out their activities are not conformed to.

II. The community facilities are not adequately provided

III. The standards are not conformed to because PA are not enforcing their implementation

IV. Sales of land is left in the hands of Individuals who do not comply with stipulated policies because they want to maximize their gains

V. Individuals are left to build without being properly checked therefore they do not observe the plot coverage allowable for flow of ventilation in and around our dwellings.

From the findings it is save say that our new settlements are not planned and building developments are just going haphazardly. This is not a good development for the present day situation where sustainability is the watch word in developing our environments.

To achieve sustainable development and sustain our built environment the government must make concerted effort to acquire available land for development then plan and provide the facilities require for community service before selling to individuals as noted in the case of Kabama layout in Zaria. Government should not compromise in the discharge of their responsibility in the built environment as this has direct bearing on health and safety of the inhabitants of such community.
REFERENCES


AN EMPIRICAL STUDY OF THE MAGNITUDE OF CONSTRUCTION CLAIMS IN BUILDING PROJECTS

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Claims are unavoidable tasks in implementing construction projects nowadays due to advanced technologies, new standards and consultants/client-desired additions and changes. The study adopted six different types of construction claims assessed their magnitudes and evaluated the relationship between them and the initial contract sum. Archival data were collected from 53 projects that had been completed in which claims were involved. Data collected were analysed using percentile and Pearson correlation. The study revealed that the most frequent type of claim was different site conditions claims while none of the projects experienced delay claims. The analysis also showed that projects with contract ambiguity had the highest amount of claims averaged 22\% of the initial contract sum while the overall claims was averaged 60\% of the initial contract sum. The study further revealed that there was significant relationship between initial contract sum and different type of claims (change claims, acceleration claims, different site conditions claims, contract ambiguity claims and extra works claims). The study recommended that 'purposeful tender' should be considered in the award of contract and the provision of the conditions of contract regarding variations should be amended to include 'limit of changes' that could be made to contract based on the magnitude of the project.

Keywords: construction claims, contract sums, magnitude of claims, Nigeria, types of claims.

INTRODUCTION

The construction industry is subject to inevitable changes because of the nature and complexity in the operations and activities involved in the process of realising its final products. According to Singh and Kandan (2005) in an exegetical literature argued that construction projects are complex because they involve many human and non-human factors and variables; they usually have a long duration, various uncertainties and complex relationships among the participants, therefore, the need to make

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changes in a construction project is a matter of practical reality. These authors concluded that changes usually plague the construction industry into a wide range of claims and the final effect of claims on construction projects are cost and time overruns. Yates and Epstein (2006) argued that construction claims take place as a result of enormous factors such as improper drafting of contract documents; inaccurate preparation of bids; failure of the client in his responsibility of providing access to the site or inability to take required action in a timely manner and inadequate contract administration on the part of clients, contractors, architects and other participants in the construction process. Kahssay (2003) in a survey in Ethiopia concluded that construction claims occurred when the terms and conditions of the contract change in such a way that the contractor is unable to recover expenses and profit. Chovichien and Tochaiwat (2006) in a survey in Thailand proved that construction claims are found in nearly every construction project.

Ogunsemi (2002) in a study concluded that there is no gainsaying that the twin problem of cost and time overruns may not yet be over as they still characterize construction projects in most parts of the world especially in developing countries like Nigeria. Mohamed et al. (2011) concluded that construction claims occur due to opportunity bidding behaviour of the contractor. That is contractor can bid low if there is opportunity to recoup his losses through claims during the execution of the contract.

Oyewobi, Ganiyu, Oke, Ola-Awo and Shittu (2011) submitted that the Nigerian construction is extremely susceptible to ethical erosion due to heterogeneous nature of the industry which makes it imperative for construction professionals to exhibit high level of professional ethics. In addition, one of the circumstances that deter meaningful development in the Nigerian construction industry is the menace of corruption and corrupt practices which in turn result in time and cost overruns. According to Obiegbu (2005), the circumstance mentioned above includes favour in the selection and award contracts to incompetent contractors in Nigeria through corruption and informal relationships instead of merit. The institution of the Budget Monitoring and Price Intelligence Unit (BMPIU) by the Federal Government in 2002 has not solved these problems. Ezekwesili (2005) observed that the problems faced by BMPIU includes ignorance and lack of cooperation among some official to comply with the provisions of the circulars, inadequate definition of projects scope, lack of involvement of professionals in some projects packaging and supervision, inadequate documentation and delays in responding to issues. This means that the problems such as the need to make changes, misuse of claims clauses by contractors and corrupt practices that will always lead to construction claims cannot be avoided on majority of the construction contracts in Nigeria. Therefore, it is important to study the current trend and nature construction claims in Nigeria. Previous studies on construction claims in Nigeria has been considering either a single claim head or treat claims holistically, none it has considered different claim
heads and used archival data to determine the magnitude of each claim head.

It is in this context that this study is set to evaluate the frequency and magnitude of different types of construction claims in the study area. The relationship between different types of construction claims and initial contract sum was also assessed.

**CRITICAL REVIEW OF TYPES MAGNITUDE OF CONSTRUCTION CLAIMS**

Ho and Liu (2004) examined the dynamic nature between construction claims and opportunity bidding and confirmed that construction claims are considered by many participants to be one of the most disruptive and unpleasant events of a project. Zaneldin (2006) in study concluded that claims are common in construction projects and can happen as a result of several reasons that can contribute to delaying a project and/or increasing its costs. Ren, Anumba and Ugwu (2003) in research confirmed that analyzing the various types of claims is an important task to resolving these claims. Therefore, it is important to critically review previous studies on the types and magnitude of construction claims in order to identify the gap in literature and determine the focus of this study.

There have been several research studies in the area of types and magnitudes of construction claims. There are two schools of taught on the classification of construction claims. The first group of researchers categorized construction claims according to the conditions of contract while the second group classified construction claims on the legal basis. The first group includes Diekmann et al. (1985) who carried out survey of the frequency and severity of different types of construction claims in Colorado-Boulder, U S A and identified fourteen types of construction claims. The results indicated that contract sum increased by about 6% and that 72% of the claims were due to design errors or Owner initiated changes. The shortcoming of this study is that the sample size is too small and no rigorous statistically based tests were conducted before conclusions were made. In addition, archival data from completed construction project would have been more appropriate in this type of study. Moura and Teixeira (2007) examined the types of construction claims in Portuguese and identified eight types of construction claims. The results discovered that direct changes by the Owner are the most expensive type of claim. Although historical data from completed projects were used, the sample size was too small due to the fact that authors considered six different types of construction project in the study.

Zaneldin (2006) in a survey in United Arab Emirates (UAE) collected information for 124 claims related to different projects and classified them into six types of construction claims. The results of the study indicated that changes claims were the most frequent type of claim. The finding of this study would have been good, but it was based on perception of the
stakeholders rather than historical data that can give real life situation of the construction projects. Fonseka (2008) study was based on the perception of the stakeholders on construction claims: causes, types, frequency and how to minimise in UAE. The results identified six types of construction claims and concluded that the most common type of claim is extra works/changes. This study was also faulted in that stakeholders perception that was based on small sample may not be the best, a research that is based on archival data will be a good compliment.

The second group of researchers are those who categorize construction claims by considering legal basis. Chapell (1984) and Huges et al. (1992) in guidance documents classified construction claims into three major types: Contractual claims, Extra-Contractual claims and Ex-gratia claims. The results of these authors were based theoretical literature review and personal experience. Al Mohsin (2012) in a study in Oman identified three types of construction claims, namely: Common law claims, Ex-gratia claims and Contractual claims. The results of this study were also based on theoretical literature review and personal experience of the author. An improved approach will have been based on archival data.

Several attempts were also made to study the magnitude of construction claims. Stemple et al. (1994) in a survey on construction claims and disputes: causes and cost/time Overruns in Western Canada. The results show that the large majority of claims in construction projects involved delay which goes beyond the original contract duration by over 100% and that more than half of the claims were an additional cost of at least 30% of the original contract value. As good as the finding of this study would have been, it was based on the survey of 24 disputed claims. This can be argued as bias for the choice of a particular type of claim. Ahmed et al. (2003) in a survey on delays in construction: a brief study of the Florida construction industry. The results indicated that the major causes of delay is building permits claims in Florida is building permits approval and that 44% of the delays on construction site are caused by the contractor. The findings of this study are faulted in that it was based on contractor’s opinion only. This may not be the best in judging causes of delays in Florida, the stakeholders’ perception would have been better.

Aibinu and Jagboro (2002) in a survey on the effects of construction delay on project delivery in Nigeria. The results shows that cost and time overruns are about 18%. In this research the clients’ opinion were left out and archival data from completed project will be the best in judging the effects of construction delay on project delivery. Omoregie and Radford (2006) used the results of survey from Mansfield et al. (1994) on infrastructure delays and cost escalation: causes and effects in Nigeria. The results indicate that the minimum average percentage escalation of cost was 14% while the minimum average percentage escalation period of projects was found to be 188%. Despite the empirical analysis, this study is faulted in that the survey was carried out more twenty years ago and the archival data used was from Highway project also more than twenty years ago.
ANALYTICAL FRAMEWORK OF STUDY

The following questions served as guide for this paper so as to address the identified problems:

1. How frequent are different types of construction claims?
2. What the magnitudes of different types of construction claims?

METHODOLOGY

The study adopted case study approach and archival data were collected from 53 projects that had been completed with construction claims. All the projects considered were constructed over a period of nine years (from 2006 until 2014, inclusive) in Ondo State, Nigeria. There were 5 health services buildings, 34 institutional buildings, 2 residential buildings, 3 social services buildings and 9 office buildings. The information collected on claims contained the activities of both main and subcontractors. Thirty five percent of the projects had more than 4 floors, while the remaining sixty five percent are had less than 4 floors. The costs of the projects ranged from N24million to N4.1billion. The assumptions made in the study includes that (i) the type of claims used as independent variables are linearly related to the initial contract sum (ii) change in projects characteristics and specifications do not materially affect the relationship between the types of claims and initial contract sums. The data collected were analysed with frequency, percentile and correlation using Excel and SPSS version 18 software.

Average initial contract sum (AICS) is the ratio of the initial contract sum to the number of projects used for the research:

$$AICS = \frac{\sum \text{IICS}}{N}$$

Where ICS = Amount of initial contract sum and N= Number of projects used for the research = 53.

Average claim (AC) is the ratio of the amount of claim to the number of occurrence of the claim.

Average claim (AC) = \(\frac{\sum \text{C}}{F}\) Where C = Claimed amount and F = frequency, e.g. in different site conditions claims, F = 46

RESULTS OF ANALYSIS

Table 1 shows that different site conditions claims occurred in 46 projects with 33% and were ranked first while change claims occurred in 43 projects with 31% and were ranked second. Table 1 also indicates that contract ambiguity claims occurred in 33 projects with 24% and were ranked third while extra work claim occurred in 13 projects with 10% and
were ranked fourth. Table 1 further indicates that acceleration claims occurred in 3 projects with 2% and were ranked fifth while none of the projects experience delay claims and was ranked sixth.

Table 1: Frequency of different types of Construction Claims

<table>
<thead>
<tr>
<th>Types of claims</th>
<th>Frequency</th>
<th>Percent</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Different site condition claims</td>
<td>46</td>
<td>33.33</td>
<td>1</td>
</tr>
<tr>
<td>Change claims</td>
<td>43</td>
<td>31.16</td>
<td>2</td>
</tr>
<tr>
<td>Contract activity claims</td>
<td>33</td>
<td>23.91</td>
<td>3</td>
</tr>
<tr>
<td>Extra works claims</td>
<td>13</td>
<td>9.42</td>
<td>4</td>
</tr>
<tr>
<td>Acceleration claims</td>
<td>3</td>
<td>2.18</td>
<td>5</td>
</tr>
<tr>
<td>Delay claims</td>
<td>0</td>
<td>0.00</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>138</td>
<td>100.00</td>
<td></td>
</tr>
</tbody>
</table>

Table 2 indicates that the amount of contract ambiguity claims were 22% of the initial contract sum and were ranked first while the amount of acceleration claims were 19% of the initial contract sum and were ranked second. It also shows that the amount of extra works claims were 9% of the initial contract sum and were ranked third while the amount of change claims were 8% of the initial contract sum and were ranked fourth. The table further indicates that the amount of different site conditions claims were 3% of the initial contract sum and were ranked fifth while the overall claimed amount were averaged 60% of the initial contract sum.

Table 2: Comparison of the amount of each Type of Claim with the average Initial Contract Sum**

<table>
<thead>
<tr>
<th>Types of Claims</th>
<th>Average amount of claims (₦)</th>
<th>Percent % on average contract sum</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contract ambiguity claims</td>
<td>50,483,912.47</td>
<td>22.00</td>
<td>1</td>
</tr>
<tr>
<td>Acceleration claims</td>
<td>42,332,783.33</td>
<td>18.00</td>
<td>2</td>
</tr>
<tr>
<td>Extra works claims</td>
<td>20,316,677.64</td>
<td>9.00</td>
<td>3</td>
</tr>
<tr>
<td>Change claims</td>
<td>17,058,357.85</td>
<td>8.00</td>
<td>4</td>
</tr>
<tr>
<td>Different site Conditions claims</td>
<td>5,905,914.97</td>
<td>3.00</td>
<td>5</td>
</tr>
<tr>
<td>Delay claims</td>
<td>0.00</td>
<td>0.00</td>
<td>6</td>
</tr>
<tr>
<td>Overall average %</td>
<td></td>
<td>60.00</td>
<td></td>
</tr>
</tbody>
</table>

**The average initial sum = ₦228,202,485.69

Test of Hypothesis

H₀ - There is no significant relationship between different types of construction claims by contractors and the initial contract sum.

H₁ – There is significant relationship between different types of construction claims by contractors and the initial construction sum.
Table 3 presents the hypothesis testing of correlation coefficient for the relationship between initial contract sum and different types of claims. Table 3 shows that the relationship between initial contract sum and these four types of claims: change claims; acceleration claims; different site conditions claims and contract ambiguity claims were statistically significant at 0.01 level of significant while the relationship between initial contract sum and extra work claims is statistically significant at 0.05 level of significant. The null hypothesis is rejected.

**Table 3: Correlation between Initial Contract Sum and Different Types of Claims**

<table>
<thead>
<tr>
<th>Types of Claims</th>
<th>Correlation value</th>
<th>Sign (2-tailed)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change claim</td>
<td>0.820</td>
<td>0.000</td>
<td>Significant at 0.01 and 0.05</td>
</tr>
<tr>
<td>Acceleration claim</td>
<td>0.773</td>
<td>0.000</td>
<td>Significant at 0.01 and 0.05</td>
</tr>
<tr>
<td>Different site condition claim</td>
<td>0.499</td>
<td>0.000</td>
<td>Significant at 0.01 and 0.05</td>
</tr>
<tr>
<td>Contract Ambiguity claim</td>
<td>0.870</td>
<td>0.000</td>
<td>Significant at 0.01 at 0.05</td>
</tr>
<tr>
<td>Extra work claim</td>
<td>0.882</td>
<td>0.021</td>
<td>Significant at 0.005</td>
</tr>
</tbody>
</table>

This means that there is 1 % chance of making error in the relationship between initial contract sum and the four types of claims: change claims; acceleration claims; different site conditions claims and contract ambiguity claims. In the case of the relationship between initial contract sum and extra works claims there is 5% chance of making error.

**RESULTS AND DISCUSSION**

The study reveals that the most frequent type of claim was different site conditions claims. This is in contrast with Zaneldin (2006) and Fonseka (2008) who asserted that in United Arab Emirate the most frequent type of claim was changes and extra work/changes claims respectively. The study also revealed that overall construction claims averaged 60% of the average initial contract sum. This disagreed with Stemple et al. (1994) that reported that in Western Canada, claims were an additional cost of at least 30% of the original contract value. Reverse was also the case for Omorogie and Radford (2006) who postulated that costs of projects in Nigeria escalated by an average cost of 14%.

The result Karl Pearson’s coefficient of correlation shows that strong positive relationship existed between initial contract sum and (change claims and contract ambiguity claims). The result also indicates that a moderately strong positive relationship existed between initial contract sum and (acceleration claims and different site conditions claims). The result further indicates that statistical significant relationship existed between initial contract sum and extra works claims at 0.05 level of
significant. This implies that there is significant relationship between the initial contract sum and different types of construction claims.

CONCLUSION

The following conclusion has been drawn from the results of the analysis:

1. The most frequent type of claim was different site conditions claims followed by changes claims while there none of the projects used for the study experienced delay claim.

2. Projects with contract ambiguity claims had the highest amount claim while the projects with different site conditions claims had the least amount of claim. The study also revealed that the overall amount claimed by the contractors was more than half of the initial contract sum.

3. There were significant relationship between different types of claims (change claims, acceleration claims, different site conditions claims and contract ambiguity claims) and initial contract sum at a low level of significant level than the relationship between initial contract sum and extra works claims.

RECOMMENDATIONS

Based on the findings, the following recommendations were proposed:

1. Site investigation and adequate planning should be carried out in order to reduce the magnitude of different site conditions claims.

2. ‘Purposeful tender’ that satisfy the clients’ requirements should be considered for the award of contract rather than the lowest responsive tender as currently recommended by the procurement Act of 2007. This is to discourage the award of contract to contractor that based his bid on opportunity behaviour which will result in excessive claims during the execution of the contract.

3. The provision of the conditions of contract regarding variations in the original contract sum should be amended to include ‘limit of changes’ by the client and consultants based on the magnitude of the project. This will ensure adequate planning by the stakeholders at the inception of the project and reduce clients/consultants desired additions and changes.

4. The five different types of claims that were statistically related to initial contract sum should be considered as core determinants in estimating the cost of uncertainty associated with building projects.
REFERENCES


AN OVERVIEW OF THE ROAD INFRASTRUCTURE DEVELOPMENT IN GHANA

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Road sector development requires huge capital investment. The government of Ghana however, is constrained with limited financial, technological, and other requisite resources. These have over the years hampered its effort to provide adequate infrastructure to ensure comfort and economic growth. The paper discusses the trend in the development of the road network in Ghana for the past decade, identifying and ranking the key factors that affect the delivery of infrastructure projects in Ghana. The paper adopts a mixed approach with the distribution of 105 questionnaires to construction clients, professionals and experts in the built environment receiving a response rate of 91%. Secondary information was sourced from articles, journals, reports, and historical documents from the agencies relevant to the study. Findings from field studies indicate that funding is a dominant challenge hindering the delivery of road infrastructure in Ghana. Currently, the approximate ratio or tarred to un-tarred road network is 18.7 to 81.2. At the current rate of 7.13% per annum, all things being equal, it would take country close to 2 decades to meet its road needs. It was revealed that the key factors that affect road infrastructure delivery are adequate funding, procurement system, political interest, contractor characteristics, project team performance and Technical supervision. To close the gap in the road sector, road financing in Ghana would require a joint effort from both the public and private sector to take advantage of the private sectors adequate resources in terms of finance, technology and expertise.

Keywords: feeder road, road development, road financing, private sector, public sector, trunk road, urban road

INTRODUCTION

Road infrastructure is vital indicator of every nation’s economic growth. Investment in road transport makes up a large proportion of public expenditure in many developing countries (Kerali, 2003). Road Infrastructure may be considered to be one of the skeletal framework on which a society is built and in Ghana, it forms a formidable part of the

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Ghana Shared Growth and Development Agenda (GSGDA 201-2013) as a key focus area addressing infrastructure and human settlement. Road is the dominant mode of transport in Ghana and has been identified as one of the catalysts in creating wealth. Development in road infrastructure creates opportunities for people to access various economic and social resources. It facilitates the movement of people, goods and services. It also provides vital and complementary services to all sectors of the economy including tourism, mining, health, trade, education, agriculture, energy among others (Adu, 2009). Road infrastructure Projects are capital intensive and usually takes huge percentage of national budget. However, the need for its investment cannot be underestimated due to its enormous contribution to the national economic growth. Its provision takes due cognizance to issues bordering on time, scope, cost and quality.

Road infrastructure is very essential for the growth of every economy. Development in road infrastructure creates opportunities for people to access various economic and social resources. Road networks facilitate the movement of people, goods and services for several diverse purposes. It provides service to other sectors such as tourism, mining, health, trade, education, agriculture, energy among others (Adu, 2009). Restriction of accessibility limits efficient factor mobility, and defers the transfer of human and material resources to places where they can be employed most productively. It has been estimated that road transport accounts for 94% of freight ton-miles and about 97% of passenger miles in Ghana (Ghana Investment Promotion Centre, 2009). With an approximate Gross Domestic Product (GDP) of 39.2 billion US dollars (World Bank report, 2011), Ghana still suffers road and other infrastructure deficit. The Government is the main financier of road infrastructure development in Ghana. This fund comes from three main sources; the Consolidated Fund, the Ghana Road Fund and Donor Funds. The main sources of inflows into the Consolidated Fund are Taxes, Fess, Charges and government income from undertaking economic activities (Ministry of Transport, 2007). The Government of Ghana requires huge fund to close its infrastructure gap. According to the World Bank report, Ghana will need not less than 2.5 billion US dollars annually for the next ten years to close its infrastructure gap. Comparing this huge expected financial commitment to the Ghana government balance sheet, it will be very difficult for the government to close its road infrastructure gap. The purpose of this paper is to determine the trend in road infrastructure delivery and the factors that militate against the provision of road infrastructural deliver in Ghana and recommending the way forward.

According to the Ghana infrastructure plan (GIP, 2012), Ghana’s current roads network is approximately 67,450 km, out of which 63% is feeder roads, 18% is urban roads and 19% is trunk roads. This road network serves as the major linkage to all the regions and districts. It nevertheless suffers from congestion in terms of very high traffic density in major urban centers; rapid deterioration with only 41% of the road network considered in good condition; and poor connectivity in rural areas, where only one
fourth of rural population live within 2km of an all season road (GIP, 2012).

EMPIRICAL REVIEW

Though the road sector development requires huge investment capital, the government of Ghana is however constrained with limited financial, technological, ineffective procurement strategy and other infrastructural development resources. These have over the years hampered its effort to provide adequate infrastructure to ensure comfort and economic growth. The central government usually undertakes projects without any form of formal partnership. Owusu (2010), postulates that the traditional design-bid-build procurement strategy which is mostly engaged in Ghana has been identified to produce unsatisfactory results as it is characterized by delay in delivery, quality deficiency and cost overrun. Owusu (2010), further holds that road projects scheduled to be completed in one year tend to be delivered in six to seven years with substandard quality and huge cost overrun due to financial, technical and management challenges among others. This normally disrupts or nullifies the original objective of the proposed project. Road infrastructure consist of highway networks, including structures (bridges, tunnels, culvers, retaining walls, etc), signage and markings, electrical systems (street lighting and traffic lights), edge treatment (curbs, sidewalks, landscaping), and specialized facilities such as road maintenance depots and rest areas that support mobility of goods, services, human capital etc, for diverse purposes. Roads that need to be considered in effecting an integrated transport system can be categorized into the following: Local, Arterial and National roads (Khulumane, 2008).

According to the GIP (2012), Ghana’s roads network comprises 66,200 km, out of which 42,192 km is feeder roads, 12,400 km is urban roads and 11,628 km is trunk roads. The network links all districts and regions, as well as most population settlements, and is considered adequate to meet the minimal requirements for sub-regional integration. It nevertheless suffers from congestion in terms of very high traffic density in major urban centers, rapid deterioration (with 41% of the road network considered in good condition), and poor connectivity in rural areas, where only a fourth of rural population live within 2km of an all season road. While continued expansion of the network is desired, priority is given to improving roads quality through the introduction of improved/latest construction technology, better maintenance and regulation, decongesting urban traffic (in Accra first), and improving rural connectivity. To overcome the road transport gap expansion, in length and number of lanes, up-grading of road pavement and road furniture (drains signage etc.) and improved inter-connectivity of roads in all the three road sectors namely Highways, Urban and Feeder Roads across the country must receive very urgent and appropriate intervention (GIP 2012).
Trend of road development in Ghana
The network distribution by class in Ghana remained at 19% of trunk roads, 63% of feeder road and 18% urban roads. The total portfolio of roads stood at 37,321km in 2000 and grew up to 67,450km in 2009. This represents an annual average growth of 182.2km, 1801.9km and 171.7km for urban, feeder and trunk road respectively within the years of 2000 to 2009. As at 2009, the total length of paved and unpaved road in Ghana stood at 12,442km and 53,863km respectively. The figure 1 illustrates the total network size by road type from 2000 to 2009.

![Figure 2.1 The trend of road infrastructure development from 2000. Source: MRH, road infrastructure development annual report, 2011.](image)

These roads apart from their surface nature, suffers from congestion in terms of very high traffic density in major urban centers, rapid deterioration (with 49% of the road network in bad condition), and poor connectivity in rural areas, where only one fourth of rural population live within 2km of an all season road. While continued expansion of the network is desired, priority should be given to improving roads quality through the introduction of improved/latest construction technology, better maintenance and regulation, decongesting urban traffic (in Accra first), and improving rural connectivity. Overall, Ghana has allocated substantial resources to the road sector in recent years; it spends on average 1.5% of GDP on roads (GIP, 2012).

Financing road infrastructure projects in Ghana
Generally, central government is responsible for the development, expansion and maintenance of road infrastructure for the benefit of all its citizens. The road infrastructure needs are prepared by the government’s road or transport ministry or agencies and submitted to the government finance agencies for funding consideration. In many countries, roads infrastructure are funded by the central government through revenue generations, donor support in the form of loan or grants from bilateral and multilateral Donor Agencies and the road fund. Ghana road provision and
maintenance funding is of no difference (Ministry of Transport, 2007). The government’s main source of funding for the road sub-sector are the road fund, the Consolidated Fund and the donor Funds. The main sources of inflows into the Consolidated Fund are Taxes, Fess, Charges and government income from undertaking economic activities. Fuel levy, road tolls, bridge tolls, ferry tolls, road use fees, vehicle registration fees and International transit fees are also the various constituents of road fund contribution (MRH Review Report on road transport infrastructure, 2010).

According to Nana-Benyin, (2011), most of Ghana’s road network development has been accelerated through bilateral and multilateral Donor Agencies supports, with road infrastructure funding acquired in the form of loans or grants from agencies such as IDA - International Development Association (World Bank), AfDB - Africa Development Bank, OECF-Overseas Economic Co-operation Fund of Japan, EU-European Union, KFW- Kreditanstalt fur Wiederaufbau (Bank for Reconstruction), ECGD-Export Credit Guarantee Department of UK, JICA-Japan International Co-operation Agency, BADEA- Arab Bank for Development in Africa, OPEC- Organization of Petroleum Exporting Countries, DANIDA-Danish Government, Saudi Fund. Thus, the Donor Agencies contribution to the Ghana government’s road infrastructure development cannot be underestimated. In the case study of Road Funds in Ghana, Malawi and Tanzania, it was reported that, the overall Government of Ghana (GOG) road sector funding from 1996 to 2001 was US$ 1,121 million and Donor Funding represent about 44%, which is US$ 496.00 million (Andreski, 2008).

Traditional approach to road infrastructure provision in Ghana

Generally, central government is responsible for the provision, expansion and maintenance of road infrastructure for the benefit of all its citizens. The road infrastructure needs are prepared by the government’s road or transport ministry or agencies and submitted to the government finance agencies for funding consideration. Capital intensive projects such as road, bridge etc, usually consume high percentage of national budget and demand. In many countries, roads infrastructure are funded and controlled by the central government through revenue generations, donor support in the form of loan or grants from bilateral and multilateral Donor Agencies and the road fund. In 2010, the federal government and state and local governments spent about $160 billion to build, operate, and maintain roads. Almost all of those infrastructure projects were undertaken using a traditional approach in which a state or local government assumes most of the responsibility for carrying out a project and bears most of its risks, such as the possibility of cost overruns, delays in the construction schedule, and, in the case of toll roads, shortfalls in the road’s revenues.

Road infrastructure gap in Ghana

The length of the main (primary and secondary) network is more than adequate to achieve regional and national connectivity. The record on road network quality is quite reasonable, with 75 percent of the paved network in good or fair condition and, more impressive, 74 percent of the unpaved
network in good or fair condition (Foster and Pushak 2011). Road infrastructure gap is the difference between the road infrastructure required to support economic growth and the road infrastructure available. It is measured by accessing the road infrastructure investment required for the present and future needs and the capacity of the present and the future economic budget to provide. From table 1, and as indicated in the infrastructure plans Consultative Group Meeting, June 19, 2012, funding requirement of the various sectors were indicated. It was revealed that an amount of US$ 2,832,000 was required to bring the rail network to standard and with a corresponding amount of US$ 5,497 million required to close the road infrastructure gap in Ghana (GIP, 2012).

**Table 1 Infrastructure Investment Plans 2012-17 (US$ million)**

<table>
<thead>
<tr>
<th>Sector</th>
<th>Required investment in million dollars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generation</td>
<td>1,980</td>
</tr>
<tr>
<td>Transmission</td>
<td>903</td>
</tr>
<tr>
<td>Distribution</td>
<td>1,000</td>
</tr>
<tr>
<td>Roads</td>
<td>5,497</td>
</tr>
<tr>
<td>Ports</td>
<td>674</td>
</tr>
<tr>
<td>Rails</td>
<td>2,832</td>
</tr>
</tbody>
</table>

Source: GIP 2012.

The amount is to be invested in expansion in length and number of lanes, up-grading of road pavement and road furniture (drains, signage etc.) and improved inter-connectivity of roads in all the three road sectors namely Highways, Urban and Feeder Roads across the country (GIP 2012).

**Causes of road infrastructure deficit**

Road infrastructure deficit in many developing countries can be a symptom of low economy due to fiscal constraints and other several factors. According to the World Bank infrastructure diagnostic report, it is noted that 35 percent of the infrastructure funding gap which includes road can be attributed to inefficiency in the existing spending, poor governance, poor planning of investments, under-investment in maintenance or lack of maintenance, under-charging for services and operating inefficiencies (World Bank Africa infrastructure diagnostic study, 2008). Other factors which have contributed to road infrastructure deficit in Ghana are;

- **Lack of long term Strategic Development Plan:** The country over the years has moved from one policy document to the other. From GPRS I, GPRS II and now GSGDA and all these policy documents have different development agenda and different policy directions. The development plan of this country is politically led, thus each political party when voted into power does what it feels or deems convenient for it at that particular point in time. This makes certain development infrastructures that do not fit into the plans of the current government loose. Mostly, road infrastructure projects are initiated by governments as part of their development agenda but
when it is not completed within the tenure of office of that particular government then, it risks being abandoned if it does not fit into the development agenda of the next government. This is simply because, there is no long term strategic development plan or legislation, that compels all governments no matter which political party it is from to commit itself to the completion of projects initiated by the previous government (WBADR, 2008).

The use of ineffective procurement strategy: The governments of Ghana have not adopted an effective procurement strategy that encourages private sector to combine effort financially with the public sector to enhance the effort of the government in road infrastructure provision. Most of the procurement strategies adopted by the government are those whose funding is one sided, mostly the public sector (government). Resource from the public sector for purposes of undertaking projects of this nature is inadequate and thus leaves most road infrastructure projects abandoned or uncompleted. The right procurement strategy that the government can adopt to ensure that road projects are effectively completed is one that is able to efficiently combine resources from both the private and public sector towards the completion of road projects. When such procurement strategies are adopted, it will boost the government effort financially towards road infrastructure development (WBADR, 2008).

Technical and financial challenges of resettling homes or houses affected: Roads infrastructure development mostly affect homes and properties especially, during expansion or construction of new roads, and there is often the need to compensate or resettle those affected. However, the financial resource needed for resettlement purpose sometimes poses a challenge to the government. Resettlement programs are very expensive and may require financial resource that may be more than the actual road construction cost. When the government realizes the cost of resettlement and the actual road construction cost to be too much, it discourages the government from undertaking such projects. This is simply because there is limited financial resource available to meet those demands (WBADR, 2008).

Poor Commitment to road Infrastructure as a result of rising pressures to satisfy other sections of the economy: Mostly, road infrastructure projects are deferred or abandoned due to the fact that there is rising pressure to develop other sectors of the economy. The government sees it relevant to invest in sectors of the economy that will generate enough revenue for the country. For instance, the government may see it necessary to invest in the agricultural sector rather than transportation. This is simply because, enough foreign exchange is accumulated through exports of agricultural produce rather than the returns that roads will bring into the economy.
Cultural and Traditional influence on development: Values, Norms and Ideologies embodied in culture and traditions mostly impede certain development projects especially, road infrastructure. This is because roads may be designed to pass through certain traditionally sacred places like cemeteries, shrines, churches, mosques, trees and mountains etc. But these do not make the execution of such road projects easy because, the chiefs and other traditional stakeholders who are custodians of such traditionally sacred landmarks usually do not allow the government to undertake the project even though they know very well the importance and benefit they will derive from the road projects (WBADR, 2008).

Corruption: Corruption can be witnessed from the project inception up to completion. Contracts are awarded to only contractors who are the current government affiliates or favorites. The system popularly described as ‘whom you know’. These contractors are mostly not qualified to undertake such projects and they end up doing shoddy work. Hence, projects undertaken by such contractors deteriorate in no time. Bribery has become the order of the day and people from all walks of life use their position to acquire wealth. Government officials and politicians who have been entrusted to seeing to ongoing road projects demand tips (bribes) from the local stakeholders before they perform or attend to their requests, when development projects are to be constructed in their regions. Corruption is said to be the abuse of public power for private benefit (Owusu, 2010). Also, some road contractors influence the road project supervisors by giving them bribes to keep their mouth shut and eyes closed for them to do shoddy work. These cause completed projects to deteriorate easily in no time.

Inadequate Finance: There is huge road infrastructure deficit or gap needed to be closed in Ghana ranging from feeder roads, urban roads and highways. However, road infrastructure development is capital intensive and requires huge financial resources to be able to close or fill this gap. Though the government of Ghana is trying its best to meet road infrastructure demands, it seems to be moving on a snail’s pace. This is due to the fact that, the government is faced with fiscal challenges which make it budgetary constrained and always relies on bilateral and multilateral donor agencies assistance. Effects of road infrastructure deficit (WBADR, 2008).

One can argue that, the high price of food items or farm products in the urban centers cannot only be attributed to the higher demand of food items in urban centers but rather due to poor and expensive transport accessibility. If farmers are not able to distribute their products due to transport problems, the majority of the other economic sectors such as education, defense and security, health, governance, communication etc. would be indirectly affected. These have motivated many countries to invest huge resources into improving, expanding, maintaining and
modernizing road infrastructure through several innovative procurement strategies.

METHODOLOGY

Research design is a plan or blue-print of how a researcher intends to conduct the research (Kumar, 2005). The research question(s) of every study determines the type of research design to be used for data collection. This means that, for this study, whatever research method employed should assist in answering the research question below:

- What are the key factors that affect the delivery of road infrastructure Projects in Ghana?

The survey design

Based on the quantitative research method adopted for the research, a questionnaire was designed according to the objectives of the study. The respondents were asked to rank or indicate the level of appropriateness or significance of identified factors that affect the delivery of road infrastructure projects using a five point Likert scale of 1-5. 5-Very High, 4-High, 3-Medium, 2-Low, 1-Very Low.

The sample size was determined using the Kish formula (Kish, 1965), holding the four road sector agencies as strata as indicated in table 3. A total of one hundred and fifteen (115) questionnaires were administered to the four categories of respondents of which one hundred and five (105) were received representing a response rate of 91.3%. Aibinu A.A. et al. (2006), in accessing construction delays and their causative factors in Nigeria indicated that “the result of a survey could be considered as bias and little value if the return rate was lower than 30-40%”. This assertion indicates that the response rate of 91.3% was adequate for the analysis. Table 3 shows the response rate for all the respondent institutions:

Table 3: Detail of questionnaire distribution, rate of return and response

<table>
<thead>
<tr>
<th>Categories</th>
<th>Nomenclature</th>
<th>Questionnaire Issued</th>
<th>Questionnaires Received</th>
<th>Questionnaires Responsive</th>
<th>Response Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Road Agencies</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>100</td>
</tr>
<tr>
<td>B</td>
<td>Local Consultant</td>
<td>55</td>
<td>50</td>
<td>50</td>
<td>90.9</td>
</tr>
<tr>
<td>C</td>
<td>Ministry of Finance and Economic Planning</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>100</td>
</tr>
<tr>
<td>D</td>
<td>Donor Institution</td>
<td>15</td>
<td>10</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>115</td>
<td>105</td>
<td>105</td>
<td>91.3</td>
</tr>
</tbody>
</table>


Factors affecting road infrastructure provision

There are several factors that affect project delivery with respect to time, cost and quality. Several researchers such as Chua et.al, 1999, Copper,
2001, Alkathami, 2004 and Jha and Lyer, 2008, have discovered a lot of factors that affect the delivery of projects as indicated in the literature review. To determine the relative ranking of importance with respect to project delivery in Ghana, the relative importance index formula was adopted (Tam et al. 2000):

\[
\text{Relative Importance Index (RII)} = \frac{\sum W}{W \times A \times N}
\]

### Table 4. Factors Affecting Road Infrastructure Provision

<table>
<thead>
<tr>
<th>Srl</th>
<th>Factor</th>
<th>Degree of relative importance quoted by the respondent</th>
<th>Responses</th>
<th>(\sum W)</th>
<th>(\text{RII} = \frac{\sum W}{(W/S) \times N})</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Availability of Adequate Fund</td>
<td>70 95 0 10 10 105</td>
<td>425</td>
<td>0.96</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Type of procurement system for the project</td>
<td>50 35 9 6 5 105</td>
<td>434</td>
<td>0.83</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Project characteristics</td>
<td>42 24 24 10 5 105</td>
<td>385</td>
<td>0.73</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Availability of Adequate fund</td>
<td>70 95 0 10 10 105</td>
<td>420</td>
<td>0.80</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Type of procurement system for the project</td>
<td>50 35 9 6 5 105</td>
<td>434</td>
<td>0.83</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Project characteristics</td>
<td>42 24 24 10 5 105</td>
<td>385</td>
<td>0.73</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Project team performance (Quality of Technical supervision)</td>
<td>25 12 25 43 0 105</td>
<td>420</td>
<td>0.80</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Contractor's characteristics</td>
<td>90 90 90 90 90 105</td>
<td>900</td>
<td>0.90</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Type of procurement system for the project</td>
<td>50 35 9 6 5 105</td>
<td>434</td>
<td>0.83</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Project characteristics</td>
<td>42 24 24 10 5 105</td>
<td>385</td>
<td>0.73</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Project manager's coordinating and leadership skills</td>
<td>21 16 2 45 21 105</td>
<td>286</td>
<td>0.54</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Monitoring and Feedback by the participants</td>
<td>32 19 40 10 4 105</td>
<td>380</td>
<td>0.72</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Project characteristics</td>
<td>90 90 90 90 90 105</td>
<td>900</td>
<td>0.90</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Coordination among project participants</td>
<td>3 34 10 32 26 105</td>
<td>271</td>
<td>0.52</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Client or owner's competence</td>
<td>90 90 90 90 90 105</td>
<td>900</td>
<td>0.90</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Social conditions</td>
<td>90 90 90 90 90 105</td>
<td>900</td>
<td>0.90</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Economic conditions</td>
<td>30 40 90 70 8 105</td>
<td>349</td>
<td>0.75</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Economic conditions</td>
<td>30 40 90 70 8 105</td>
<td>349</td>
<td>0.75</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Availability of plants and equipment</td>
<td>33 25 15 30 2 105</td>
<td>372</td>
<td>0.71</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>The condition of the ground</td>
<td>90 90 90 90 90 105</td>
<td>311</td>
<td>0.56</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Availability and quality of construction materials</td>
<td>17 23 23 12 30 105</td>
<td>300</td>
<td>0.57</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Disputes and conflicts</td>
<td>90 90 90 90 90 105</td>
<td>349</td>
<td>0.75</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Availability of labour and productivity</td>
<td>21 9 14 21 40 105</td>
<td>265</td>
<td>0.50</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>The proposed project completion schedule or date</td>
<td>20 19 18 25 23 105</td>
<td>303</td>
<td>0.58</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Nature of project planning</td>
<td>13 16 98 68 90 105</td>
<td>278</td>
<td>0.53</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Nature of technology</td>
<td>90 90 90 90 90 105</td>
<td>349</td>
<td>0.75</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Political interest in the project</td>
<td>30 17 18 6 0 105</td>
<td>499</td>
<td>0.80</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>The proposed project completion schedule or date</td>
<td>20 19 18 25 23 105</td>
<td>303</td>
<td>0.58</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>Long term strategic vision</td>
<td>30 39 27 5 4 105</td>
<td>401</td>
<td>0.76</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>Acts of God</td>
<td>90 90 90 90 90 105</td>
<td>349</td>
<td>0.75</td>
<td>11</td>
<td></td>
</tr>
</tbody>
</table>

Source: Field survey, 2012
Where, \( W \) = the weighting given to each factor by respondents, ranging from 1 to 5,
\( A \) = the highest weight (i.e. 5 in the study), \( N \) = the total number of samples.

**DISCUSSION**

For successful delivery of road infrastructure projects, it is very important to know the key factors that affect their successful delivery. The identification and studying of these factors will enable one propose a suitable strategy to control the implementation of such projects. It is indicated that, generally, the evaluation dimensions in any project correspond to the traditional constraints of time, cost and quality parameters (Rohaniyati, 2009). However, there are several factors that affect project delivery with respect to time, cost and quality. Several researchers such as Chua et al., 1999, Copper, 2001, Alkathami, 2004 and Jha and Lyer, 2008 have discovered a lot of factors that affect the delivery of projects. Since the year 2000, a concerted effort has been made all over the world to determine remedies to the issues of project delays.

Aiyetan, 2010 in his effort to examine influences on project delivery time, compiled some factors that affect project delivery, identified by the following researchers and authors; Aibinu and Jagboro (2002) in Nigeria; Belout and Gauvreau (2003) in Canada, Koushki and Kartam (2004), Assaf and Al-Hejji (2005), and Faridi and El-Sayegh (2006) in Saudi Arabia, Frimpong et al. (2002) in Ghana, and Bryde, Iyer and Jha 2005 and Robinson (2005) in the UK. These factors are: Availability of fund; type of procurement system for the project; Project characteristics; client representation characteristics; project team performance (experience); client representative’s characteristics; contractor’s characteristics; Design Team characteristics; external conditions; project Manager’s Competence; top Management support, project manager’s coordinating and leadership skills; monitoring and Feedback by the participants; decision making; coordination among project participants; client or owners’ competence; social condition; economic condition; climatic condition; availability of plants and equipment; the condition of the ground; availability and quality of construction materials; disputes and conflicts; availability of labour and productivity; nature of project planning; environmental regulations; nature of technology; political interest in the project.; the proposed project completion schedule or date; means of communication.

Based on the field survey and analysis of responses, it has been revealed that the availability and adequacy of funding is the main factor affecting the road delivery in Ghana. The above affirms the research by Aiyetan, 2010, and Frimpong et al., (2002). From previous research, it was upheld that the deficit in road delivery was mainly caused by lack of funds and cash flow challenges and Ghana is not an exception. It is interesting to note that projects, which are funded directly by the government, suffer
serious schedule overruns due to the challenge of cash flow from the government. The road fund is not able to generate enough funds for these projects coupled with the scare inflow generated from taxes which is shared amongst all the sectors of the economy. Generally, donor funded projects are completed relatively on schedule provided no political undertones comes in. Since funding is the main driver for every project, the challenge of funding for road infrastructures results in projects either abandoned midway during implementation, or original road designs are altered.

The second factor ranked highly as having significant effect on delivery of road infrastructure delivery is the procurement system adopted for the project. Generally, integrated procurement systems such as design build own operate and transfer, public private partnership and other risk shared systems tend to provide a higher assurance of road delivery compared to the traditional system. The traditional road procurement tends to be long, with lots of political interference and possible corruption influences. This thus affects the delivery of these projects. This affirms previous research by Jha and Lyer (2008)

Political interest for government funded project is imperatively seen everywhere. Nonetheless, the political interest in Africa on specific project is overwhelming. This is particularly seen during political changeovers, when new governments abandon projects executed by previous government just to make a political name. This has made some projects to be abandoned and other linger over a long period of time before completion. Thus, in projects where the political interest is low, funds may not be committed to projects. This affirms previous research by Copper, 2001, Alkathami, 2004

Another factor which was rated as highly significant is the Contractors characteristics and competence, project team performance (quality of technical supervision) lack of long term strategic vision as a nation. At 5% level of significance, 94% of the respondents held that the contractor’s characterization was the major factor affecting the road infrastructure delivery. From previous research, Jha and Lyer, 2008; and Copper, 2001, Alkathami, 2004 all affirmed these factors as significant affecting the road infrastructure provision.

CONCLUSION

The problem of road deficit is apparently pervasive in all developing countries. Inadequate road infrastructure leads to road accident, traffic congestion (which causes waste of fuel, increase travel time and global warming) and other economic and social losses. Extensively, the cost of road infrastructure deficit can be felt in almost all sectors of national economy. Some of the economic sectors which may experience the major impact include agriculture, health service, education, defense and security service, governance etc. This is because most of the activities of these
sectors rely on road transport particularly in the developing countries. In agriculture for instance, the majority of farmers are located in the rural areas with less competitive market price for farm products. These compel them to transport their products to the urban centers where demand is higher for better sales value.

Based on available secondary data analyzed, the average annual total road development from 2000 to 2009 is represented by 7.11%, aggregated as 30.36% in 2001, 11.44% in 2004, and 6.76% in 2008. Meanwhile on the average, the urban road network has grown by 4.227% from 2000 to 2009. Considering the current growth rate, all things being equal, it would take the nation close to 20 years to reach optimum road development. To enhance accelerated growth in the road sector, there is the need for a concerted effort by all stakeholders. The public and for that matter the road user must be ready to pay more tolls for the use of the road and the private sector should be ready to partner the government in the accelerated growth through direct investment and financing, using the public private partnership scheme. Finally, the government should put in procurement structures with open arms to the private sector by removing all bottlenecks.

Based on the field studies, it has been established that the main causes of road infrastructure deficit includes: availability and adequacy of funding. This factor has been the major setback for road infrastructural delivery. Again, the use of ineffective procurement strategy has a considerable effect on the delivery efforts of road projects in Ghana. Other factors that were ranked higher were political interest and poor commitment of government to road infrastructure development, the cultural and traditional influence on development, corruption, Contractors characteristics and competence, project team performance (quality of technical supervision) and lack of long term strategic vision as a nation. Imperatively, these factors have a considerable effect on the delivery on road projects. To go beyond the current 7.11% development rate on road infrastructure, all efforts must be put in place to overcome the above mentioned setbacks.

In conclusion, it has been established that the importance of road infrastructure cannot be overemphasized. The lack of modern infrastructure which includes road is a major challenge to many developing countries’ economic development and constitutes a major impediment to the achievement of the various projected development goals. This is a serious development constraint, especially in countries, where transport cost is a major determinant of prices of basic goods and services. There is an urgent need for road maintenance, reconstruction, expansion among others in several countries. This is an evidence to what pertains in many Sub-Sahara African countries, where on average about one-fourth of the entire network are in poor condition and require urgent interventions to prevent the networks from complete collapse (Amoatey, 2007).
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ANALYSIS OF BUDGETS FOR PHYSICAL INFRASTRUCTURE FOR PUBLIC SECONDARY SCHOOLS

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Budgetary allocations to the educational subsector have fallen short of UNESCO standard which stipulates that 26 percent of the budget be set aside for the sector. This research analyses the capital budgets for secondary schools physical infrastructure with a view to revealing existing relationships between total and capital budgetary allocations to the (educational subsector and secondary schools). The research obtains data from the ministry of economic planning (budget department) for the period (2000-2007). Using simple and multiple methods of statistical of tool regression carried out at 5 percent level of significance, it evaluates the existing relationships between total and capital budgetary allocations. Research findings established that (i) there were no significant relationships between the tested budgetary parameters (ii) the values of the R-square, P, Fcal and Ftab of all the observed relationships were between (0.70-28.4%), (0.233-0.84%), (0.144-0.993) and (5.79-5.99), respectively (iii) the transpositions of the linear relationships to their exponential and polynomial formats, were not significantly different from the earlier linear ones. The research concludes that budgetary allocations to capital funding had no significant influence on secondary schools physical infrastructure development. The research recommends further studies exploring the possible adoption of innovative budgeting technique which inputs demographics and anthropometrics as basis for the establishment of appropriate empirical parameters for the allocation of capital budgets for secondary schools physical infrastructure development.

Keywords: budget, education, physical infrastructure, secondary school

INTRODUCTION

Physical infrastructure is one of the fundamental needs of an economy. Physical infrastructure constitutes the capital stocks of an economy. The physical infrastructure stock for the educational subsector of the economy includes schools and associated facilities for primary, secondary and tertiary institutions (Seeley 1983). The place of physical infrastructure is beginning to be better understood and appreciated in terms of: its

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contribution to national development, its inherent propensity to increase the productive capacity of economies, contribution towards sustainable economic development and the budgetary allocations needed for its financing. According to El-Rufai (1989), infrastructure is needed to increase the productive capacity of human societies and consequently impacts on the standard of living and the environment. Nordberg (2000), has opined that a vast majority of developing countries have tried to use the construction sector to achieve sustainable economic growth and that implicit in the attainment of development goal, is the development of physical infrastructure; buildings, industrial and commercial buildings, schools, hospitals and housing.

Efficient budgetary systems and allocations form the fulcrum upon which the financing, survival and sustenance of public and private organizations are based. Public secondary schools system is not an exception. Owusonye’s (2010), assertion has revealed that physical infrastructure, including schools are characteristically capital intensive and need high public investment at all levels of government. Amaewhule (2007) from a study, has however observed that budgetary allocations to the educational subsector have fallen short of UNESCO standard which stipulates that 26 percent of the budget be set aside for the sector. The study revealed that the federal government expenditure within the period 2000-2005 was less than 10%. The years 2000, 2001, 2002, 2003, 2004 and 2005 had percentage allocations of (8.36), (7.0), (6.30), 4.75), (9.59) and 5.30) respectively. The statistics is abysmally low and because of the perennial neglect education deserves a national emergency attention.

Underfunding for capital development, shortfalls in infrastructure requirements and associated decadence, quality drop and a crisis prone educational subsector are some of the consequential impacts and manifestations of dwindling budgetary allocations to educational subsector as well as secondary schools physical infrastructure development, in the early eighties to date. Newswatch (1988), reveals a declining and fluctuating budgetary allocation since in the 1980(s) and asserts that within the period under review (1980-1988) the budget for sector was less than 10%, government highest vote was in 1981, when it spent 1.326 billion naira. Statistics advanced by the national planning commission (1993), Udoh and Akpan (1996) also revealed capital allocations to the educational subsector by state governments were at unprecedented levels within the period (1994-1996). Allocated funds were between N845.65 to N962.55 million. According to Ukwuoma and Abubakar (1996) and Salim (1988), the observed underfunding for capital development led to endless decay, overcrowded classrooms and inadequacies and shortages in the number of schools and facilities.

Inadequacy and shortages in the number of schools and facilities in addition to the endless decay and overcrowded classrooms constituted a problem area of capital underfunding for secondary schools. Ajisegiri (2004) and Shuaib (2006), have identified inadequate capital funding in the areas of laboratories, workshops, communicational and recreational
facilities. The budgetary trends (2000-2007) of Rivers State, the study location also established unfavourable allocations that were negatively skewed towards capital allocations for educational subsector and secondary schools. This trend has become a source of serious threat to the survival of secondary schools. This deficiency needs to be addressed for various reasons: The pivotal roles of education, towards the development of the individual and nations. Obebe (1977), articulated issues on the philosophy and objectives of the national policy on education as they border on national consciousness, unity values and the needed mind set of the individual for the development of appropriate skills, abilities and requisite competencies needed for development.

Max and Jackson (2009), reiterated the vital roles of education, which include its usage as a means an instrument for national development, a lifelong teaching and learning process which commences and continues until a person’s last day on earth. Education according to the [Academic Staff Union of Universities, ASUU (2000), Ezejule (2003) and Kakahel (2000)], plays a central role in the economic, political as well as its socio-cultural transformations. It plays a critical role in achieving environmental, ethical awareness, values, attitudes, skills and behaviours that are consistent with sustainable development. Needs (2004), further reiterated and pointed out that education has an investment worth, with future profit after a gestation period.

The Pivotal role of education is accomplished through the aid of formal locations and the adoption of stratified systems/levels of learning for socio-economic development. See Learnmond’s (2010) assertions on classrooms as physical infrastructure types which serve as formal locations for learning leading to the issuance of certificates. See, also Cuadara’s (2005) and all Global Monitoring Report (EFA 2011) articulations on secondary schools as the second tier level in the stratified formal educational setting and the induced socio-economic benefits and opportunities; which amongst others include a link between primary, secondary and tertiary education and the labour market. The benefits according to Cornell (2011), is that secondary school system is a process of gaining the right education. Mereno (2005), has revealed that the benefits include the provision of the right education, a bridge between primary, tertiary and labour market. The involvement of the World Bank (2009), in the capital financing of secondary schools in 67 countries totalling US $5.0 billion further emphasises the place of secondary schools in economic developments of countries. The results of this research will address issues of capital budgets and the impact on physical development. Public schools serve as models, providing the necessary guidelines, regulations and standards for private schools to follow. A study of the research location, Rivers State serves as a representation of the other educationally backward states in the country. The results could be applied to other states with some medications.
There is therefore an urgent need for the research to begin to explore the influences of budgetary allocations on capital funding for secondary schools infrastructure. This research begins to contribute to this agenda, through an analysis of capital budgets, with a view to revealing existing relationships between total and capital budgetary allocations to the educational subsector and secondary schools. The following defines the limits and bounds of the research within which established relationships hold: The study period is 2000-2007, represents a new era of democratic dispensation, with expected changes in budgetary processes and procedures and thus allocations for development. Allocations made to the education sector through interventionist bodies such as education trust fund (ETF) and foreign grants from donor agencies were not considered to have impacted on the research because they are occasional and selective.

The research hypothesizes that (i) the aggregate budgetary allocations to the state and secondary schools consist of capital and recurrent budgets (ii) natural linear relationships exist between the total budget and the parameters of capital and recurrent budgets (iii) the total budget for the state is predominantly influenced by the revenue from Federal account (that is Oil revenue and other sources of government internally generated revenue (both federal and state), the total budget is also predominantly influenced by macro-economic variables of exchange, balance of payments, government fiscal and monetary policies. The predictability function of the established relationships from the tested parameters as models are limited; the raw data for both total and capital budgets used for analysis derived their premises from the line-item budgetary technique. The study location is Rivers State, in the Niger Delta Region of Nigeria.

The research draws from previous studies on budgetary allocations. See for example the works of Dalhatu (1998), Kutigi (2002) and Ibrahim (2003) conducted in Niger State (Nigeria), established that the sectorial allocation to the educational sector was between 6.71 to 17.99% for the year 1981 to 1996. The allocations to capital budget of the sector were however less than 10% of the entire education subsector. The structure of the paper is as follows: First it elucidates on argument and discussions on such issues as (i) the factors that influence budgetary allocations for capital funding (ii) what relationships exist between independent and dependent variables (iii) how does the federation account (oil and revenue) and other sources of government revenue influence the budgetary allocations for secondary schools infrastructure development. Second, a conceptual framework of the research provides a basis for the review of related literature as well as an analytic framework for the observed parameters used for the following physical infrastructure (classroom laboratories, dining halls, dormitories, assembly halls, multi-purpose halls, offices) for secondary schools for establishing the budgetary relationships. See figure (5) in appendices. Third, it summarizes the research methodology adopted. Next, it presents the research findings. Finally, conclusions were made drawing, from the research findings of the analysed parameters and offers recommendations.
LITERATURE REVIEW

Budgeting for physical infrastructure development for secondary schools

The review derives its premise from theoretical background that adequate budgetary allocations form the basis for physical infrastructure. The theories guided the choice of the empirical parameters the analysis of data, interpretations and implications of the results. Several literary postulations and reports of empirical studies evaluated issues on macroeconomics and the factors that are responsible for inadequate budgetary allocations for capital funding (ii) what relationships exist between independent and dependent variables of the research (iii) how does the federation account oil and revenue from other sources of government generated revenue influence the budgetary allocations for secondary schools infrastructure development (iv) what other factors influence budget allocations and physical infrastructure development. A conceptual framework of the research provided the basis for literature review, it also provided the analytic framework for the observed parameters used for establishing the equations of the budgetary relationships. See (figure 5) in appendices.

Budgets as planning and control instruments for physical infrastructure development

Evident from the foregoing is that efficient budgetary systems and allocations form the fulcrum upon the survival and sustenance of physical infrastructure for public institutions and private concerns. Public secondary schools are not exceptions, their continuous existence and survival are dependent on budgetary system adopted by government and its agencies. Providing answers to the foregoing questions revealed that budgeting for physical infrastructure is surrounded by great complexities, which require critical analysis and planning that are geared towards undertaking an efficient budgetary allocation exercise. Bozeman and Strausssman (1982), have observed that the process of arriving at a planned statement of expenditure and revenue involves competing and often countervailing forces; issues of centralization and decentralization, autonomy and independence, macro and micro politics.

In a related manner Premehand (1984), has postulated that though the goals and objectives of budgets are conceptually explicit and clear to most people; this clarity may only be superficial and that in practice the budget tends to represent a variety of things to different people. It is an intricate and complex process containing many pieces viewed as a puzzle that cannot always be arranged sequentially because several of them interact simultaneously. According to Wahab (1999), budgeting as a predetermination of proposed expenditure and income over a period that are translated into targets time, involves a number of actions and processes which are normally put in place in order to achieve realistic budgetary planning and control. Adetola (1999), has also noted that it is through the budget that a company's plan and objectives can be converted
into quantitative and monetary terms; it is used for planning and controlling of income and expenditure.

**Considerations for secondary schools physical infrastructure budgeting**

The budgetary allocation exercises for secondary school physical infrastructure is guided by an analytic process that considers the total finances available, the proportions of capital and recurrent expenditures, personnel and overhead expenses. The analysis also appraises the proportion of capital budget set aside for physical infrastructure. Economic analysis include financial options that are opened for sourcing, the impact of sourcing terms on capital finance and the impact of macro-economic variables on the capital sum allocated. In a related perspective, UNESCO (1970), has opined that considerations for the provision of secondary schools physical infrastructure are influenced by the variables of populations, population growth and population density. Other variables include enrolment of students, increase in the number of subjects offered by schools and increase in national, state and local government population. Considerations of the impact of these variables on physical infrastructure are functions of the efficacy of educational planning. Bathurst and Butlers (1980) headings, form a good basis for discussion on the variables that need consideration for the financial control of infrastructure development.

The need for new schools, the replacement of war-damaged and obsolete buildings, the movement of population from city to new suburbs, the creation of new towns, a general increase in the numbers of school children, rise in birth rate, new educational concepts and changes in leaving age. Bruser (1987), has advanced variables that should constitute basis for consideration during budgeting for physical infrastructure development which include economic analysis for all types of project and for all the different forms of finance which are available or which are being sought for, the various financial options which include a country’s internal resources through taxation, through borrowings from national and international banking system, or by grant or loan from a donor or other institutions. Umoren (1994), has postulated that budget is viewed as a mandate for and a limit on expenditure asserting further that economic analysis of physical financing should be presented in the form of budget and that in most cases actual spending generally should coincide quite closely with the budgetary appropriations. Mogbo (1995) posited and suggested that principles of cash flow equal to work flow, phasing strategies drawn from designed projections should form good basis for achieving realistic budgets built through disciplined planning and research and in-built factors for safety.

**Factors influencing budgetary allocations**

Mogbo (1995), has noted that the selection and commissioning of projects are to be based on expert financial advice coupled with some political considerations. Rising budgets deficits of governments at federal, state and local levels should give cause for concern to all Nigerians especially those knowledgeable enough to understand the consequences of unplanned
government spending. Macro-economic variables are essential ingredients that determine the estimates preparation of proper and useful capital budget estimates. The prevalence of exchange rate, interest rate, duties, locational peculiarities, population, land constraint, materials and actions and inactions make the achievement of a realistic budgetary planning and control a complex exercise (Wahab 1999). Government can through its macro-economic instruments effect one or more of its economic goals. By changing monetary, fiscal and other policies, governments can avoid the worst excesses of the business cycle or increase growth rate of potential output. Government expenditures also affect the overall level of spending in the economy and private consumption. Monetary policy determines the money supply and financial conditions. Charges in money supply move interest rates up and down and affect spending in sectors such as business investment, housing and foreign trade. Monetary policy has an important effect on both actual GDP and potential GDP (Samuelson and Nordhaus 2005).

RESEARCH METHODOLOGY

The research is fundamentally effected through field work that is predicated on literature reviews which articulated existing knowledge on budgetary allocations for capital funding for secondary schools physical infrastructure development. The methodology adopted is considered suitable for the research in view of the nature of data that is collected, collated and the computational techniques employed. See, Hughes (2010), articulations on the underlying philosophies and guidelines that influence the choice of procedures for carrying out research works and the subsequent impact on the adopted research methods and design. Mac-Barango’s (2011), research on the impact of distance and demographic variables on price of cement provides an appropriate basis for the choice of the research method. This research appraises the total budgetary allocations to the educational subsector and the secondary schools and the impact on capital budget for physical infrastructure development. The research has the following as its parameters of interest (i) Total budget for Rivers State (ii) Capital for Rivers State (iii) Recurrent budget for Rivers State (iv) The total budget for the educational subsector (v) The capital budget for education (vi) The recurrent budget for education (vii) The total budget for secondary school (viii) The capital budget for secondary school (ix) The recurrent budget for secondary schools.

Data on the tested budgetary parameters is obtained from the ministry of economic planning (department of budget), within the time series 2000-2007. The mean values of the budgetary parameters of the period under review (2000-2007), were used for the analysis. Statistical computer package. (SPSS), was used for the data analysis. The regression analysis established values which formed the basis for the establishment of the degree of relationships (strong, fair and weak), existing between the budgetary parameters tested. The values of Fcalculated, F tabulated of the
statistical technique of regression adopted for the analysis of the relationships between the tested parameters, according to Hamburg (1979), provides estimates for values of dependent variables from values of the independent variables. The device used to accomplish this estimation procedure, is the regression line. David (1981), opines that simple regression is used when the relationship between the dependent and independent variable is linear. It basically embraces the analysis of relationships between variables so as to enable predictions or estimates to be made. The straight line equation which is in the form, $Y = a+bx$, where $Y$ and $X$ are the independent and dependent variable respectively. The general multiple regression model is expressed as, $Y=a+b_1x_1 + b_2x_2 + b_3x_3 + \ldots + b_nx_n$ where $Y$ is the dependent variable, $a$, the regression constant, $b_1$, $b_2$, ..., $b_n$, = the regression coefficient and $x_1$, $x_2$ ..., $x_N$ = the independent variables.

Table 4.1: Rivers State Annual Budgets Parameters (2000-2007).

<table>
<thead>
<tr>
<th>Year</th>
<th>Total State Budget N</th>
<th>State Capital Budget N</th>
<th>State Recurrent Budget N</th>
<th>Total Education Budget N</th>
<th>Capital Budget for Education N</th>
<th>Recurrent Budget for Education N</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>29,822,499,102</td>
<td>22,134,908,741</td>
<td>7,687,590,361</td>
<td>3,074,745,261</td>
<td>1,311,000,000</td>
<td>1,763,745,261</td>
</tr>
<tr>
<td>2001</td>
<td>46,854,000,000</td>
<td>32,607,191,053</td>
<td>14,246,908,173</td>
<td>838,904,173</td>
<td>69,467,666</td>
<td>144,227,507</td>
</tr>
<tr>
<td>2002</td>
<td>63,951,135,583</td>
<td>42,819,922,598</td>
<td>21,131,212,985</td>
<td>1,614,288,034</td>
<td>1,427,550,000</td>
<td>186,738,034</td>
</tr>
<tr>
<td>2003</td>
<td>68,124,299,624</td>
<td>48,090,307,337</td>
<td>20,033,992,287</td>
<td>2,206,888,743</td>
<td>1,990,050,000</td>
<td>216,838,743</td>
</tr>
<tr>
<td>2004</td>
<td>7,936,977,180</td>
<td>48,211,785,777</td>
<td>31,157,990,403</td>
<td>3,005,803,108</td>
<td>2,811,122,900</td>
<td>194,574,108</td>
</tr>
<tr>
<td>2005</td>
<td>96,750,000,000</td>
<td>64,575,751,373</td>
<td>32,174,248,627</td>
<td>2,355,601,952</td>
<td>2,156,675,000</td>
<td>198,926,952</td>
</tr>
<tr>
<td>2006</td>
<td>168,030,823,479</td>
<td>1,248,043,287,155</td>
<td>43,226,494,764</td>
<td>2,074,870,327</td>
<td>1,866,200,000</td>
<td>208,670,327</td>
</tr>
<tr>
<td>2007</td>
<td>183,384,098,500</td>
<td>140,146,098,324</td>
<td>43,283,000,176</td>
<td>2,942,677,456</td>
<td>2,723,700,000</td>
<td>218,977,456</td>
</tr>
</tbody>
</table>

Source: Ministry of Economic Planning (Budget Department, Port Harcourt (2010))

The illustration explains how the equations derived in respect of this research formed the basis for the prediction of one budgetary parameter, when the value of the other is known. Regression equations were used in the determination of the significance of the established relationships, carried out at a significance level of 5%. The P values determine the decision to accept or reject the established relationships of the tested budgetary parameters derived from the regression analysis. The parameters of the established linear regression equations were either positively or negatively correlated. Positively correlated parameters within the equations tend to change in same direction; showing increases in their values. Negatively correlated parameters, tend to change in opposite directions, with either increasing or decreasing values. The transpositions of the variables to their exponential formats (square and cube roots were considered in attempts to find better fits for the tested parameters of the derived equations of the established relationships).
Descriptive Statistics: Is also employed for purposes of establishing some trends; the illustrations and explanations of patterns and rhythms between the tested parameters or the features of dependent and independent variables over the time series (2000-2007).

DATA PRESENTATION

Data for the budgets are presented in tables in 4.1 and 4.2

Table 4.2: Rivers State Annual Budgetary Allocations of Some Budgetary Parameters for secondary schools (2000-2007)

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>1,412,258,068</td>
<td>350,550,000</td>
<td>1,055,708,068</td>
<td>1,037,519,709</td>
<td>18,188,359</td>
</tr>
<tr>
<td>2001</td>
<td>2,773,134,464</td>
<td>150,221,666</td>
<td>2,622,912,798</td>
<td>2,429,288,484</td>
<td>179,970,735</td>
</tr>
<tr>
<td>2002</td>
<td>3,246,912,756</td>
<td>300,000,000</td>
<td>2,946,912,756</td>
<td>2,751,288,484</td>
<td>195,624,314</td>
</tr>
<tr>
<td>2003</td>
<td>3,209,257,032</td>
<td>15,000,000</td>
<td>3,194,257,032</td>
<td>2,917,076,017</td>
<td>54,831,015</td>
</tr>
<tr>
<td>2004</td>
<td>1,154,499,752</td>
<td>696,454,000</td>
<td>458,045,752</td>
<td>224,406,575</td>
<td>233,639,177</td>
</tr>
<tr>
<td>2005</td>
<td>3,259,437,928</td>
<td>629,000,000</td>
<td>2,630,437,928</td>
<td>235,936,966</td>
<td>244,020,804</td>
</tr>
<tr>
<td>2006</td>
<td>4,084,586,339</td>
<td>1,290,550,000</td>
<td>2,794,033,639</td>
<td>2,525,756,591</td>
<td>268,277,084</td>
</tr>
<tr>
<td>2007</td>
<td>4,258,849,407</td>
<td>775,000,000</td>
<td>3,483,849,407</td>
<td>3,212,414,523</td>
<td>271,434,884</td>
</tr>
</tbody>
</table>

Source: Ministry of Economic Planning (Budget Office Department 2010)
PRESENTATION OF RESULTS OF RESEARCH PARAMETERS

Tables 4.3 and 4.4 present the results of analysis on research parameters.

**Table 4.3: Results of Simple Correlation Analysis between Budgetary Parameters**

<table>
<thead>
<tr>
<th>Exp No</th>
<th>Variables</th>
<th>Type of Mod</th>
<th>Observations</th>
<th>Inferences</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X</td>
<td>Y</td>
<td>Regression Equation</td>
<td>R²</td>
</tr>
<tr>
<td>1a</td>
<td>Total Education budget</td>
<td>Linear</td>
<td>Secondary Schools Total Budget = 4 x 10⁹ 0.440 Total Education budget</td>
<td>9.1%</td>
</tr>
<tr>
<td>1b</td>
<td>Total Education budget</td>
<td>Quadratic</td>
<td>Secondary Schools Total Budget = 7 x 10⁹ 8.838 Total Education budget</td>
<td>36.9%</td>
</tr>
<tr>
<td>1c</td>
<td>Total Education budget</td>
<td>Cubic</td>
<td>Secondary Schools Total Budget = 1 x 10⁶ + 6.02 x 10¹⁰ Total Education budget² – 1.2 x 10¹⁸ Total Education budget³</td>
<td>42.6%</td>
</tr>
<tr>
<td>2a</td>
<td>Total Education budget</td>
<td>Linear</td>
<td>Secondary Schools Capital Budget = 1 x 10⁶ – 0.175 Total Education budget</td>
<td>10.9%</td>
</tr>
<tr>
<td>2b</td>
<td>Total Education budget</td>
<td>Quadratic</td>
<td>Secondary Schools Capital Budget = -5 x 10⁶ + 0.920 Total Education budget – 1.1 x 10¹⁰ Total Education budget²</td>
<td>17.2%</td>
</tr>
<tr>
<td>2c</td>
<td>Total Education budget</td>
<td>Cubic</td>
<td>Secondary Schools Capital Budget = 4 x 10⁶ – 0.886 Total Education budget</td>
<td>18.1%</td>
</tr>
<tr>
<td>3a</td>
<td>Education Capital budget</td>
<td>Linear</td>
<td>Secondary Schools Total Budget = 3 x 10⁹ 0.133 Education Capital budget</td>
<td>0.7%</td>
</tr>
<tr>
<td>3b</td>
<td>Education Capital budget</td>
<td>Quadratic</td>
<td>Secondary Schools Total Budget = 8 x 10⁹ 2.541 Education Capital budget – 6.6 x 10¹⁰ Education Capital budget²</td>
<td>9.2%</td>
</tr>
<tr>
<td>3c</td>
<td>Education Capital budget</td>
<td>Cubic</td>
<td>Capital budget + 1.2 x 10⁹ Education Capital budget² – 2.4 x 10¹⁸ Education Capital budget³</td>
<td>35.3%</td>
</tr>
</tbody>
</table>
DISCUSSION OF RESULTS OF THE TESTED PARAMETERS

The results of the inferential analysis as presented in tables 4.3 and 4.4 are discussed as follows: The simple regression established that (i) There were no significant relationships between the tested parameters (ii) The degree of correlation between the tested parameters of the established relationships were weak (showed negative or positive linear relationships) (iii) The R-square values of the established linear equations were between (9-25) percent. (iv) The P values were between (0.233 – 0.843). (v) The results of the Multiple Regression analysis as presented in tables 4.4 did not establish any significant departure from the results of the simple regression analysis. The relationships indicated a weak negative linearity between the parameters. (vi) The relationships between the parameters, using multiple regression analysis did not establish any significance.

The independent variables of the linear equations from the regression analysis cannot be predicated from the dependent variables; that is the total budget for education (combined capital and recurrent budget) cannot form a reasonable basis for the prediction of total budget for secondary school, as well as the capital budget for secondary schools. Arbitrariness appears quite predominant in the budgetary allocations over the study period. The results of the analysis is explainable by the fact that the raw budgetary data values were obtained from the incremental line – budgeting technique. This accounts for the observed limitation of the predictability function of the relationships established between the parameters. Figure 5, as presented (see appendices), provided the basis for the literature review and an analytic framework for the observed parameters of the established budgetary relationships. The works of several scholars appear to have given credence to the results and implications of the tested parameters, which established that the budgetary allocations were not adequate. This is indicative of an education sub-sector that is crisis prone and by implication secondary schools and the capital funding required for physical infrastructure development.
Table 4.4: Results of Multiple Correlation Analysis between Budgetary Parameters

<table>
<thead>
<tr>
<th>Exp No</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
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<tr>
<td>6</td>
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</tbody>
</table>

### Observations

<table>
<thead>
<tr>
<th>Observations</th>
<th>Inferences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression Equation</td>
<td>R²</td>
</tr>
<tr>
<td>Secondary Schools budget = 4 x 10⁹ - 1.114 Education Capital Budget – 0.112 Education Recurrent Budget</td>
<td>28.4%</td>
</tr>
<tr>
<td>Secondary Schools Capital budget = 3 x 10⁷ Education Capital Budget + 0.268 Education Recurrent Budget</td>
<td>22.7%</td>
</tr>
</tbody>
</table>

### DISCUSSIONS OF THE DESCRIPTIVE CHARTS FOR THE BUDGETARY PARAMETERS.

Figure 5 as presented, see appendices, provided the basis for the literature review as well as the analytic framework for the observed parameters of the established budgetary relationships. Figures 4.1 to 4.4 (see appendices) present the descriptive analysis of the budgetary trends for the educational subsector and secondary schools under the period of the review (2000-2007). The salient features of the figures 4.1 – 4.4 are as follows: figure 4.1, indicated that secondary schools received more funds that the educational subsector, when expressed as a percentage of the total education budgets for the period (2000-2007). In figure 4.2, the chart showed that the values of capital budgets for secondary schools expressed as a proportion of total budget for the educational subsector was slightly above 10 percent in the year 2000. In the years 2001, 2002, 2003, 2004, 2005 2006 and 2007, the allocations for capital expenditure were less than 25%. In 2006, it was slightly above 60%. In figure 4.3, the chart indicated that the budgetary allocation for capital funding for the educational subsector was high as high as 400 percent in 2001. In 2004, the proportion of allocation set aside for capital expenditure from the educational subsector was less than 50 percentage. Figure 4.4, the chart showed that the values of the capital budgets of the secondary schools, taken as a proportion of the total budgets for education during the period were all below 70 percent, though in the year 2006, the expenditure for secondary capital funding was up to 70 percent. The charts show budgetary allocation patterns that would seem characterized by arbitrariness over the study period. This is in resonance with the results of the inferential statistics (using simple regression) which established that the relationships between the tested parameters that is (i) The total education budget and total budget for secondary school (ii) total budget for education
and capital budget for secondary schools (iii) capital budget for education and total budget for secondary schools (iv) capital budget for education and capital budget for secondary schools, did not establish any significance. Also the results of the established relationships using multi-multiple regression (see table 4.4 for the parameters), did not also establish any significance.

**CONCLUSION**

The following conclusions arising from the review of related literature and field work are reached. The research reveals in adequate budgetary allocations to the education subsector and by implication secondary schools and their capital funding for physical infrastructure development. This occurrence has led to neglect, decadence, deterioration, over stretching of facilities and threatened the survival and sustainable development of secondary schools in the study location within period under review. The tested budgetary parameters of total budget for education, secondary school total budget, secondary school capital budget and the capital budget for education cannot be used for predicting budgets for secondary schools physical infrastructure. The existing budgets (which formed the basis of raw data), are products of the traditional incremental line-item budgeting method are found inadequate for secondary schools physical infrastructure.

Based on the results and conclusions the following recommendations are made: The incremental line-method from where allocations for secondary schools physical infrastructure are made should be discontinued. The observed shortfalls in capital funds for secondary schools physical infrastructure should be eliminated. An innovative approach should provide a basis for the assessment of the needs requirements and subsequently the expected cost and thus the budgetary allocations. The innovative approach has the capacity and the likelihood to eliminate the problems associated with the incremental line-method; it should input demographics and anthropometrics into budgetary regime. Capital funding and budgetary allocations could be tailored for study in the various subsectors of the economy, different time series and locations and also exploring the impact of macro-economic variables on budgetary allocations for public secondary schools.

**REFERENCES**


NEEDS, (2004) Development of infrastructure as one of the key sectors needed to increase capacity and productivity of Nigeria’s economy.


APPENDIX
Summary of Descriptive Charts

Figure 1: Secondary Schools Total Budget expressed as percentages of the Total Education Budgets of Rivers State for the period (2000-2007).

Figure 2: Secondary Schools Capital Budget expressed as percentages of the Total Education Budgets of Rivers State for the period (2000-2007).

Figure 3: Secondary Schools Total Budget expressed as percentages of the Education Capital Budgets of Rivers State for the period (2000-2007).
Figure 4: Secondary Schools Capital Budget expressed as percentages of the Education Capital Budgets of Rivers State for the period (2000-2007).

Figure 5: Conceptual Framework for the Analysis of Budgetary Variables for Secondary Schools Physical Infrastructure Development.
ANALYSIS OF SPATIAL INEQUALITY AND URBAN POVERTY TRAPS IN AKURE, NIGERIA

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The incidence of spatial inequality and poverty traps are evident in the developing countries of the world including Nigeria. This scenario is stemmed out of the disparity in differential investment activities and economic prosperities. The paper appraises poverty traps and spatial inequality in Akure - the capital city of Ondo State. The study covers five out of the nine existing political wards of Akure metropolis. These five political wards were purposively selected for the study on the basis of their peculiar nature. The sampled wards are: ward 4, ward 7, ward 9, ward 10 and ward 11 respectively. The study adopted direct observation and oral interview. Development pattern and interaction where used in identifying gaps of socio-economic inequality and poverty traps in the study area. For better understanding, the city was clustered alongside with political wards where study was carried out. However, general overview of the city was also examined in line with facility and infrastructural distribution and the level of its accessibility by residents. The study identified limited access to insurance, credit facilities and unstable equilibrium among urban competitors as some of the factors responsible for spatial inequality and poverty traps. In view of the foregoing, the paper posited that cities should be studied and analysed on sectoral basis, cities appraisal should be carried out on the peculiarity of neighbourhood units, provision of urban basic services as well as massive reinvestment towards bridging the gaps, achieving city livability and urban sustainability in Africa.

Keywords: Akure, Nigeria, poverty trap, spatial inequality, urban competitor

INTRODUCTION

The development of our urban areas changes not only the physical environment but also the social and economic characteristics. These changes are yet to commensurate with the level of globalization and poverty alleviation programme so far embarked upon by governments at various levels; as poverty traps still remain an eyesore in our cities.

Cities and towns are by their varied nature, always in a state of flux with new people, new trade opportunities, new forms of power and opportunities. These dynamics lead to tension, violence, often linked to control over space and the changing, nature of vulnerability (Ursula,
In the developing countries in particular, poverty traps are identified to be prevalent but not limited. In support of this, Kate et al (2010) attested that billions of people around the world live in spatial poverty traps. These phenomenon are found in detached, remote rural areas and also in the burgeoning slums of cities. These sectors of our cities harbor a large numbers of people as around 1.8 billion people live in less “favoured” “Low potential” areas, and around 1 billion people live in slums in the developing world (Pender and Hazell, 2000, in CPRC, 2004; World Bank, 2008 in CPRC, 2010). In another view, Ursula (2010) argued that urban spatial poverty traps are grossly evident in the developing country context, and that these situation exist alongside with rapid urbanization and rising urban poverty.

Amis (2002) was with the view that urban is assuming, an increasing proportion of overall poverty. This proportion is measured through households income as majority households live below the national poverty line still tends to be slightly lower in urban areas than rural areas, but a substantial amount of total poverty in many countries of Africa and Asia is now urban (on excess of 20%).

**LITERATURE REVIEW AND THEORETICAL BACKGROUND**

Inequality has in recent years come back on the agenda in international development debate and practice as academics are asserting the importance of income inequality for growth, efficiency, poverty reduction and many political processes (Rasmus, 2002).

Geographic aspects of inequality and poverty are attracting particular attention, both because they seem to be empirically important and because models of imperfect competition and transaction cost have made it possible to rigorously model spatial inequalities that persist over time (Rasmus, 2002).

Ursula (2010) emphasized that spatial poverty traps literatures drawn an evidence and observations that pockets of poverty exist in particular locations and concludes that people living in the same area experience similar risks and vulnerabilities opportunities and economic conditions. He concluded that for an area to be a poverty trap, the majority of the population is poor and local resources are extremely limited. It could be deduced from the submission of Ursula (2010) that poverty traps could be locational relative. In the same vein, Rasmus (2002) asserted that regression based techniques can be used to directly assess how much geographical characteristics contribute to total income inequality, controlling for other factors such as the characteristics and endowments of the individual and its household. Empirical assessment of returns to location is of substantial interest for policy and research. Therefore, policy implications of spatial inequality depend on whether it is caused by
differential accumulation of assets across regions or by variation in returns to location (Rasmus, 2002)

The assertion above is in line with this statement that spatial poverty traps may be geographically remote, that is, area that are far from the centre of political and economic activity, low potential or ecologically disadvantaged area that have low agricultural or natural resources, politically disadvantaged areas or weakly integrated areas, poorly linked both physically and in terms of communication and markets (CPRC, 2004). The endowments of an area explain a substantial proportion of the poverty of people living in it, controlling for individual and household characteristics, such as age, household composition or ethno-linguistic group (Jalan and Ravallion, 1977; Ravallion and Wodon, 1997).

Theoretical and conceptual literature establishing spatial disparities has been accompanied by numerous empirical studies that demonstrate the existence of spatial poverty traps, following Jalan and Ravallion’s original work in China, several studies demonstrate empirically the existence, and drivers, of spatial poverty traps. Bird and Shepherd (2003), in their empirical study of semi-arid zones in Zimbabwe, identify a clear link between high levels of remoteness, low levels of public and private investment and high incidence of chronic poverty.

Escobal and Torero (2005) and similar results in Peru: they identify a strong association between spatial inequality and variation in private and public assets. Minot et al. (2003) argue explicitly for the presence of spatial poverty traps, given that interventions have been unable to address the small number of agro-climatic and market access variables that explain roughly three-quarters of poverty in rural Vietnam. In his work on Indonesia, Daimon (2001) describes the presence of a spatial poverty trap in which spatial factors, including quality of public goods in a district of residence, remoteness and rural residence, are statistically significant in determining levels of per capita expenditure and poverty rates. Christiansen et al.(2005), in their cross-Africa study, find that the impact of economic growth on poverty reduction depends on how remote households are from economic centres and how well they are served by public depends on how remote households are from economic centres and how well they are served by public infrastructure. Drawing on research from Madagascar, Fafchamps and Moser (2004) argue that, in the developing world, isolated regions tend to have more banditry and are more likely to harbor armed terrorist or insurgent groups than better connected areas, and that this can lead to the deepening of spatial poverty traps.

Spatial poverty traps present many challenges to development policy. On such challenge is that they may in fact be the result of development policies or interventions, as Fu (2004) find in China, where regional disparities are related intimately to the structure of exports and foreign direct investment. The emphasis on a pattern of economic growth associated with foreign direct investment, labour-intensive production and
processing-related exports in the coastal regions has attracted relatively mobile and efficient resources from the inland regions, but has offered only limited growth to the sending regions, exacerbating regional disparities. Another challenge spatial poverty traps present is their heterogeneity, which means that varied policy responses are required. For example, Okwi et al (2006) find that a range of spatial factors explain the differentiation in welfare levels across provinces in Kenya, which therefore require variable policy responses.

Summarily, literatures in relation to spatial inequality and poverty traps are in exhaustible. However, the studies did not give general overview of spatial inequality and poverty traps in Africa in desirable details. Although, these studies are pertinent and crucial to the understanding of those listed case studies of countries and continents but did not give absolute representation of poverty traps and spatial inequality in Nigeria per settlement. Hence, the need to conduct an independent study that will reveal the true position of situation in the study area becomes imperative.

Moreover, these studies reviewed above were selective in approach as each study centred on specific location and does not provide an evident based platform for the study area. For the purpose of empirical and direct understanding of the subject matter, there is need for an evident based study or research work which will showcase pattern and nature of spatial inequality and urban poverty traps that will serve as basis for further research and provide information that will be useful for policy makers and program designers towards curtailing the attendant problems in the study area.

The Value of social analysis to understanding urban poverty
Social analysis is imperative to our understanding of urban spatial poverty traps. Social geographical analysis, for example, enables the detailed unpacking of those things which make up a town or city and the influences they have in society. Understanding these dynamics is critical to understanding why poor people live in certain neighborhoods, and why certain areas remain poor over periods of time (Ursular, 2010).

Urban geography and social science
The development of urban areas changes not only the physical environment but also the social environment. Ursular (2010) Urbanization transforms social relations, such as class and caste systems and gender dynamics, in ways which may provide benefits example for greater freedom for women to enter the labour market, but also costs such as poor labour or citizenship rights for migrant workers. As we have seen, urban areas are in a constant state of flux: new people, new trade opportunities, new forms of power and opportunity. Understanding these transitions greatly enhances our comprehension of how poverty traps might evolve in urban areas –often linked to control over space and the changing nature of vulnerability (John and Vincent, 2011).

First, cities are created not randomly but in response to advantageous features. Urban ecology, for example, links city growth to advantageous
environmental features (shores of rivers, fertile plains, intersection of trading routes or railways). Industry is situated near raw materials and supply lines; populations increase and diversify; land values and property taxes rise. This theory draws urban development along concentric rings from the Centre, with business in the Centre, alongside central cramped established neighborhoods, and more affluent, newer resident areas moving out to form suburbs around the parameter. This is underpinned by processes of invasion and succession: as property decays in a central or near-central area, ethnic minority groups might start to move into it, precipitating others to move elsewhere in the city and the suburbs (Giddens, 2006).

Second, urban areas are often characterized as more modern, autonomous and anonymous places. Urbanism provides a body of theory that accepts that density of social life creates distinct neighbourhoods. Yet these neighbourhoods may retain the character of small communities, for example immigrant areas may retain traditional types of social interaction. Over time, such distinctions decline as different groups merge and are absorbed into different neighbourhoods. Thus, urbanism is not just an expression of society but also itself shapes and influences society as it develops (Giddens, 2006 in Ursular, 2010).

Urban environments therefore represent symbolic and spatial manifestation of broader social forces. The taxation system influences who is able to buy or rent where and who builds where. Large corporations, banks and insurance companies, which provide capital for building projects, have a great deal of power over these processes. But government agencies also directly affect many aspects of city life, by building roads and public housing and planning green belts on which new development cannot encroach, for example (Giddens, 2006). Urban centres are created environments, reflecting social and economic system of power. As wealth and power concentrate in some areas and sectors, others are left to decay. These social processes are interdependent (Harvey, 1973).

Social theory is relevant here. First, analysis of ‘networks; (Social capital) uses social theory (e.g. Wilson, Putnam, Fafchamps, Briggs) to map the spatial isolation of the poor from survival and mobility strategies. How people link to and define social groups can play a significant role in forming identities and enabling livelihood support, particularly among those living difficult lives. There may well be important issues around neighbourhood homogeneity here. If poor people tend to live in areas that largely house other low-income people, what might the implications be for their social capital? Social capital for support during times of hardship may be strong but the kinds of social and socio-political capitals that enable escape from poverty may be limited.

Second, theories of exclusion/inclusion are also useful. People’s experiences of their environment are embedded in social relationships. Many key services, for examples, are necessarily delivered in and through social relationships for example doctor-patient, teacher-students. The same is
true of how people are incorporated into economic, political and other socio-cultural spheres. Ethnic tensions and unemployment along ethnic lines are referred to as the invisible fault lines within cities, which can erupt through urban violence and riots. City planning plays a major role in making city life liveable for the poorest in society such as barrel-shaped benches that stop homeless people from sleeping on them, availability of public toilets, sprinkler systems in parks among others. Often, planning efforts aim to contain the more visible urban poverty problems such as homeless people or squatter settlements within certain zones or move them out of the city such as evictions and harassment.

**AIM**

The aim of the paper is to assess the pattern of spatial inequality and poverty traps in Akure with a view to curtailing its attendant problems.

**OBJECTIVES**

The specific objectives of the paper are to:

- explore the spatial distribution of spatial inequality and poverty traps in Akure.
- identify area of disparity within the urban context among various competitors.
- identify the role of governmental and non-governmental organizations in bridging the gap of spatial inequality and poverty within Akure.
- generate information that will be useful for policy makers and program designers in Akure and Ondo State at large.

Research questions: some of the research questions are:

- What is responsible for unequal access to basic necessity of life in Akure?
- Do all residents in your city of residence have equal access to basic necessity of life?
- What are the programmes of government in bridging the gap of spatial inequality and poverty traps amongst the residents' population?
- What is between poverty rate, average per capital expenditure and spatial inequality?

**STUDY AREA**

Akure, a typical traditional city in the South Western geo-political zone of Nigeria, is located on latitude 7°17' North and Longitude 5°14' East at an altitude of about 370m above the sea level as shown in figures 1 and 2. The city accommodated a population of 38,852 in 1952, 71,000 in 1961, 109,000 in 1980, and 112,000 in 1981; 114,000 in 1982; 117,000 in 1983;
120,000 in 1984; 123,000 in 1985. This population of Akure rose to 239,124 in 1991. In 2014, the city has an estimated population of 375,425.

Figure 1: Map of Nigeria showing Ondo State

Figure 2: Map of Ondo State showing Akure South Local Government Area
The Akure area, which is located in a gently undulating terrain surrounded by inselbergs, in underlain by granites, charnockites, quartzite, granite gneisses and migmatite gneisses (Olarewaju 1981). The granites occupy about 65% of the area. The migmatite gneisses, being the oldest rocks in the Nigerian basement, are both litho- and tectonostatigraphically basal to all superjacent lithologies and orogenic events (Rahman, 1976). The area is flanked in the north by Ikere Batholith and in the south by Idanre batholith. The drainage pattern in the area is dendritic and the major rivers are River Ala, River Owena and River Ogburugburu (Anifowose and Kolawole, 2012)

MATERIALS AND METHODS

The study covers five out of the nine existing political wards of Akure metropolis. These five political wards were purposively selected for the study on the basis of their peculiar nature. The sampled wards are: ward 4, ward 7, ward 9, ward 10 and ward 11 respectively. The study adopted direct observation and oral interview. Development pattern and interaction where used in identifying gaps of socio-economic inequality and poverty traps in the study area. For better understanding, the city was clustered alongside with political wards where study was carried out.
However, general overview of the city was also examined in line with facility and infrastructural distribution and the level of its accessibility by residents.

**FINDINGS AND DISCUSSIONS**

The inner city is characterized with insufficient access to basic services. Access to basic necessity of urban life is seriously inadequate. This part of the city is also characterized with illegalities and insecurity. There is also manifestation of physical overcrowding, which render or subject the area to wide threats and vulnerabilities. This overcrowded high density area or neighbourhoods demonstrate high indecent urban life which present extreme health hazards, which consequently impacts on the health and wellbeing of slum population. This part of the city can be classified as the run down part of the city.

On the contrary, in some selected neighbourhoods, were improved housing with adequate access to basic necessity life among others. This is reflected in plate 2.

Urban livelihoods at the inner city, which is characterized by the city poor is grossly typified by high formal unemployment, underemployment, casual and informal labour. They have limited opportunities to some and also acquire assets, own to high cost of living and inability to access credit facilities. In addition, the people who reside at the inner city that is predominantly occupied by the poor do not have access to insurance. Moreover, since they could not be accommodated into the mainstream of the economy, they choose to involve in black market trading and other illegal activities become their means of livelihoods and viable alternatives.

Plate 1: showing obsolescence housing at the down town of the city (Habitation of the poor). Source: Author’s field survey, 2014
In contrary, residents of Ijapo, Oba-Ile housing estates move of formal employments with full access to basic support like access to credit and insurance facilities. The neighbourhoods or the districts of the poor in the study area are characterized by slums which is the physical manifestation and expression of urban inequality. These zones are crowded with squatters, ghettos and general poor housing conditions. The various zones being occupied by the urban are dirty, unkempt and unsafe for human habitation.

They are also embattled with physical, social and mental stress and threats. These geographical areas showed an exclusion from formal planning of basic services, although they fall within entire urban geographical area. These dynamics lead to gap and separation between
urban poor and the rich. Educational dissemination does exist as poverty trap in the study area. There is a direct relationship between wealth and educational level of children within a particular district. This disparity is as result of the income level of parents and unequal distribution of government assets. There is variation in access to quality of education and this manifested within neighbourhoods. The discrimination in access to education identified is hinged on inequalities in family wealth and status. The study also revealed that this discrimination does not end at primary school level but also manifested in secondary schools and post-secondary school education. It is also hinged on government inability to ensure equity among its citizenries in the state in having access to basic education. Such disparity and gap do manifested in the case of Mega primary schools of a controlled population with other public schools in the state. Plate below explains further the case.

Plate 4: Showing improved primary school in the study area (Mega primary school). Source: Author’s field survey, 2014

Plate 5: Showing obsolete primary school in the study area (The Salvation Army Primary School, Odo-Ikoryi, Akure). Source: Author’s field survey, 2014
Lack of access to basic infrastructure was also identified as poverty trap in the study area. The poor in various districts and neighbourhoods could not have access to basic necessity of life like potable water, sanitation, health, affordable transportation, electricity among others. Study revealed that some have to spend qualitative time before they can get potable for their family consumption, while some result in taking of the unsafe water that is available at their districts. This is manifested as people along continental road were fetching water from drainage channel from broken water mains.

Plate 6: Residents of NEPA and Oshinle Areas queuing for water
Source: Author’s field survey, 2014

Plate 7: Residents of Continental Road in Akure fetching water from damaged water mains in drainage channels. Source: Author’s field survey, 2014
In general, urban infrastructures in the districts of the poor are in dilapidated conditions. Urban infrastructure is not uniformly accessible or distributed to the rapidly growing urban needs. Transportation also constitutes another phase of poverty trap as many poor have to walk for several kilometres before they can get to their place of means of livelihood.

**Implication on Research, Policy Makers, and Nigerian Society**
This article has several implications for future researches and policy makers and as well as the Nigerian society at large. It describes pure and applies a novel and appropriate promising approach to study the causes of spatial inequality and poverty traps and its change. This article seeks to generate and empirical assessment of the relative contribution to spatial inequality of demographics, education, occupation, assets and geography. This also produces facts concerning the causes of spatial inequality and urban poverty traps that can help to guide future theoretical work. In addition, information on the spatial distribution of poverty and inequality is useful because it will assists policy makers and program designers by shedding light and facilitating efforts to focus poverty alleviation programs on the poorest neighbourhoods and the like in the study area and Ondo state at large. The article will also serve as base-line information for further research works in the study area. The implication of the situation on Nigerian society is that poor neighbourhoods could easily be identified for immediate attention. On the contrary, if policy makers did not apply appropriate measures, society polarization will be worsened as cities will be further separated into more clearer distinctive classes.

**RECOMMENDATIONS**
The previous analysis shows that there has been an upsurge and incessant inequality in many sectors of our urban fabric due to unequal distribution of both social and economic value in terms of incomes, wages and general investments. On this basis, the following recommendations are made.

- Cities should be studies and analyses in segment and not in aggregate. This will help to contextualize urban data effectively for poverty reduction and policy making for sustainable city planning and development.
- Bearing in mind that density of social life creates distinct neighbourhoods, then, analysis should be done in pocket of neighbourhoods in line with their peculiarity.
- There be increased in educational investments and micro economic policies support towards employment creation in reducing inequalities among citizenries in the area, this will afford the deprived and discriminated to have access to standard quality of...
education. This will guarantee universal basic education to all intended citizens in the study area.

- There should be basic social protection programme in government. This will serve as one of the effective means of protecting people from poverty and keeping inequality in serious check. This policy will ensure basic income security, in form of various social transfers in cash or kind, such as pensions for older persons, income support for individual with disabilities. This concept will ensure that individuals do not slip into poverty as a result of loss of employment, poor health or external shocks. However, the result of this may not guarantee absolute equality, but ensure that social mobility ladder is not far apart. It provides an opportunity to participate in the social, economic and political activities more widely.

- Government should also embark on low housing scheme for the low income earners and the less privilege towards bridging gap of sharp and too far apart housing classes in the study area. This will afford the deprived and the marginalized to have access to decent accommodation at possible least cost.

- There should be increased in the minimum wage. The implementation and strict enforcement of improved minimum wage will be significant in improving distribution and redistribution of wages in the state. Improved minimum wage will assist in reducing the gender gaps in wages, particular by those who clustered around the lower end of wages distribution in the state.

**CONCLUSION**

It is obvious that poverty traps and spatial inequality do exist in our society and this has actually stampeded sustainable city livability and aggregate comfortability. It is also deduced that there is no single policy approach of government towards curtailing the growing spatial inequalities and poverty traps. Since there is no definite policy of government tending towards promoting sustained, equitable and inclusive growth, where both social and macro-economic policies should be integrated in tandem to facilitate urban growth coupled with decent employments to tackle poverty, inequality and makers to review their various policies towards, addressing the subject matter through affirmative action plans, public investment, special social specific initiative towards ensuring equal access to education, health, housing among via redistribution of fiscal policy that will grossly address the problem of spatial inequalities and urban poverty trap in achieving equality, economic development social justice environmental protection, administrative and cultural realities in our state. New struggles tackle poverty must be consciously integrated into the development policies of government. These struggles must go far beyond mere policy plan but rather
implemented to confront the present trend towards stopping further deformation of citizens’ welfare to promote social security, justice and equity among citizenries.

REFERENCES


William T. Oswald (2005); The poverty trap – A critical look at how we define the causes of Poverty.

APPRAISAL OF HEALTH AND SAFETY MANAGEMENT PRACTICES OF CONSTRUCTION SMES IN ABUJA, NIGERIA

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The construction industry is a major contributor to the economic growth of developed and developing nations. Surprisingly, it is also a major contributor to the occupational accidents and ill-health record. This research was undertaken to evaluate the health and safety (H&S) management practices of Small and Medium Sized Enterprises (SMEs) operating in the construction sector of the Federal Capital Territory of Nigeria. The data for the study was collected using questionnaires. The research population comprised construction SMEs operating in Abuja and registered with the Federation of Construction Industry (FOCI). The data were analysed using relative importance index (RII). Out of the fifty-eight (58) H&S management practices identified from literature, this study revealed that forty-six (46) were important. The 46 H&S management practices were categorized under five core practices: company commitment, worker consultation and participation, communication, health and safety planning, and education and training. Dominant H & S practices include provision of first aid facilities on site, provision of personal protective equipment and keeping of safety record and follow-ups. It was concluded that all the core H&S practices are capable of improving the health and safety performance of construction SMEs.

Keywords: accident, SME, hazard, health and safety management, Nigeria, risk.

INTRODUCTION

The construction industry has been identified as one of the most risky and hazardous of all industries in terms of health and safety. This is because the industry’s fatality record of 13% is placed only after coal and petroleum industries with 21.9% fatality record (Diugwu et al, 2012). The majority of indigenous construction businesses in developing countries, such as Nigeria, are Small and Medium-size Enterprises (SMEs) operating within the domestic markets (Koehn et al. 1995; Kheni et al. 2006; Idoro, 2011).

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These businesses have been shown to often lack sufficient capacity to compete effectively in the international market or undertake large and complex development schemes. This, coupled with an underdeveloped local construction material base, inadequate technology and low foreign earnings, explains the continuing dominance of foreign contractors in piloting complex engineering schemes in developing countries (Diugwu et al., 2013). Kheni et al (2006) reported that while foreign contractors operating in developing countries effectively manage health and safety, indigenous construction businesses do not have effective arrangements in place for managing health and safety issues.

The health and safety regulatory environment within which the construction industry operates includes building and related codes, licensing requirements and safety legislation. Yet, previous studies report that management policies do not adequately address employees’ health and safety concerns (Akpan, 2011); that the industry still experiences careless attitudes, overconfidence and failure to provide healthy and safe working measures as well as periodic health and safety seminar for the stakeholders and general public (Okpan and Agha, 2013); and that the regulations do not reflect the local environment (Idoro, 2008). Okeola (2009), Idoro (2011) and Idubor & Oisamoje (2013) further reported that the Nigerian contractors operate a production method that are prone to high injury because the level of compliance to and implementation of safety rules by the construction firms is abysmal.

Recommendations from previous studies have remained ineffective in addressing the challenges of health and safety in the Nigerian construction sector because the studies have been largely generalised without taking cognisance of the peculiar determinants of effective health and safety system such as the size, age and sector of operation of the key players. The study reported in this paper is a pilot study, which is part of an ongoing doctoral research aimed at assessing the effect of organisational characteristics on health and safety management practices by Nigerian construction firms. The purpose of the paper is to report on the evaluation of health and safety management practices of Nigerian construction SMEs.

PREVIOUS RELATED STUDIES ON HEALTH AND SAFETY MANAGEMENT PRACTICES OF CONSTRUCTION SMES

Past researches have shown that certain practices can lead to improved health and safety performance. Kheni (2008) and some other authors provided a summary of these previous studies as presented in Table 1.
<table>
<thead>
<tr>
<th>Year and Authors</th>
<th>Summary of Research</th>
<th>Health and Safety Management Practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liska et al. (1993) cited in Kheni (2008)</td>
<td>Identified zero accident techniques.</td>
<td>Identified the following to be associated with safety success: * safety training and orientations; * provision of safety incentives; * safety pre-task planning included in safety goals; * safety person or personnel; * safety policies and procedures; * fire protection programme; * accountability/responsibility and safety budget; * alcohol and substance abuse programme in place; * accident and near-miss investigation; and, * record keeping and follow-ups.</td>
</tr>
<tr>
<td>Jaselskis et al. (1996) cited in Kheni (2008)</td>
<td>Strategies for achieving excellence in construction safety performance.</td>
<td>Companies with lower recordable incidence rates were characterized by the following: * more detailed safety programmes; * expended large percentage of revenue on safety programmes; * greater safety training time; * more formal safety inspections per month; and, * more safety meetings.</td>
</tr>
<tr>
<td>Gallagher (1997) cited in Kheni (2008)</td>
<td>Identified factors associated with improved health and safety performance.</td>
<td>The study identified the following factors to the associated with better health and safety performance: * high level of top management commitment; * health and safety responsibility known; * supervisor involvement encouraged; * active involvement of health and safety representatives who have a broad role; * effective health and safety committees; * planned identification of risk and hazard elimination/control emphasis; and, comprehensive approach in inspections and investigations.</td>
</tr>
<tr>
<td>Aksorn and Hadikusumo (2008) cited in Kheni (2008)</td>
<td>Investigated the effectiveness of safety programmes in the construction industry.</td>
<td>Safety performance was found to be influenced by the nature of the implemented programmes. Particular elements of safety programmes found to be positively associated with safety performance included: * accident investigations; * jobsite inspections; * job hazard analysis; * safety inductions; * safety record keeping; * safety committees; * safety incentives; and, * control of subcontractors.</td>
</tr>
<tr>
<td>Idoro (2011)</td>
<td>Studied the influence of mechanization on OHS performance of the Nigerian Construction Industry.</td>
<td>Mechanization was discovered to have the tendency to worsen OHS performance of the construction industry when not properly managed. It was then recommended that: * stakeholders should give more attention to OHS management plan; and, * hazard management plan in the use of plant and equipment on site should be given more priority.</td>
</tr>
<tr>
<td>Agwu (2012(a))</td>
<td>Studied the implications of integrating safety and social responsibility initiatives at the organizational level in the Nigerian construction industry.</td>
<td>It was concluded that integrating safety and social responsibility in construction activities results in better corporate performance. The following were suggested as linking factors between safety and social responsibility * the use of ISO 26000; * holding top management accountable for safety; and, * communicating safety value to corporate stakeholders.</td>
</tr>
<tr>
<td>Agwu (2012(b))</td>
<td>Assessed the impact of employees' safety culture on organizational performance.</td>
<td>The organizational cultural factors identified to be improving employees' safety performance at work are: * visibility of management commitment to construction employees' safety culture; * establishment of monthly safety incentive schemes for employees; * training and retraining of employees on safe work procedure; * increase in site safety audits; and, * focusing on monthly safety meetings on employees' attitudinal change towards safety.</td>
</tr>
<tr>
<td>Agumba and Haupt (2014)</td>
<td>Examined the validity and reliability of H&amp;S practices and respondents' demographic attributes perception on these H&amp;S practices implementation of South African construction SMEs.</td>
<td>It was established that management commitment &amp; involvement, employee involvement &amp; empowerment, project supervision, project H&amp;S planning &amp; communication and H&amp;S resources &amp; training are valid health and safety practices for improving health &amp; safety performance of construction SMEs.</td>
</tr>
</tbody>
</table>
From Table 1, the health and safety management practices capable of improving the health and safety performance of construction contractors can be summarized under five core practices. These are company’s commitment, health and safety planning, workers’ involvement, education and training and communication.

It was revealed from the study’s background and reviews of literature that health and safety researches in developing countries, especially in Nigeria, have not properly addressed the issue of safety practices of construction contractors in relation to the provision of enabling environment to promote good health and safety management practices for improving health and safety performance. In order to develop a good background to bridge this gap, this study gave a critical appraisal of health and safety practices of the Nigerian construction SMEs which specifically identified important practices which are capable of enhancing safety performance of construction SMEs.

RESEARCH METHOD

The study involved the conduct of questionnaire survey comprising of both closed and open-ended questions which were used to examine the significance of health and safety practices of construction SMEs. The population of the study comprise of contractors registered with Federation of Construction Industry (FOCI, Nigeria), which is 84. These contractors are majorly indigenous contractors. Questionnaires were administered to 55 firms adjudged to be SMEs, out of which 40 were completed and returned (response rate of 72.7%). All the 40 questionnaires were found to be suitable for analysis.

Analysis of data was carried out using relative importance index (RII). This was used to rank the identified health and safety management practices adopted by the construction SMEs. The analysis of data was carried out with the aid of Microsoft Excel Software Package. The decision rule used for the analysis using RII is given in Table 2.

<table>
<thead>
<tr>
<th>RII</th>
<th>Decision/Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8 to 1.0</td>
<td>Most Important</td>
</tr>
<tr>
<td>0.6 to 0.8</td>
<td>Important</td>
</tr>
<tr>
<td>0.4 to 0.6</td>
<td>Undecided</td>
</tr>
<tr>
<td>0.2 to 0.4</td>
<td>Less Important</td>
</tr>
<tr>
<td>0.0 to 0.2</td>
<td>Least Important</td>
</tr>
</tbody>
</table>
DATA ANALYSIS, PRESENTATION AND DISCUSSION OF RESULTS

The review of literature revealed that 58 health and safety management practices are adopted by construction SMEs to control the risks of hazards on construction sites. The results of the RII showing the important health and safety management practices are presented in Table 3.

Table 3 revealed 46 important health and safety (H&S) practices under 5 major or core H&S categories: company’s commitment, workers’ consultation and participation, H&S communication, H&S planning and H&S education and training. Twelve (12) important H&S practices were identified under company’s commitment with RII ranging between 0.92 and 0.71. The practices here range from provision of first aid box which is the highest ranked (0.92) to implementation of employee drug testing which is the least ranked (0.71). Four (4) important H&S practices were identified under workers’ consultation and participation. These range between rewarding workers who demonstrate exemplary safe behaviour on site with RII of 0.81 and consulting trade union representatives on health and safety matters with RII of 0.78.

H&S communication comprises of 8 (eight) important H&S practices ranging from using health and safety posters and other signs to give safety education (RII = 0.88) to communicating health and safety through company newsletter (RII = 0.70). The twelve (12) important H&S practices discovered under H&S planning range between identifying hazards on sites before work commences (RII = 0.90) and obtaining a labour certificate for every contract (0.70). The twelve (12) important H&S education and training practices range between organizing health and safety training and retraining for supervisors and/or senior management (RII = 0.88) and organizing alcohol- and substance-abuse programme (RII = 0.74).

The finding of this study agrees with the studies of Kheni (2008), Idoro (2011), Agwu (2012(a) and (b)) and Agumba and Haupt (2014). Kheni (2008) used these health and safety practices to enhance the development of a framework for improving the health and safety performance of construction SMEs in Ghanaian construction industry. Idoro (2011) adopted some of these health and safety practices to enhance hazard management plan in the use of plant and equipment by construction contractors in the Nigerian construction industry. Agwu (2012(a)) used most of these health and safety practices to study the implications of integrating safety and social responsibility initiatives at the organizational level in the Nigerian construction industry. Agwu (2012(b)) identified most of these health and safety practices as organizational cultural factors capable of improving employees’ safety performance at work. Agumba and Haupt (2014) identified most of these core health and safety practices as leading indicators which can be used to identify incidences beforehand and put preventive measures in place. All these studies support the result of this study that the five core health and safety practices are important and capable of improving health and safety performance of contractors.
Table 3. Ranking of Health and Safety Practices

<table>
<thead>
<tr>
<th>S/NO</th>
<th>COMPANY’S COMMITMENT</th>
<th>RII</th>
<th>RANK</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Provision of first aid box</td>
<td>0.92</td>
<td>1st</td>
</tr>
<tr>
<td>2</td>
<td>Provision of personal protective equipment</td>
<td>0.88</td>
<td>2nd</td>
</tr>
<tr>
<td>3</td>
<td>Keeping of safety record keeping and follow-ups</td>
<td>0.88</td>
<td>3rd</td>
</tr>
<tr>
<td>4</td>
<td>Provision of procedures for investigating accidents and nearmisses</td>
<td>0.87</td>
<td>4th</td>
</tr>
<tr>
<td>5</td>
<td>Existence of formal health and safety policy</td>
<td>0.86</td>
<td>5th</td>
</tr>
<tr>
<td>6</td>
<td>Provision of adequate work space and neat environment</td>
<td>0.84</td>
<td>6th</td>
</tr>
<tr>
<td>7</td>
<td>Having a designated safety personnel</td>
<td>0.84</td>
<td>7th</td>
</tr>
<tr>
<td>8</td>
<td>Having fire protection programme</td>
<td>0.84</td>
<td>7th</td>
</tr>
<tr>
<td>9</td>
<td>Provision of cloak and toilet</td>
<td>0.82</td>
<td>9th</td>
</tr>
<tr>
<td>10</td>
<td>Provision of procedures for reporting accidents</td>
<td>0.79</td>
<td>10th</td>
</tr>
<tr>
<td>11</td>
<td>Using outside health and safety consultants</td>
<td>0.78</td>
<td>11th</td>
</tr>
<tr>
<td>12</td>
<td>Existence of minimization policy for cost of ill-health and injury</td>
<td>0.83</td>
<td>12th</td>
</tr>
<tr>
<td>13</td>
<td>Provision of drinking water on site</td>
<td>0.76</td>
<td>13th</td>
</tr>
<tr>
<td>14</td>
<td>Provision of canteen service on site</td>
<td>0.74</td>
<td>14th</td>
</tr>
<tr>
<td>15</td>
<td>Use of ISO 26000 to identify social responsibilities of employees</td>
<td>0.74</td>
<td>14th</td>
</tr>
<tr>
<td>16</td>
<td>Implementing employee drug testing</td>
<td>0.71</td>
<td>16th</td>
</tr>
<tr>
<td></td>
<td><strong>HEALTH AND SAFETY COMMUNICATION</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Using health and safety posters and other signs to give safety education</td>
<td>0.88</td>
<td>1st</td>
</tr>
<tr>
<td>18</td>
<td>Using verbal communication with operatives during site tours</td>
<td>0.88</td>
<td>1st</td>
</tr>
<tr>
<td>19</td>
<td>Communicating safety value to corporate stakeholders and use of two-way safety communication</td>
<td>0.84</td>
<td>3rd</td>
</tr>
<tr>
<td>20</td>
<td>Discussing health and safety during site meetings</td>
<td>0.83</td>
<td>4th</td>
</tr>
<tr>
<td>21</td>
<td>Communicating health and safety performance to employees</td>
<td>0.83</td>
<td>4th</td>
</tr>
<tr>
<td>22</td>
<td>Focusing your monthly safety meetings on employees’ attitudinal change towards safety</td>
<td>0.83</td>
<td>4th</td>
</tr>
<tr>
<td>23</td>
<td>Networking with other companies/institutions</td>
<td>0.78</td>
<td>7th</td>
</tr>
<tr>
<td>24</td>
<td>Communicating health and safety through company newsletter</td>
<td>0.70</td>
<td>8th</td>
</tr>
<tr>
<td></td>
<td><strong>HEALTH AND SAFETY PLANNING</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Identifying hazards on sites before work commences</td>
<td>0.90</td>
<td>1st</td>
</tr>
<tr>
<td>26</td>
<td>Providing job hazard analysis</td>
<td>0.90</td>
<td>1st</td>
</tr>
<tr>
<td>27</td>
<td>Documenting risk assessments</td>
<td>0.88</td>
<td>3rd</td>
</tr>
<tr>
<td>28</td>
<td>Carrying out post-accident investigation</td>
<td>0.87</td>
<td>4th</td>
</tr>
<tr>
<td>29</td>
<td>Pricing health and safety in preliminaries</td>
<td>0.85</td>
<td>5th</td>
</tr>
<tr>
<td>30</td>
<td>Carrying out safety pre-task planning</td>
<td>0.85</td>
<td>5th</td>
</tr>
<tr>
<td>31</td>
<td>Documenting method statements</td>
<td>0.84</td>
<td>7th</td>
</tr>
<tr>
<td>32</td>
<td>Exercising disciplinary measures to correct wrong behaviours to H&amp;S</td>
<td>0.83</td>
<td>8th</td>
</tr>
<tr>
<td>33</td>
<td>Providing emergency response plan</td>
<td>0.81</td>
<td>9th</td>
</tr>
<tr>
<td>34</td>
<td>Providing insurance cover for sites and Employer-paid insurance plan</td>
<td>0.77</td>
<td>10th</td>
</tr>
<tr>
<td>35</td>
<td>Ensuring adequate welfare provisions on site</td>
<td>0.74</td>
<td>11th</td>
</tr>
<tr>
<td>36</td>
<td>Obtaining a labour certificate for every contract</td>
<td>0.70</td>
<td>12th</td>
</tr>
<tr>
<td></td>
<td><strong>WORKERS’ CONSULTATION AND PARTICIPATION</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>Rewarding workers who demonstrate exemplary safe behaviour on site</td>
<td>0.84</td>
<td>1st</td>
</tr>
<tr>
<td>38</td>
<td>Asking workers for their ideas on health and safety matters</td>
<td>0.80</td>
<td>2nd</td>
</tr>
<tr>
<td>39</td>
<td>Involving workers to participate in hazard identification on sites</td>
<td>0.80</td>
<td>2nd</td>
</tr>
<tr>
<td>40</td>
<td>Consulting trade union representatives on health and safety matters</td>
<td>0.78</td>
<td>4th</td>
</tr>
<tr>
<td></td>
<td><strong>HEALTH AND SAFETY EDUCATION AND TRAINING</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>41</td>
<td>Organizing health and safety training and retraining for supervisors and/or senior management</td>
<td>0.88</td>
<td>1st</td>
</tr>
<tr>
<td>42</td>
<td>Organizing orientation on safety for new workers</td>
<td>0.88</td>
<td>1st</td>
</tr>
<tr>
<td>43</td>
<td>Organizing health and safety training of operatives - first aid, manual lifting etc</td>
<td>0.88</td>
<td>1st</td>
</tr>
<tr>
<td>44</td>
<td>Organizing site inductions for operatives</td>
<td>0.86</td>
<td>4th</td>
</tr>
<tr>
<td>45</td>
<td>Organizing toolbox talks</td>
<td>0.74</td>
<td>5th</td>
</tr>
<tr>
<td>46</td>
<td>Organizing alcohol- and substance-abuse programme</td>
<td>0.74</td>
<td>5th</td>
</tr>
</tbody>
</table>
CONCLUSIONS

The study identified, from literature review, 58 health and safety management practices adopted by construction SMEs in controlling the risks of hazards on construction sites. Out of these 58 practices, 46 were established by the study reported in this paper to be important. These 46 important health and safety management practices were categorized under five core practices: company commitment, worker consultation and participation, health and safety communication, health and safety planning, and education and training.

Twelve important practices were identified under company’s commitment ranging between provision of first aid box and implementation of employee drug testing. Four important health and safety practices were identified under workers’ consultation and participation ranging between rewarding workers who demonstrate exemplary safe behaviour on site and consulting trade union representatives on health and safety matters. Health and safety communication comprises of 8 health and safety practices ranging from using health and safety posters and other signs to give safety education to communicating health and safety through company newsletter. Twelve important health and safety practices were discovered under health and safety planning range between identifying hazards on sites before work commences and obtaining a labour certificate for every contract. Health and safety education and training has 6 health and safety practices ranging between organizing health and safety training and retraining for supervisors and/or senior management and organizing alcohol- and substance-abuse programme.

It can be concluded that all the 46 health and safety practices are important and capable of improving the health and safety performance of Nigerian construction SMEs. In the light of these, the construction SMEs need to be aware of these important health and safety management practices which can greatly control or minimize the risks of accidents and hazards to workers and visitors on construction sites. Construction SMEs are therefore advised to always make provision for first aid box, mobile clinic and Personal Protective Equipments and ensure regular usage. In addition, there is need for regular employees’ awareness and training on good safety conduct and the use of illegal substances and drugs to enhance good safety performance.

The outcome of this research therefore forms a good background for the larger study. This is because it forms a good basis for the development of a framework for improving the safety performance of construction SMEs.

REFERENCES


ARCHITECTS AND INTERDISCIPLINARY RESEARCH: REFLECTIONS FROM ETHNOGRAPHIC AND MEASURED FIELDWORK

Joy Joshua Maina
Department of Architecture, Ahmadu Bello University, Zaria, Nigeria

Contemporary problems observed in the built environment often necessitate architects and other construction professionals to employ interdisciplinary approaches from allied disciplines in order to adequately address them. However, few experiences by architects conducting fieldwork in this regard have been reported. This paper presents some practical considerations, problems and prospects of conducting interdisciplinary research by an architect to address housing related problems in Tangale land, northeast Nigeria. These relate to the predisposition towards naïve realism; characteristics of the field and study area; gender, language and communication; nature of data required and modalities for analysis; appropriate style of reporting ethnographic research in architecture; ethical considerations as well as issues related to extensive time frame for interdisciplinary fieldwork and funding. Experiences accruing from the fieldwork reveal employing interdisciplinary methods from anthropology, sociology, behavioral studies and architecture proffer good prospects in addressing issues regarding housing and the built environment. Recommendations for future planning of similar studies implore researchers to carefully consider the scope and methodology for the research; conduct a thorough SWOT analysis; evaluate ethical and funding considerations and make adequate allowances for the time required in processing research applications.

Keywords: architect, ethnography, fieldwork, interdisciplinary research

INTRODUCTION

Dynamic changes in vernacular housing and the built environment often present architects and other allied professionals with complex problems frequently necessitating the use of methods from different disciplines. Several studies conducted by architects, anthropologists and sociologists employ the use of measured drawings, sketches, demographic interviews, photographs or participant observation to document salient aspects of the built environment and traditional housing (Maina 2014; Lwamayanga, 2008; Asquith, 2006; Popoola, 1984; Schwerdtfeger, 1982). These have been instrumental in the analysis of urban problems and

production/improvement of culturally sustainable housing for communities in specific contexts.

Employing mixed methods however presents methodological and practical problems. Methodologically, many of the research instruments in exploratory and descriptive studies specifically participant observation and interviews are often subsumed within the larger field of Anthropology. Unfortunately, “an anthropology of architecture that focuses on the entanglement of architectural, social and symbolic processes does not seem to have emerged as yet despite the repeated calls and recent claims to the contrary” (Vellinga, 2007, p. 757). Practically, it is often not clear what to look out for when planning architectural research involving mixed methodologies and fieldwork because “genuine experiences of living in the field remain rare in architectural studies” (McGowan, 2011, p. 8). Consequently, there is a dearth of practical considerations to aid and improve planning for similar studies in future.

This paper presents my experiences as an architect conducting ethnographic fieldwork and a measured survey of selected compounds in Tangale land, northeast Nigeria as part of a PhD on socio-cultural issues related to housing. The research question posed by the paper is what practical issues should researchers consider when planning interdisciplinary research in Architecture employing methods from Anthropology, Sociology and Behavioral studies? The aim is to proffer recommendations towards improving planning for future research along similar lines.

The paper is structured in three main sections after the introduction. The second section briefly presents a background to the study, methodology employed and main findings accruing from the research. Following this is a discussion on some of the practical issues and problems encountered during the research and fieldwork. The paper concludes with a brief discussion on prospects of conducting interdisciplinary research to address housing and other related problems in the built environment as well as recommendations regarding planning for future studies.

**ETHNOGRAPHIC AND MEASURED FIELDWORK IN TANGALE LAND**

The study addressed three issues in the study area: the relationship between changes observed within culture and built environment, dearth of architectural data as well as abandoned and modified government provided prototype units in Tangale land, a traditional community undergoing rapid urbanization in North East Nigeria (Figure 1). The methodology employed interdisciplinary approaches in ethnographic and measured surveys employing methods adapted from Sociology, Behavioral studies, Anthropology and Architecture (Maina, 2013b; 2014).
Sociologists generally approach the study of vernacular architecture in relation to family structure, norms and values and the effect that the family has on the way space is constructed in and around the home (Asquith, 2006). Behavioral approaches focus on individual activities, meanings, attachments, responses and perceptions in relation to space use. In built environment studies, both approaches often overlap or are subsumed within the larger body of Anthropological approaches especially participant observation and interviews. Anthropological approaches basically seek to explain how purposefully built environments reflect social organization on a shared culture (Lawrence and Low, 1990). The house is viewed as a symbol of the culture that produced it, a concept that has been employed to explain how houses and settlements develop. The mutual interdependence of the house (physical entity) and the House (people who produce and inhabit the house), specifically in terms of materiality and agency is what Vellinga (2007) argues has not been fully explored by anthropologists. Anthropological approaches are beneficial in providing insightful general explanations on relationships between culture and the built environment. Consequently, they rarely explain the practical sources of specific architectural form. Architectural approaches “are primarily topographical, concentrating on the physical form and structure and how architectural styles have evolved over time” (Asquith, 2006, p. 2), usually presented in the form of plans, layouts, elevations or sketches. These are tools traditionally employed by architects to represent buildings. Recently, architectural studies have been concerned with identifying spatial organization and configuration of space and its use largely through space syntax analysis to improve the link between theory and practice (Hillier, 2007).

The review of literature on vernacular architecture studies in Nigeria generally explore, document, describe and analyze the built environment and its complex relationship to human activities within them. Many of the studies are however unclear regarding theoretical/conceptual frameworks and few studies attempt to adequately link theory to architectural practice (Maina, 2013c).

To address problems related to housing to bridge the gap between theory and practice in the study area, an ethnographic survey from Anthropology was first conducted to establish any relationship between changes in culture and the built environment. This was instrumental in proffering the
idea that architecture through vernacular housing reflects changes in
dynamic culture in a passive capacity (Rapoport, 1969). Results from
survey questionnaires and measured drawings from Sociology and
Architecture provide evidence supporting the hypothesis by correlating
historical events and changes in housing typologies (Maina, 2014).
Similarly, scaled drawings, space syntax analyses and observation of space
use from Architecture and Behavioral Studies suggest that architecture
through vernacular housing simultaneously serve as a mechanism of
cultural resistance in an active role (Frampton, 2002). This is evidenced by
the sustainability of certain traditional practices despite changes in
culture due to urbanization (Maina, 2014).

The implication of these findings on design and practice is that
community-produced compounds are revealed to successfully balance the
dynamic tension between the active and passive role architecture plays in
the study area. In contrast, government-provided housing are not as
successful (ibid). This suggests possible reasons behind the modification
and outright abandonment of some government-provided prototype units
in the study area (Maina, 2013a). Future policies in urban planning
therefore need to consider locating residential areas within occupied clan
lands for social network and security according to traditional practices.
Architectural designs need to integrate spaces considered basic by
community standards such as courtyards and verandas to adequately link
various parts of public housing units. Specifically, the most integrated
space should be 1 step away from a veranda or courtyard (ibid). Future
public housing also need to be flexible to accommodate multi-function and
expansion of sleeping and storage spaces (Maina, 2014).

The foregoing discussion highlights benefits of employing interdisciplinary
methods to holistically address often-complex socially related housing
problems within the built environment. Without this integrated approach,
investigating the relationship between observed changes in culture and
housing, documenting the current housing situation and analyzing
modified/abandoned prototype units in the community would have at best,
been per functionary. As is, the process was not without problems.
Conducting fieldwork integrating various approaches from different
disciplines presents several areas architects and other allied professionals
working along similar lines in future need to carefully consider.

**PRACTICAL CONSIDERATIONS FOR
INTERDISCIPLINARY ARCHITECTURAL RESEARCH
AND FIELDWORK**

**Predisposition towards naïve realism**

While conducting ethnographic fieldwork to establish a relationship
between architecture and changes in culture, I subconsciously attempted
to test the assertion that changes in the lifestyle of the community would
be reflected in the built environment. This was largely based on ontological
knowledge gathered in school while training as an architect. I took for granted that my informants viewed the built environment as I did. I was wrong. I became aware of this disparity in thought from several informants after I had explained my aim for conducting such fieldwork. The first of such encounters made me rethink many assumptions, what ethnographers refer to as naïve realism, the tendency to believe that “all people define the real world of objects, events and living creatures in pretty much the same way” (Spradley, 1979, p. 4). After exchanging customary pleasantries with my first informant, I inquired if he could grant me an interview on the architecture of the community. His incredulous response was “Do the Tangale people possess an architecture?” I drew his attention to the fact that we stood at the intersection of two footpaths which were mostly lined with walls above which could be seen houses or huts roofed with corrugated iron sheets or thatch. As an architect, I had mentally categorized the array of typologies while postulating the possible influences on domestic building types. “Oh, these are *mana* and not the architecture you think” he replied. I was referring to the structures community residents designed and built to accommodate their daily routines, lifestyles and families, not the towering skyscrapers, glass and concrete jungles my informant assumed was ‘architecture’. On obtaining similar responses several times, I realized my informants had their own set of presumptions. My focus needed to change from architecture to culture/lifestyle, from being an interviewer of respondents to a student learning from informants, from an architect to an anthropologist, sociologist and observer of behavior. This was an exercise I was ill equipped for despite my years of formal training as an architect. Although I had attended a number of preparatory graduate courses on ethnography and anthropological survey methods prior to embarking on fieldwork at the University of Nottingham, UK, the finer points of conducting such a study was learnt hands on, in the field.

**Characteristics of the field and study area**

Conducting ethnography and measured fieldwork necessitate living in the study area for some period of time. Every field is different, presenting varying challenges depending on the circumstances of a research. Researchers need to carefully consider this in planning similar studies in future. In my study of Tangale vernacular architecture, I contended with insecurity, poor infrastructure and a different way of life.

Tangale land is situated in the northeast region of Nigeria. This is a region that has recorded an unprecedented rise in insecurity and insurgency in the past five years (Herskovits, 2012; UNHCR, 2015). Consequently, conducting interviews during this period was often psychologically and physically distressing. Checkpoints, secured by fully armed military personnel were frequent on federal highways such as the A345 passing through Billiri linking major towns and some state capitals within the region. Journeys on such roads therefore took longer periods than were

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2 *Mana* in the Tangale language refers to a house, compound, home, family or community depending on the context it is used (Maina, 2013b).
necessary. I frequently had to travel to Gombe, the state capital 56km away for supplies during the course of fieldwork. Lwamayanga (2008) also proffered insecurity problems as a serious limitation in his study of vernacular architecture in Tanzania.

Another problem encountered was poor services notably an epileptic electric supply in the study area. I had to sometimes employ two mobile cell phones alongside rapid note taking to record discussions. Larger tape recorders easily ran out of charge. They also made informants self-conscious and uncomfortable. Mobile phones, widely used in the community, can be recharged at roadside shops using portable generators for a small fee. This has become a veritable source of income for a couple of residents. This situation warranted transcribing field notes and observations onto my laptop when electricity supply was restored, frequently late at night. Furthermore, interviews were conducted towards the end of the year during harvest time, which is hot, dusty and uncomfortable. An equally poor road network further aggravated the situation as the vast majority of compounds are linked by footpaths or laterite streets. Conducting interviews during this period however ensured that many residents were at home processing farm produce for storage. I could observe how spaces were used within compounds through participant observation.

Additionally, I needed to first secure permission for the interviews as they involve taking demographic data as well as physical measurements of the compounds during the second survey. This usually necessitated a minimum of two visits. The Tangale people place a high value on courtesy and personal contact. The positive outcome was that informants frequently choose a time when they were at leisure frequently within forecourts with other friends so focus group discussions ensured. This greatly added value to the stories, narratives and experiences I gathered. Unfortunately, the necessity of securing permission for the second survey meant that the measured compounds were in reality, not truly randomly sampled. It was however a prerequisite to obtaining scaled measured drawings of the compounds.

Gender, language and communication

It has been asserted that ethnography is a gendered subject (Beattie, 2011). Future researchers need to carefully and reflexively consider the possible effects of gender on the outcome of a study. My being female proved to be an advantage in this regard largely because of the insecure nature of the environment. Tangale culture, as common with many African societies, views women as physically weaker than men and thus unlikely to pose security threats within compounds. In many traditional communities worldwide, men are unlikely to be allowed into private areas due to religious or cultural restrictions. Popoola (1984) reports similar problems in his study of Katsina, Northern Nigeria.

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3 Two surveys were undertaken in the study. The first, an ethnographic survey took place between December 2010 and February 2011. The second, a demographic and measured survey was conducted between September 2011 and January 2012.
Additionally, being fluent in the language broke down initial inhibitions as well as drastically reduced the time spent in communication. Although a native of the community, I was raised in several urban towns of northern Nigeria by parents who were civil servants working for the government. My grandmother who lived with us throughout my childhood could only communicate effectively in Tangale. This meant my siblings and I learnt the language in order to relate well with her. Consequently, communicating with the elderly, who formed the vast majority of informants in the ethnographic survey, became much easier.

**Nature of data required**

As mentioned above, securing permission meant that only compounds whose compound heads agreed to sign the survey consent form were measured. Researchers need to be conscious of the specific form of data required and if need be, negotiate in the field to obtain practical results. Conducting a pilot survey proved advantageous in this regard. For example, during the course of ethnographic interviews, I soon realized that the transfer of information in the Tangale community was based on an oral tradition. Beattie (2011) reports similar experiences in an ethnographic study in Kolkata, India. Consequently, the narrative I gathered lacked precise dates and time frames. This was frustrating for an architect trained to work with precise measurements. I had to eventually accept this reality and report findings as presented by informants. Additionally, the inability of residents to fill out their daily routines in a time dairy as originally planned had to be re-evaluated. This arose largely because residents are unaccustomed to filling out survey forms in such traditional communities. Instead, I observed activities conducted in the course of a day for all surveyed compounds, verifying my observations with members of the family and the compound heads during the course of physical measurements. These became instrumental in space syntax analysis of the compounds and prototype units.

**Modalities and software for data analysis**

Employing interdisciplinary approaches often necessitates using computer software for analyzing data. Researchers embarking on similar projects need to understand the modalities of such software, their suitability to the task and possible limitations that may arise during analysis. *Depthmap™* version 10, the software developed by Space Syntax Laboratories at the University College London was employed to analyze floor plans of compounds obtained from the measured survey. To test the validity of the method, integration values (IVs)⁴ of the first fifteen compounds, a third of the sample, were manually calculated using the formulae from Hanson (1998, pp. 27-28). The IVs were then compared to results obtained by running a similar procedure in *Depthmap™*. These were found to be accurate to 4 significant figures. This process however revealed that the convex tool encompassed areas within another spaces. This is the tool

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⁴ This is a mathematical figure calculated for each space of a house or complex as a reflection of the extent to which that space organizes and integrates access and movement and by implication, social activity and network (Hillier and Hanson, 1984)
Maina

employed to draw outlines or boundaries of functional spaces on floor plans, which are then linked and analyzed within Depthmap™. In this sample, bungalows located in the middle of compounds were taken as one entity by the software (Figure 2). Creating a break within the courtyard convex space resolved the problem (Figure 3). This probably occurred because the software may have been programmed to analyze discrete spaces common in western designs. Non-western spatial layouts as found in many Tangale compounds may not always follow this pattern. Notwithstanding, the software proved to be an accurate and invaluable tool for simplifying what would otherwise have been a cumbersome task in calculating IVs employed for the study.

**Figure 2:** Depthmap™ v 10 analysis showing no break in the courtyard convex space of a compound

**Figure 3:** Depthmap™ v 10 analysis showing break in the courtyard convex space for the same compound illustrated above

**Appropriate style of reporting ethnography**

Architects and other allied professionals embarking on ethnographic studies need to familiarize themselves with the appropriate style of reporting ethnography. The challenge in ethnography involves understanding and translating a culture and subsequently communicating the cultural meanings discovered to others unfamiliar to that culture (Spradley, 1979). Several colleagues who proof-read my thesis were uncomfortable with ethnographic accounts written in the third person or the use of direct quotes obtained from informants. I frequently was at a loss on striking the balance between reporting ethnography and writing a formal scientific argument that made up my thesis. Fortunately, several resources exist to serve as guides to non-ethnographers and non-cultural anthropologists. One of the most helpful suggestions I found regarding this issue was the choice of an appropriate target audience and thesis/argument. This became influential in writing up the final draft of my PhD.

**Ethical approval and consideration**

Ethical approval for studies involving human subjects is increasingly becoming a thorny issue for many funding bodies and institutions. This is

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5 Spradley and McCurdy (2012), Spradley (1979) for example, offer practical advice on ethnographic fieldwork along with good samples of ethnographic reporting covering various subjects from around the world.

6 Dr. Ian Cooper proffered this advice in June 2013 at Nottingham, UK.
frequently done to protect informants’ identity and to safeguard the researcher’s safety especially in areas prone to insecurity. This may have consequences for the time needed to process such an application and as well as provide limitations on some form of documentation. In this study, ethical considerations prevented my taking photographs or videos that would directly link any source of information to participants. Additionally, all quotes in my thesis are disguised to secure the identity of informants. Researchers working along similar lines in future need to take this into consideration to allow adequate time for administrative processing of applications from University Ethical Committees and funding bodies.

**Limited time for extensive interdisciplinary research**

As discussed in foregoing paragraphs, this study approached the housing problem in Tangale land from three problems-the possible relationship between socially related ills and changes in the built environment, lack of intense architectural research and abandonment of prototype units. Addressing this broad scope necessitated conducting two different surveys within the time frame allotted for a PhD. This traditionally, is three years. In reality, this was not an easy task to accomplish. The practicalities of arranging transportation and other logistics such as internet connectivity for communication with my supervisors while in the field, identifying key informants, making initial contacts with compound heads, re-scheduling meetings and appointments with several households, taking physical measurements of 45 compounds and the samples of abandoned prototype houses within a total period of seven months was often daunting. Maintaining a tight schedule with deadlines proved beneficial in this regard. In retrospect, such a study should have been conducted piecemeal, in stages, some aspects to be continued after the doctorate program. Furthermore, interdisciplinary researches usually involve several professionals from different disciplines, unlike the present study. The time and effort needed for collaboration and communication need to be taken into account when planning to minimize overhead and administrative costs during the research.

**Funding**

Research involving interdisciplinary methods requires careful planning and adequate funding as researchers embarking on fieldwork often encounter unexpected situations in the field incurring extra financial commitment. For example, due to the rising insurgency and insecurity in the northeast region during the period I conducted both surveys, I frequently had to re-schedule interviews. This necessitated extra trips to several villages and towns in the study area. Beattie (2011) and Lwamayanga (2008) report similar experiences in Kolkata, India and Kagera, Tanzania respectively. Such unforeseen contingencies should be incorporated within applications for funding. Holmes and Harris (1999, p. 16) note, “There is simply no denying that ethnographies are expensive in terms of human and non-human resources. Long periods of time spent in the field equate to large salary requirements, travel subsistence and accommodation costs”. Ultimately, approval for such funding depends on
how well presented and articulated the research proposal is with regards best value in terms of resources.

Table 1: SWOT analysis combining methodologies from four disciplines in the study area

<table>
<thead>
<tr>
<th>Parameters</th>
<th>INTERNAL QUALITIES (From methods)</th>
<th>EXTERNAL INFLUENCES (From the field)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tangale Ethnography (from Anthropology and Sociology)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strengths</td>
<td>Weaknesses</td>
<td>Opportunities</td>
</tr>
<tr>
<td>1. Inductive nature of approach suited to investigating the Tangale culture</td>
<td>1. Too broad in scope</td>
<td>1. New uncharted area, little architectural research conducted</td>
</tr>
<tr>
<td>2. Exploratory broad approach uncovered many salient features of the culture</td>
<td>2. Non-specific exploratory nature</td>
<td>2. Good for generating new data</td>
</tr>
<tr>
<td>3. Good for generation of theories in the built environment</td>
<td>3. Subjective results, dependent on researcher’s understanding and interpretation of phenomena</td>
<td>3. Responsive cooperative residents</td>
</tr>
<tr>
<td>4. Overview of events /influences on the lifestyle of the community</td>
<td>4. Easy access to informants</td>
<td>5. Open nature of outdoor living easy to observe by an outside observer</td>
</tr>
<tr>
<td><strong>Housing in Tangale land: typologies and space syntax analysis (from Architecture and Behavioral studies)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strengths</td>
<td>Weaknesses</td>
<td>Opportunities</td>
</tr>
<tr>
<td>1. Specific/narrow scope</td>
<td>1. Physical measurements and interviews requires effort and time</td>
<td>1. Good cooperation and help from residents during measured surveys</td>
</tr>
<tr>
<td>2. Deductive nature suited to test identified theories</td>
<td>2. Space syntax analysis requires specialist training</td>
<td>2. Easier documentation of simple built forms and spatial organization of spaces within compounds</td>
</tr>
<tr>
<td>3. Precise quantitative data obtained from scaled measured drawings, space syntax analyses and interview transcripts</td>
<td>3. Non robust nature of space use data based on general descriptions by respondents and observations by the researcher</td>
<td>3. Formation of good social network and learning from informants</td>
</tr>
<tr>
<td>4. Replicable and objective approach with the possibility of obtaining similar results</td>
<td>4. True random sampling not always possible due to permission for interviews</td>
<td>4. Access to cheap fresh food and transportation costs</td>
</tr>
<tr>
<td>5. Offered a good strategy of establishing theories in the study area</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Prototype housing (from Architecture and Behavioral studies)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strengths</td>
<td>Weaknesses</td>
<td>Opportunities</td>
</tr>
<tr>
<td>1. Specific aim</td>
<td>1. Few samples of 2nd prototype to arrive at a definite conclusion</td>
<td>1. Presence of abandoned and modified prototype units provide evidence of inadequacy of public housing delivery</td>
</tr>
<tr>
<td>2. Objective results</td>
<td>2. No time available for feedback from the community on results obtained and recommendations to be proffered</td>
<td>2. Easy access to units due to their proximity to the A345 highway</td>
</tr>
<tr>
<td>3. Suited for testing link between theory and practice</td>
<td></td>
<td>3. No permission required, saved time</td>
</tr>
<tr>
<td>4. Replicable methods</td>
<td></td>
<td>4. Access to resident opinions on abandoned units</td>
</tr>
<tr>
<td>5. Precise original data generated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Results beneficial for aspects of future policies in urban planning and architectural design</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
DISCUSSION ON PRACTICAL CONSIDERATIONS

Notwithstanding the issues outlined above, valuable prospects exist to employing interdisciplinary methods for architectural research. These are summarized in a SWOT analyses presented in Table 1.

Additionally, opportunities in the field counteracted some disadvantages encountered. Time expended in locating initial key informants for the ethnographic survey was later redeemed by easier access to other informants during the second measured fieldwork. Inconveniences presented by poor infrastructure and inadequate power supply was offset by cheap transportation and feeding costs while problems related to risks in taking physical measurements were minimized by the cooperation of most residents and the relatively simple building forms/spatial organization of compounds. While situations vary from those outlined above, experiences garnered from this study illustrate the wealth of information that can be obtained by integrating methods from allied disciplines to address housing needs of indigenous communities.

CONCLUSIONS

This paper presents my experiences as an architect conducting fieldwork employing interdisciplinary methodologies from anthropology, sociology, behavioral studies and space syntax from architecture to address housing related problems in Tangale land, northeast Nigeria with the aim of further enlightening researchers especially architects and other professionals in the built environment embarking on similar projects in future. While not exhaustive, the challenges present areas future researchers need to carefully evaluate before embarking on interdisciplinary research.

Practical recommendations in planning future interdisciplinary architecture research

- Researchers planning similar studies in future need to carefully consider the scope of the project especially regarding the aims, research questions and hypotheses. If the study can be split into several individual studies, researchers should consider the advantages and disadvantages of all options available to them before deciding on the best line of action.

- It is well worth the effort to thoroughly review relevant literature especially regarding the appropriate methodologies to employ to address the aims of the study. This should include a review and familiarity with tools and methods for analysis such as software and modalities for interpreting results.

- The possible location(s) for obtaining data to address the aims, research questions or hypotheses also need to be thoroughly considered as this may influence the collection and analysis of data.
In light of the above, it is advisable to conduct a SWOT analysis to consider strengths, weaknesses, opportunities and threats of the entire project as done in business proposals. Experiences from the present study reveal employing interdisciplinary approaches presents huge opportunities in generating architectural data and theories beneficial in addressing architectural and housing related problems in the built environment.

Researchers also need to seriously consider the requirements for ethical approval and funding available for the study. This is crucial and could influence the overall logistics for the study.

Finally, researchers working along similar studies need to make adequate allowances for the time necessary for the application to be processed. This recommendation is also pertinent for issues such as time for processing travel documents (if required) and as well as other logistics.

ACKNOWLEDGEMENTS

The Nigerian government by way of a fellowship grant of the Education Trust Fund (ETF) funded this research. I am deeply indebted to Dr. Ian Cooper of Eclipse Research Consultants, Cambridge and Dr. Nicole Porter of the University of Nottingham for the advice and encouragement proffered during my viva, which formed the basis of this paper.

REFERENCES


ASSESSING THE EFFECTS OF UNAUTHORIZED BUILDINGS IN THE SEKONDI-TAKORADI METROPOLIS OF GHANA

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The proliferation of unauthorized buildings has resulted in many socio-economic, environmental and health related problems in some Municipal and Metropolitan Assemblies across the globe. The rising effects of unauthorized buildings show that, past interventions by local authorities, to address the problems, have not yielded the desired results. As a result, this research identifies the problems induced by unauthorized buildings in Asakae, a suburb of the Sekondi-Takoradi metropolis, and suggests measures to curb them. In view of this, a sample size of 182 House-owners was chosen for the study using Fisher et al. formula and questionnaire survey approach was adopted for the study. More so, data generated from the survey was further analyzed, by mean scores. The findings of the survey indicated that, the variables identified as problems induced by unauthorized buildings, through the qualitative survey, reflect the consensus of the respondents. Furthermore, the mean score rankings, indicating the extent of severity of the problems, ranked lack of adequate accessibility and services and deforestation as first and tenth respectively. It is recommended that, services should be extended to all zoned land to facilitate even distribution of developments. More so, the Assembly should adopt automatic building detection systems for quick detection of unauthorized buildings so that appropriate measures could be taken even before they are completed. In addition, the Sekondi-Takoradi metropolitan assembly can widen their revenue net by regularizing structurally sound unauthorized buildings so that owners will be eligible to pay property rate to the Assembly.

Keywords: questionnaire, Sekondi-Takoradi metropolis, unauthorized building

INTRODUCTION

Unauthorized buildings are buildings constructed without approval, legal bureaucratic sanction and without regular engineering control and checks (Kahraman et al., 2006). In this paper, unauthorized buildings also include: extensions and additions to buildings without approval.

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According to Ali and Sulaiman (2006), the proliferation of unauthorized buildings has contributed to many socio-economic, environmental and health related problems. Thus, Weiner (2003) argued that, it is rare for governments to supply infrastructure and services critical to the health and general well-being of people who live in unauthorized buildings; having quite significant effect on the quality of life and life expectancy rates of the inhabitants of such areas (Wakhungu et al., 2010).

Several authors have opined several problems induced by unauthorized buildings, as further discussed in the subsequent sections of this research. Though the effects may be similar across the globe, it is very imperative to localize research, focus researches, to make research findings more focused, accurate and meaningful (CRLS Research Guide, 2004); thus, this research gives an empirical account of the problems induced by construction of unauthorized buildings in Asakae, a suburb of the Sekondi-Takoradi metropolis, and suggests measures to curb them by providing answers to the research questions:

- What are the effects or problems induced by unauthorized buildings in Asakae?
- What measures are to be put in place to mitigate the effects of unauthorized buildings in Asakae?

Though, the findings of the paper may be a true representation of what is prevailing in the six metropolitan assemblies in Ghana and may even be helpful to authorities concern, the researcher does not seek to generalize the findings. It is only limited to Asakae, a suburb of the Sekondi-Takoradi metropolis and to a greater extent, the Sekondi-Takoradi metropolis. Furthermore, this research is limited to the views of house-owners who have stayed in Asakae, at least, for the past five years and not necessary that they are owners of unauthorized buildings.

**Effects of Construction of Unauthorized Buildings**

Uncontrolled construction of unauthorized buildings has accounted for physical disorders, uneconomical land utilization, excessive encroachment into good agricultural land, environmental degradation and pollution risks and many environmental and health related problems over the years (COLE, 1995). Similarly, Ali and Sulaiman (2006) argued that, the common effects of unauthorized buildings included, induced flood, deforestation, encroachment of good agricultural land and lack of accessibility; with the later making it very difficult for government to send social and economic infrastructure/services to these areas (ibid.). More so, Adinyira and Anokye (2013) reasoned that, as a result of the congested nature, which is synonymous with areas full of unauthorized buildings, means of escape during fire outbreaks are normally obstructed, making firefighting and rescuing more difficult; contributing to casualties and damages that results from fire outbreaks. Addressing further the subject matter, Weiner (2003) observed that, owners of unauthorized buildings are not able to use their buildings as collateral for loans since the building lacks appropriate...
legal status for existence. Thus, more often, they are not able to raise loans, with their building as collateral, to improve their buildings.

In another related instance, Lai and Ho (2001) and Kumar (2012) observed that, unauthorized buildings are likely to suffer structural soundness due to loading implications; visual and aesthetics implications; lighting and ventilation effects; and fire risk implications.

In view of the literature reviewed, there are plethora of problems induced as a result of construction of unauthorized buildings and this paper discusses them under the following thematic areas: flood, deforestation, structural instability, encroachment of agriculture land, revenue loss, lack of adequate accessibility and services, poor aesthetic/ventilation: lighting and impedes access of fire fighters during fire outbreak for a more focused and meaningful discussion.

LITERATURE REVIEW

Flood
In the report of Adams (2012), it was observed that structures [buildings] built on waterways has contributed to the existing flood threat that the Sekondi-Takoradi metropolis has been witnessing over the past years. Similarly, Ameyibor et al. (2003) shed more light on this subject by relating how some unauthorized buildings block many natural water ways and frequently lead to floods during rainy seasons. At times, buildings and other properties are washed away by the floods, forcing inhabitants to vacate such areas. Owusu-Mensah (2003) observed that, the actions of some traditional authorities and landowners have contributed to the annual flood experienced at certain areas in the metropolis by allocation of water ways to developers for their own selfish interest. In the long round, these developers site their buildings on the water ways and block the free flow of water especially during the raining season.

Deforestation
Owing to the shortage of legal housing unit to cater for the rising human popsulation of the world (UN-Habitat, 2011; Adjei Mensah, 2013); Ali and Sulaiman (2006) and Kwofie (2013) observed that, natural forests and catchment areas are being invaded, and the ongoing shrinkage of the Masingini forest on the outskirts of Zanzibar Town and Achimota forest in Ghana, respectively, are typical examples. This practice has reduced the amount of ground water and resulted in environmental degradation. Thus, in a foreseeable future, if restraints are not exercised, forest belts may be completely degraded and this may have a ripple effect on revenue generation in the country as some forests in Ghana serve as tourist attraction centres and bring the nation foreign income.

Structural instability
Unauthorized buildings, especially additions and extensions, cause structural weakness in buildings. This situation in turn results in structural failures that may cause injury to occupants (Adinyira and Anokye, 2013).Accordingly, Lai and Ho (2001) argued that, unauthorized
buildings may impose additional loadings to buildings which were not factored for at design stage. This at times leads to cracks in buildings and even collapse of buildings. Again, detailing of reinforcement may have become insufficient in some areas due to shift of inflexion point of the bending moment (Kumar, 2012).

**Encroachment of Agricultural Land**
The uncontrolled increase in unauthorized buildings, has led to conversion of some best agricultural lands for building. Eventually, contributing to the decrease of crop production and associated poor income to agricultural families (Ali and Sulaiman, 2006). According to Ioannidis *et al.* (2007), the lower prices of agricultural land coupled with the low profit from agricultural products, has led to unauthorized buildings scattered on agriculture lands. Consequently, Pogucki (1955, cited in Darkwa and Attuquayefio, 2012) described this situation as “retreat of cultivated areas as a result of the extension of town limits”.

**Revenue Loss**
In Ghana, it is mandatory that owners of buildings pay property rates periodically to their respective local authorities (Metropolitan, Municipal and District Assemblies). This together with other forms of revenue generated by the local authorities is used in financing the budget of the authority (Asiama, 2006). However, owners of unauthorized buildings are not fully taxed because of their illegal status. This may account for decrease in state revenue. But that notwithstanding, the owners of unauthorized buildings expect the government to furnish them with services they need (Ioannidis *et al.*, 2007). This Kumar (2002) argued that it contributes to “black economy”.

In addition to this, house-owners of unauthorized buildings generally bribe corrupt officials, so as to ensure that their illegal building is not demolished. Furthermore, Andoni (2007) observed that, construction of unauthorized buildings account for rising economic losses of nations; because, according to Ioannidis *et al.* (2007), such buildings are not taxed, therefore, there is no income stream to pay for health or other municipal services that are required for its inhabitants.

**Lack of Adequate Accessibility and Services**
Lack of access is one of the most common problems associated with areas where an unauthorized building abounds because, house-owners tend to build up to almost 100 per cent of their plot size. At times they even build into roads thus, blocking access (Ali and Sulaiman, 2006). Accordingly, Nawagamuwa and Viking (2003) argued that, they create highly congested and blighted residential areas. Similarly, there is no reserve for social services like schools, hospitals; children’s play grounds, among others, as people encroach in various degrees. As a result, people and service movement in these areas is very restricted and residents have to walk long distance to obtain services like health, education, transport and the like (Ali and Sulaiman, 2006).
Poor Aesthetics/Ventilation/Lighting
According to Lai and Ho (2001), unauthorized buildings may be visually obstructive or intrusive. Similarly, Adinyira and Anokye (2013) opined that, most often, they deface buildings as they are done without expert’s supervision. In some instances too, they tend to block the in-let of natural light, making visibility very vague in the inside of the building even during the day. More so, it leads to poor aeration of the inner space of the building, as at times, no adequate widow provisions are made.

Impeding of Access for Fire Fighters during Fire Outbreak
Construction of unauthorized buildings may create potential fire loads or obstruct “means of escape” (Lai and Ho, 2001). Unauthorized buildings could impede access to buildings especially to the fire department during occasions of fire outbreaks and other emergency and rescue operations. They become impediment to fire fighters and ambulances, as they may find it difficult to locate places being engulfed by fire in case of outbreak and could result in loss of lives (Adinyira and Anokye, 2013).

RESEARCH METHOD
Guided by the research questions the study seeks to find answers to coupled with the practical considerations and limitations of the study, a questionnaire survey approach was adopted for this study. Questionnaires were administered to house-owners of the study area to elicit their views on the variables (factors) identified from literature to have been the problems induced by unauthorized buildings. Data collected from respondents included: the age of the respondents, the number of years they have lived in Asakae, gender and the problems induced by construction of unauthorized buildings in Asakae. In all, 182 house-owners were used for the study. The sample size for the house-owners at Asakae was obtained using the Fisher et al. (1998) formula. Since there was no adequate sampling frame for house-owners (developers), the snowball sampling technique was used to select house-owners.

The house-owners were selected for the study because, they were the actual actors or agents whose actions might have induced the problems of unauthorized buildings in the town. In addition to this, they live in the town and suffer the immediate effects induced by construction of unauthorized buildings (c.f Adinyira and Anokye, 2013). Accordingly, ten (10) key variables which were identified through literature review were presented to the respondents to solicit their views. The questionnaire sought to give respondents the opportunity to indicate the severity of the various effects listed on a five-point rating scale, where 1= not severe, 2= less severe, 3=moderately severe, 4= severe and 5= very severe. In analyzing the results of the effects of unauthorized buildings, the mean scores of the variables were ranked to ascertain the relative severity of the variables. The mean ranking of each criterion was compiled in order to articulate the decisions that the respondents expressed. Moreover, the
mean for each variable with its corresponding standard deviation are presented (see Table 2).

This paper is based on a single case study of Asakae, one of the sub-towns in the Sekondi-Takoradi Metropolis. A case study research design was used for the study because, it is commonly associated with a particular set of phenomena in a location such as Asakae. Yin (2003) argued that, case studies are preferred when how or why questions are posed; more so, the researcher has little control over events, and the focus is on contemporary phenomenon within some real-life context.

RESULTS AND DISCUSSIONS

Description of the Study Area
Asakae is one of the sub-towns in the Sekondi-Takoradi metropolis. It shares boundaries with Mpatado, Whindo, West- Tanokrom, Adientem, Kwesiminstim and Anaji (STMA, 2011). Because of its location, it has been a residence of choice for most of the populace; this could be attributed to the overflow of the population in Takoradi. Asakae was chosen for the study because, it is one particular area that has high incidence of problems as a result of construction of unauthorized buildings in the metropolis. The activities of landowners invariably contribute to the annual recurrence of flood that has characterized portions of the town. Accordingly, Owusu-Mensah (2003) observed that, there are instances where even waterways and reserved areas have been allocated by some chiefs for building construction. More so, developers have even encroached farm lands and other non-zoned areas in the town. Accordingly, Kumar (2012) argued that, it has led to a congested town thus, affecting the livelihood of the inhabitants. Similarly, it may obstruct fire escape routes and lead to high casualties in case of fire; causing spatial disorders (Lai and Ho, 2001; Ahmed and Dinye, 2011).

Socio-Demographic Characteristics of Respondents
This section briefly explains the background of respondents. It is imperative because, the background of the respondents will help generate confidence in the reliability of data collected; and eventually the findings of the study. Accordingly, Adinyira and Anokye (2013) argued that, it is always important to have a fair idea of the respondents so as to situate the responses within context. As a result, the relevant socio-demographic variables of respondents that this research covered included gender, age and the number of years lived in Asakae

Gender of Respondents
According to Melesse (2006), males have been identified as the main actors who normally build. Accordingly, the results from Figure 1 confirmed this observation as, (53) percent of the respondents were male and the remaining (47) percent were female. Similarly, this could be attributed to the nature of the cultural systems in Ghana, where the male are expected to work to provide for the family, including shelter, whilst the female,
usually, are caretakers of the household. However, the respondents were not gender bias; the sampling technique ensured inclusion of all members of the population being sampled for the study.

Figure 1. Gender of respondents

Age of respondents
Accordingly, respondents were asked to indicate their age. The age of the respondents were categorized in five year intervals in order to know the particular age range that contained the majority of respondents. The categorization was in line with the 2008 Ghana Demographic and Health Survey’s (GDHS) categorization of the age-groups of Ghanaians (see Adjei Mensah, 2010). The mode age of the respondents spanned from 38-42 representing 46.7% with none of the respondents ageing below 28 years (see Table 1). More so, the distribution of Table 1 suggested that, matured persons provided the needed information for this research (see Adinyira and Anokye, 2013).

Table 1. Age of respondents

<table>
<thead>
<tr>
<th>Age(years)</th>
<th>Frequency</th>
<th>Percentages (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 22</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>23-27</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>28-32</td>
<td>6</td>
<td>3.3</td>
</tr>
<tr>
<td>33-37</td>
<td>8</td>
<td>4.4</td>
</tr>
<tr>
<td>38-42</td>
<td>85</td>
<td>46.7</td>
</tr>
<tr>
<td>43-47</td>
<td>26</td>
<td>14.3</td>
</tr>
<tr>
<td>48-52</td>
<td>19</td>
<td>10.4</td>
</tr>
<tr>
<td>53-57</td>
<td>12</td>
<td>6.59</td>
</tr>
<tr>
<td>58 and above</td>
<td>26</td>
<td>14.3</td>
</tr>
<tr>
<td>Total</td>
<td>182</td>
<td>100</td>
</tr>
</tbody>
</table>

Number of years lived in Asakae
In order to involve house-owners who were well knowledgeable about the problems induced by construction of unauthorized buildings, only respondents who had lived in Asakae for at least five (5) years were included in the study.

Effects of Unauthorized Buildings
It is worthy to note that variables like: deforestation, encroachment of agriculture land, lack of adequate accessibility and services, impedes
access by the fire fighters during fire outbreak, and Revenue loss had a standard deviation less than one (that is: 0.930, 0.840, 0.891, 0.804 and 0.912 respectively) suggesting that, there is little variability in data and consistency in agreement among the respondents. However, poor aesthetics, structural instability, poor ventilation, poor lightening and flood all had a standard deviation more than one suggesting that there are more variability and inconsistency among respondents. Though the respondents were in affirmative that the identified effects from literature pertain to their environment. In addition, the effects were ranked with their mean scores as shown in Table 2. Lack of adequate accessibility and services ranked first. This supports the observation of Nawagamuwa and Viking (2003) that, unauthorized buildings create highly congested and blighted residential areas. Revenue loss ranked second. This supports Ioannidis et al. (2007) that, unauthorized buildings accounts for decrease in state and local revenues since they are not fully taxed because such buildings are not registered. Impedes access by the fire service during fire outbreak ranked third; Structural instability ranked fourth whereas poor lightening and poor ventilation ranked fifth and sixth respectively. Poor aesthetics ranked seventh supporting Adinyira and Anokye (2013) that, unauthorized buildings negatively affect the aesthetics of the building; encroachment of agriculture land ranked eighth whiles flood and deforestation ranked ninth and tenth respectively.

**Table 2: Summary of t-test showing results of 1-tailed test and ranking**

<table>
<thead>
<tr>
<th>Effects</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Sig (1-tailed)</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood</td>
<td>2.4615</td>
<td>1.16872</td>
<td>0.000</td>
<td>9</td>
</tr>
<tr>
<td>Deforestation</td>
<td>2.0966</td>
<td>.93000</td>
<td>0.000</td>
<td>10</td>
</tr>
<tr>
<td>encroachment of Agriculture land</td>
<td>2.6313</td>
<td>.84023</td>
<td>0.000</td>
<td>8</td>
</tr>
<tr>
<td>revenue Loss</td>
<td>3.5843</td>
<td>.91205</td>
<td>0.110</td>
<td>2</td>
</tr>
<tr>
<td>structural instability</td>
<td>3.4000</td>
<td>1.07069</td>
<td>0.106</td>
<td>4</td>
</tr>
<tr>
<td>poor aesthetics</td>
<td>3.1444</td>
<td>1.23778</td>
<td>0.000</td>
<td>7</td>
</tr>
<tr>
<td>poor ventilation</td>
<td>3.1703</td>
<td>1.15083</td>
<td>0.000</td>
<td>6</td>
</tr>
<tr>
<td>poor lightening</td>
<td>3.1813</td>
<td>1.14914</td>
<td>0.000</td>
<td>5</td>
</tr>
<tr>
<td>lack of adequate accessibility and services</td>
<td>3.9278</td>
<td>.89086</td>
<td>0.000</td>
<td>1</td>
</tr>
<tr>
<td>impedes access of fire fighters during fire outbreak</td>
<td>3.4944</td>
<td>.80428</td>
<td>0.496</td>
<td>3</td>
</tr>
</tbody>
</table>

**CONCLUSION**

The findings of the paper indicated that, lack of adequate accessibility and services, Revenue Loss, impedes access of fire fighters during fire outbreak, Structural instability, poor lightening, poor ventilation, poor aesthetics, encroachment of agriculture land, flood and deforestation, in order of severity, were the problems induced by unauthorized buildings in Asakae. Thus, this paper concludes that, all the identified variables (effects) from the qualitative survey constituted the effects of unauthorized buildings in the Sekondi-Takoradi metropolis. As a result, this paper recommends that, the Sekondi-Takoradi metropolitan assembly can
increase its revenue by regularizing structurally sound unauthorized buildings, so that House-owners will be eligible to pay property rate to the Assembly; more so, services (most especially: electricity, water and roads) should be extended to all zoned land in the metropolis to facilitate evenly distribution of developments. In addition, the Assembly should adopt automatic building detection systems for quick detection of unauthorized buildings so that appropriate measures could be taken even before they are completed. Similarly, the Assembly could embark on regular decongestion exercise to decongest the town of unauthorized buildings.

REFERENCES


Despite a number of reforms undertaken by the Quantity Surveying-Division of Ghana Institution of Surveyors (GhIS) to raise the standards of professionalism and global competitiveness, Quantity Surveying Firms (QSFs) feared attrition of professionals that could lead to their extinction. Several practicing professionals and graduates yearly end up in other industries. Though employees leave for many reasons, this study aim to explore and identify factors that lead to attrition of Quantity Surveying Professionals (QSPs). This is to establish the rate, type and factors that account for attrition of QSPs in the country and attempt to propose measures to reduce professional turnover of QSPs in order to sustain QSFs. An in-depth field interviews/survey was conducted on ten QSFs in Ghana. The findings revealed the existence of voluntary and involuntary attrition of QSPs in QSFs at rate of two (2) QSPs within a firm per year and the extinction of some QSFs. QSFs in Ghana are classified as small (10 employees) per the number of employees. The tattered growth of QSFs which affects infrastructural delivery in Ghana. Rebranding QSPs/QSFs was recommended as a measure to reduce high rate of professional attrition, attractive compensative packages to QSPs, strict usage of Public Procurement Act (PPA 663) in award of contract rather than political influence and a possible review of course content for student professionals so as to add on innovative and entrepreneurial training with new technologies in work delivery. Finally, the legal framework (surveyors' bill) and its implementation must create an enabling environment for the rapid development of QSFs.

Keywords: attrition, Ghana, quantity surveying firm, quantity surveying professional

INTRODUCTION

Ghana is faced with a deteriorating employment issues with employment performance declining averagely 3.7% annually. The trade liberation programme coupled with the rapid depreciation of the Cedi led to the collapse of many efficient local enterprises and subsequently loss of jobs of many workers (Baah-Boateng, 2004). This was attributed to the sudden and progressive withdrawal of state from direct employment (Obeng-
Odoom, 2012) and the sale of over 300 state enterprises between 1987 and 2000 resulting in a reduction in formal sector employment from 18 percent in 1987 to 13 percent in 1999 (Baah-Boateng, 2004). This has made the informal sector the majority in employment to the sluggish growth of the formal sector employment where the public sector play a greater chunk of the workforce.

Cartlidge in 2002, opine that the QS profession was facing several challenges and people thought that it was on the verge of being extinct (Ofori and Toor, 2012). However, in 2006, Cartlidge noted that there was a severe shortage of quantity surveyors in UK. The success of the service industry is largely reliant on the recruitment and retention of service industry professionals, who have the right mix of skills and attributes. Currently service companies face a looming “talent crunch”, caused by shortage and deficiencies within the world-wide workforce (Ho, et al., 2010). A number of companies, especially large firms, tend to have very short-term policies in terms of retention of talent within the QS firm (Ofori and Toor, 2012). Additionally, a preliminary survey confirmed that 12 QSFs out of 73 QSFs in Ghana have folded up.

**LITERATURE REVIEW**

**The State of Attrition of Professionals**

Employee leaving organisation usually referred to as employee turnover or separations or attrition (Sanda and Ntsiful, 2013). Attrition can be internal (other better sectors or jobs in same country) and external (migration). The issue of internal and external attrition is a major concern to all stakeholders (Adu, 2010) in national development. According to Armstrong (2012) and Cappelli and Hamori (2006), attrition of key employees can have a disproportionate impact on a business due to the considerable amount of time, money and other resources to train and develop their employees; of which QSFs have their fair share. When employees are dissatisfied with their work, they become less committed and look for opportunities to quit; they may emotionally or mentally withdraw from the organisation if they fail to grasp an opportunity (Sanda and Kuada, 2013).

There is a growing scarcity of other construction professionals, and demand for experts in cost engineering and financial management (Ofori and Toor, 2012). Fanous, (2012) argued that QS are facing crucial supply and demand problems, as there is now an unprecedented and unfulfilled demand for surveyors in North America, Australia, New Zealand and also in some European Union countries. In Sri Lanka, the experienced quantity surveyors are moving abroad creating a vacuum in the local industry. However, quantity surveyors are not given due recognition and thus created lack of opportunities to enhance their knowledge (Senaratne and Sabesan, 2008). Individuals that are unemployed are known to be more likely to create new firms than those that have a job (Evans and Leighton, 1990), but firms created by unemployed also face a
higher probability of failure (Pfeiffer and Reize, 2000a). This suggests that it may be relevant to account for the macroeconomic conditions at the time of entry.

Research has revealed attrition in the Health Industry (Antwi and Phillips, 2013), Education Service (Baah, et al., 2009), Hospitality Industry (Honyenuga and Adzoi, 2012), Public and Civil Service (Sanda and Ntsiful, 2013; Mensah and Alemna, 1997), Media Industry despite of their recent growth (Quartey, 2012), etc. Likely due to their high quality training, low wages, and English proficiency, many Ghanaian workers have left for jobs abroad (Antwi and Phillips, 2013). Ghanaian small businesses are beset with many challenges inclusive high employee turnover and lose their experienced employees to large firms who poached them with higher salaries (Bamfo, 2012).

As at 2009, there were about 221 quantity surveyors, of which 16 percent are Fellows, 61 percent are Professional Associates and 23 percent are Technical quantity surveyors (Obeng-Odoom and Ameyaw, 2011). Currently, a total of 269 surveyors of which 12.6 percent are fellows, 72.2 percent are Professional Associates and 15.2 percent are Technician QS with 38 practicing firm in good standing per the regulation of the QS Division of GhIS out of 73 firms (GHIS-QS Division, 2013). This is clear that the numbers admitted as QSP is appreciating, but not in unison across the sectional categories of the profession and with the number of graduates turned out yearly.

The past two decades have witnessed some changes in the labour market due to globalisation and withdrawal of the direct involvement of government in productive economic activities.

**Significance of Quantity Surveying Profession (QSP)**

The role of the QS is currently more vital than the profession when it was originally established in England in 1785 (Senevirante, et al., 2008). The traditional duties of QS included measurement and valuation and to these were later added accounting and negotiation. As the profession evolved, these skills were extended to include forecasting, analyzing, planning, controlling, evaluating, budgeting, problem solving and modelling (Hanid, et al., 2007). Currently, the services of QS have extended to non-construction sectors namely banking and petroleum industries (Addai et al., 2009; Smith, 2009; Hanid et al., 2007). Quantity Surveyors are now engaged more frequently in the "front-end" stages of projects where their expertise is of most value with Cost Planning arguably the key service of the modern day firm (Smith, 2009).

The surveying services regulator in Ghana, Ghana Institution of Surveyors (GhIS) implicitly reinforces the situation by lobbying the state and private institutions to use the service of those experts who have undergone the professional training process (Obeng-Odoom and Ameyaw, 2011), this was a move to curtail quack QSP. According to Obeng-Odoom and Ameyaw (2011), the statement published in the print media and on the official web site of GhIS (2009) heaving the practicing surveying firms and individual
professionals under their regulation are thus bound by its: Constitution, Code of Conduct and Ethics, Disciplinary Procedures and Conditions of Engagement and Rules of Conduct. Also they possesses high professional standards in services delivery and hence recommended all Government Ministries, Departments, Agencies/Parastatals, Metropolitan, Municipal and District Assemblies, Public and Private Corporate Bodies and the General Public to engage QSFs and Professionals they recognized. The crusade by GhIS clearly demonstrates the threat of the surveying profession being taken over by other professionals in the construction industry. Nevertheless it enforces the importance of getting a professional touch into the industry to obtain value for money.

Osei-Tutu et al., (2009) proposed major attempts to develop the technical and managerial capacities of the surveying professionals through structured programmes thus building the capacities of all stakeholders from entry level to executive talents. A Continued Professionals Development (CPD) for the QS-Division in the areas of Procurement Management, Contract Administration, Rudiments of QS, Project Quality Management, Six Sigma Approach to Quality and PMBOK and Construction Technology among others to enhance QS prospects in the Oil and gas industry (Osei-Tutu, et al., 2009). Also, QS-Division of GhIS continuously organize CPD for its members to enhance their professionalism in design and Cost parameters, Negotiation theory, Principles and practices, Contractual Claims, Disputes Resolution, Arbitration and Negotiation

**Types of Attrition**

Studies show that attrition can be divided into several types. Retirement and pursuant for better job are types, and each affect human and social capital on both the firm and the economy differently (Baah, et al., 2009). Sanda and Ntsiful (2013) and Ho et al., (2010) opined that the two kinds of attrition categories are voluntary and involuntary. Gomez-Mejia et al., (2012) cited in Sanda and Ntsiful (2013) described voluntary attrition as a situation where an employee decides to leave the employer either for personal or professional reasons while involuntary attrition occurs when the employer decides to terminate its relationship with an employee, due to business demands such as a poor fit between the employee and the organisation or economic necessity.

Ho et al., (2010) further attributed employee attrition to both push and pull factors. Push factors involve employee intentions to switch jobs as a result of situational elements, and are usually related to job dissatisfaction. Pull factors, on the other hand, act as driving forces that attract an individual toward alternative work placements. In the interest of this research, the views of Sanda and Ntsiful (2013) and Ho et al., (2010) are considered in the types of attrition to be voluntary and involuntary.
Causes of Attrition
QSFs are confronted with many challenges that pose threat to their survival. These include innovation of skills, fear of extinction from other players of the construction industry, low human capital retention, and development of talents for future generation. Also, the technological advancement and complexity of new demand in the industry is rendering some functions of QS obsolete. If market processes select the most able organizations, the possession of valuable knowledge or skills should improve the chances of firms. A number of authors have pointed out that human capital, rather than physical capital, provides the basis for sustained competitive advantage (Youndt, et al., 1996). Knowledge in an organization is embedded in its individual workers/members.

Table 1: Findings on factors that lead to attrition from literature

<table>
<thead>
<tr>
<th>S/N</th>
<th>SOURCE</th>
<th>SECTOR</th>
<th>FACTORS OF ATTRITION</th>
<th>REASONS/TYPES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Baah et al., (2009)</td>
<td>Teacher Education</td>
<td>Job Satisfaction, Salary Level, Working Conditions, Worker relationship with Colleagues, and with Superiors</td>
<td>Retirement and Pursuant for Better Job</td>
</tr>
<tr>
<td>3</td>
<td>Mensah and Alemna, (1997)</td>
<td>Library Board</td>
<td>Managerial Style and Organisational Structure, Low Pay, Low Status, Delayed and Promotional</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Honyenuga and Adzo, (2012)</td>
<td>Hospitality Industry</td>
<td>Low Salary, Poor Condition of Service, and Lack of Expertise of Owner or Manager</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Cappelli and Hamori, (2006)</td>
<td>Executive Turnover</td>
<td>Unhappiness, employee mismatch with job requirement, interpersonal relationships or organizational values, interference with work-family-lifestyle balance, poor relations with co-workers, high work demand, unsatisfactory supervisory relations and perceived inequity in remuneration or work assignment</td>
<td>Voluntary and Involuntary</td>
</tr>
</tbody>
</table>

There are issues of scarcity of human resources in leading QSFs due to unattractive salaries in the quantity surveying profession. However, large firms, tend to have very short-term policies in terms of retention of talent within the firm; possibly due to un-defined vision and mission of existence. The attitude of young professionals show that the organisations have to work hard to attract, develop and retain fresh blood because many ambitious young professionals are not willing to climb the ladder of their careers, but quickly want to take up senior management positions (Ofori and Toor, 2012).
New technologies may make some traditional roles obsolete and others may be greatly altered in scope and responsibilities. However, Smith (2009) revealed that most QSFs disagree that further advancement in IT will see the end of the technical QS measurer and that future QS will be employed mainly as part of multidisciplinary practices.

Table 1, below describes the various factors that have led to attrition of professionals from extant literature review. The table contains both the factors that causes attrition, types of attrition and sectors that face the problem.

A summary of all the possible factors that could lead to attrition in any firm or organisation are illustrated in the Table 2 under the two categories identified from the large extent of literature.

<table>
<thead>
<tr>
<th>Voluntary Factors</th>
<th>Involuntary Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job Dissatisfaction</td>
<td>Lack of Expertise</td>
</tr>
<tr>
<td>Work Demands</td>
<td>Retirement</td>
</tr>
<tr>
<td>Low Salary</td>
<td>Employee Mismatch with Job Requirement</td>
</tr>
<tr>
<td>Poor Working Conditions</td>
<td>Work Assignment</td>
</tr>
<tr>
<td>Relationship with Colleague Workers</td>
<td>Unsatisfactory Supervisor-Employee Relation</td>
</tr>
<tr>
<td>Relationship with Supervisor/Managers</td>
<td></td>
</tr>
<tr>
<td>Employees Benefits</td>
<td></td>
</tr>
<tr>
<td>Organisational Culture and Structure</td>
<td></td>
</tr>
<tr>
<td>Work-Family-Lifestyle Imbalance</td>
<td></td>
</tr>
<tr>
<td>Work Stress</td>
<td></td>
</tr>
<tr>
<td>Unhappiness/Career Change</td>
<td></td>
</tr>
<tr>
<td>Poor Career Development Opportunity</td>
<td></td>
</tr>
<tr>
<td>Return to Academic Studies</td>
<td></td>
</tr>
<tr>
<td>Promotional Opportunities</td>
<td></td>
</tr>
</tbody>
</table>

**Effects of Attrition**

High attrition of skilled employees generate understaffing of firms in developing economies (Antwi and Phillips, 2013). Employee attrition is a major cost to rapidly growing companies. First, they lose the knowledge that the employee has built up over years of employment. Second there is the additional cost of replacing and training new employees (Sanda and Kuada, 2013).

High attrition rates, regionally or nationally also give rise to wage inflation, as salary levels spiral upward in an attempt to retain existing staff and attract new ones (Economist Intelligence Unit (EIU), 2007 cited in Ho et al., 2010). Coupled with financial loss associated with recruitment costs and lowered productivity and quality of services during times new
professionals complete learning curve (Amstrong, 2012; Cappelli and Hamori, 2006; Ho, et al., 2010 cf Atchley, 1996).

**METHODOLOGY**

The research adopted qualitative techniques in its data collection. The optimum sample size depends upon the parameters of the phenomenon under study (Marshall, 1996). GhIS-QS Division, as at 2013, had a total of seventy-three (73) QSFs registered members where thirty-eight were in good standing. The distribution of QSFs in Ghana is skewed towards the National capital; with a total of eighty-six percent of them are in Accra, eight percent in Ashanti and two and half percent in both the Western and the Northern regions. Purposive sampling was employed to determine a sample size of ten (10) QSFs from the 38 firms in good standing across the length and breadth of the country with a minimum of five years of working experience, active in business and stakeholders to GhIS-QS Division. A semi – structured interview was used in soliciting data from the ten respondents and each lasted averagely thirty minutes. Data regarding demographical characteristics of firms, measures to sustain QSFs, staff educational levels, number of staff employed, professional skills and memberships, vivid reasons employees give when leaving, and the duration of employment with previous and current employers were solicited; inclusive were follow up questions. The data was then transcribed and coded using QSR International Nvivo 8 Software. This aided in thinking, reflecting, linking elements of data and annotating of the contents of responses and documents and hence enabling themes to emerge by the use of tag cloud in Nvivo to display the largest words depicting the intensiveness of those tagged words to the findings. The transcribed data was sent to respondents for verification and possible amendment to increase the reliability of the data. Word AutoSummary was used to further check the themes that emerged for consistency and reliability of results and also to identify and voluntary and involuntary attrition factors.

**DEMOGRAPHY OF RESPONDENTS**

The fundamental concept of this paper revolves around Kiewiet and Janita (2007) on the importance issues of developing organisational agendas for sustaining firms. Factually, the true growth and success of QSFs or firms is a multidimensional construct that can include increases (1) in asset and employment size, (2) in sales volume and profitability, as well as (3) in the variety of business functions, products and services (Bakar, et al., 2011). Prominently, the number of employees in a firm is a major dependent variable in developing a research model of firm growth (Bakar, et al., 2011) among others in which ever firm, organisation and industry.
All the respondents from the ten QSFs interviewed had a minimum qualification of first degree in Building Technology and GhIS-QS Division professional membership. Additionally, some had international professional membership which include Royal Institute of Chartered Surveyors (RICS) and Chartered Institution of Arbitrators (MCI Arb). Most of the GQSFs are small set ups with employees totalling up to ten which confirms the ascertainment by Mensah (2004) and UNIDO (2002) that small firms in Ghana employ between 6-29 employees and with fixed asset of minimum of $100,000.00; whilst Page and Steel, (1984:42) categorizes small firms with 10-29 employees. This posit that GQSFs are small in size category. Also these QSFs had all the technical staff with qualification in QS background.

Existence of Attrition
There are some normal levels of attrition of staff in any firm or organisation and similarly in QSFs which are obvious and inevitable like retirement. The study revealed attrition of technical (QS) staff from the QSFs in Ghana; and alarmingly graduate professionals, which possibly threatens the existence of the QSFs. Almost one thousand Quantity Surveying graduate are jointly turn out by the Kwame Nkrumah University of Science and Technology (KNUST), the ten polytechnics and other private tertiary institutions in Ghana in a year. Surprisingly, less than a quarter enter into the built industry and few into the QSP. The rate of attrition of QSP stands at 2 personnel within a year. Eight of the ten Senior QSs consented to attrition and remained handicap as they claim. According to the respondents, they are challenged financially to meeting remuneration of technical staff due to lack of new projects and has led to situation where they cannot employ more QSP or replay those who have left their firms. It is therefore no doubt that the QSFs in the built industry in Ghana are faced with professional attrition.

Causes of Attrition in GQSFs
There are various attribute to staff attrition from the respondents mainly due to lack of new jobs, hard economic reasons, further studies, lack of interest by experienced QS professionals, redundancy, unfair competition of job leading to proliferation of uncertified QS practitioners and low expertise. More so, clients’ are unwillingness to pay professional fees, unprofessional way of soliciting information by other construction players, and delay of payment of professional fees further worsen the attrition and existence of the industry.

This concurs with Sanda and Ntsiful, (2013) and Ho, et al., (2010) on the type of attrition as shown in Table 2. QSFs in Ghana are faced with both voluntary and involuntary attrition. The study reveals that QSP joins the long train of attrition of technical staff within the Ghanaian economy (teachers, nurses, doctors, librarians, media men, pharmacist etc), (Sanda and Ntsiful, 2013; Quartey, 2012; Baah, et al., 2009; Mensah and Alemna, 1997). Job dissatisfaction, redundancy, low salary and benefits, personal development and advance in information technology were the largest word
from the tag cloud in Nvivo, depicting the most led factors to attrition in QSFs in Ghana as tabulated in table 2 above.

**Table 3: Factors that Account for Attrition in Ghanaian Quantity surveying firms**

<table>
<thead>
<tr>
<th>Voluntary Factors</th>
<th>Involuntary Factors</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
<tr>
<td>Poor Working Conditions</td>
<td>Redundancy</td>
</tr>
<tr>
<td>Relationship with Colleague Workers</td>
<td>Unsatisfactory Supervisor-Employee Relationship</td>
</tr>
<tr>
<td>Relationship with Supervisor/Managers</td>
<td>Economic Hardship</td>
</tr>
<tr>
<td>Employees Benefits</td>
<td>Lack of New Jobs</td>
</tr>
<tr>
<td>Organisational Culture and Structure</td>
<td>Firms Cashflow</td>
</tr>
<tr>
<td>Work-Family-Lifestyle Imbalance</td>
<td></td>
</tr>
<tr>
<td>Work Stress</td>
<td></td>
</tr>
<tr>
<td>Unhappiness/Career Change</td>
<td></td>
</tr>
<tr>
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<td></td>
</tr>
<tr>
<td>Return to Academic Studies</td>
<td></td>
</tr>
<tr>
<td>Promotional Opportunities</td>
<td></td>
</tr>
</tbody>
</table>

**Effects of Attrition the Ghanaian Economy**
The level of professional and graduate QS attrition in Ghana has led to the tattered growth of some QSFs and others to the verge of extent. African micro enterprises fail to grow or graduate into smaller enterprise and from smaller enterprise to medium and hence to larger ones (UNIDO, 2002). UNIDO (2002) submission is indeed true about GQSFs; some firms that are over two decades old are currently struggling to survive whilst new firm grapple to surface within the industry.

The industry is not expanding enough to accommodate the tons of graduates produced yearly and have remain the reason for attrition of QS graduates to other sectors due to the poor prospects of finding a QS job. QSFs have since remained small per the classification of sizes of firms posited by Mensah (2004), UNIDO (2002) and Page and Steel, (1984:42); and even deteriorate. The study confirms that from the past decade and half, twelve (12) GQSFs have foldered up. State institutions that also absorbed QSP have also failed to live to expectation.

This has inclusively resulted in ineffectiveness, high unemployment, brain drain, slow pace of nation development, reduced gross development product of Ghana, economic hardships and slow growth and sustainable QSFs.

**RECOMMENDATIONS**
The submission of Ho et al., (2010) is exactly what QSFs need to sustain QSPs and attract graduate surveyors. Attractive compensation package
will influence attrition intention and helps lure employees to move from current employment into QSFs.

The business environment is driven by politics and the practice is frustrating and affects contractors’ cash flows and businesses (Laryea, 2010). Hence the call of the passage of the surveyors’ bill will promote and streamline works of the QS and enforcement of the Public Procurement Act (PPA 663) in award of contracts to ensure fair distribution of works to deserving QSFs.

GhIS-QS Division and the country as a whole can reduce firms folding up, attrition and unemployment and enhance employment by public policies orientation towards promoting firms foundation with special emphasis on nation building and self-employment as in the case of Pfeiffer and Reize, (2000b) for over two decades. Rebranding QSFs/QSP is indeed required to curtail attrition of practicing professionals and students and further to re-launch innovative, unique and sustaining QSF operations and services to the Ghanaian economy.

In addition, observation from the study confirms non – collaboration of practice by professional (Architects, Engineers, Electrical Mechanical and Plumbing, etc.) in the built industry further worsens attrition of QSPs into other non-quantity surveying professions. Hence a call on further studies into curricular reforms, entrepreneurial development and other models to reorient the intent of the QSPs.

**CONCLUSION**

QSFs are losing technical professionals to non – built environment industry professions, which is so alarming at a rate of 2 professionals within a firm per year. Morrison et al. (2003) cited from Bakar, et al., (2011) noted that human factor is considered to be the overwhelming force that determines whether a business will prosper or not. The appauling state of attrition of QSPs from Morrison et al., (2003) have contributed to the extinction of 12 QSFs and others grapling to survive and sustain due to factors emerging from the findings that have led to voluntary and involuntary attrition of QSPs. Those that have managed to survive remain small firms, hence not growing to gain international recognition and competitiveness. It is prominent that QSPs are given the required attention in recruiting, grooming, motivating, well remunerated to help grow and sustain QSFs.

Ho, et al., (2010) is largely reliant on the recruitment and retention of service industry professionals who have the right mix of skills and attributes. However, though the technological cost is relatively low when compared to salary cost of QSs and productivity and increase business opportunities. Human capital holds the key to business success or failure.
Furthermore, it is evident that the built industry is massively supported by the operations of QSPs; this espoused challenge to QSFs from finding affects the infrastructural delivery in Ghana in not addressed.

BIBLIOGRAPHY


BRIDGING THE URBAN-RURAL GAP: KEY TO SUSTAINABLE DEVELOPMENT IN AKURE, NIGERIA

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Rural communities in Nigeria remain the major producer of food for the sustenance of the urban populace. There has been a significant and incessant rural-urban drift over the decades. This has given rise to rural depopulation and consequently, urban congestion. The study centres on unveiling developmental disparities between the urban settlements and the complementary rural communities. The study observed the intensity of the problems and unveiled the opportunities for bridging the urban-rural gap through viable sustainable development approaches. Qualitative research method was adopted, involving questionnaire administration, direct observation and oral interview. Akure metropolis and four other rural settlements were purposively selected for the study. The communities are Oda, Iwoye, Aponmu and Igbaro. The sample frame for the study was the combined population of the rural communities which was 4,874 and 2.5% or 122 of this was sampled. For the Akure urban, 0.25% of its 375,424 population was sampled, which was 939. The study identified neglect of rural economy, inadequate provision of rural infrastructure, lack of poor storage system, poor funding of rural development programmes, imbalanced sector investment-programme and gender imbalance as major determinants of Akure-urban-rural regional development disparity. Declining access to some of the basic infrastructure was observed in 2015 compared to 2014. The paper posited that rural mapping and village regrouping should be carried out, provision of comprehensive rural infrastructure should be embarked upon, adequate funding of rural development programmes, and revitalization of farm-gate processing and storage system should be vigorously pursued.

Keywords: Urban-Rural Gap, Region, Sustainable Development, Poverty

INTRODUCTION

The roles of rural areas have been identified as crucial to promoting economic growth and sustainable development of Nigeria and the Africa continent at large. This is obvious when taking into account the continuous and increased productivity, generation of income and employment that rural areas offer. The rural areas of Nigeria and Africa

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at large are primarily responsible for the sustenance of the nation in terms of food security.

Ajadi (2010) stated that rural economy is that branch of the statesmanship, which deals in agricultural activities and rural enterprise and considered rural life as an important factor in nation building. It is necessary to carefully determine the existing systems of production and other functions of rural settlements and their structural and functional linkage with the urban system.

In spite of the growing importance attributed and attached to rural areas, the rural areas of Nigeria have constantly been deprived and neglected, even though they harbour the majority of the Nigeria population. It is obvious that rural population has limited access to modern and basic necessities of life such as schools, health facilities, potable water, good feeder roads and irrigation among others (Bulu and Adefila, 2014 and Fakayode et al 2008).

Above all, there is bias in government attention and care in favour of the urban than the rural areas. This has manifested in both spatial differences and socio-economic inequalities between urban and rural areas. The foregoing presents a discernible scenario of differential poverty incidence between the rural and urban systems of Nigeria. Hence, analyzing the current scenarios and suggesting policy framework to bridge the gap becomes the focus of the study. The pertinence of this is the consideration that scanty literature and hence knowledge exist on urban-rural development gap and its implications towards sustainable development

**LITERATURE REVIEW**

Comprehensive rural-urban frameworks are explicit attempts to promote rural development with the aim of curbing migration to large cities. Integrated rural-urban development approach has contributed immensely to rural development in multifaceted ways including non-agricultural as well as agricultural activities (Cecilia, 1998).

In the same vein, exchange of goods between urban and rural areas is an essential element of rural-urban linkages. The “vicious circle” model of rural economic linkages and physical infrastructure connecting farmers and other rural producers with both domestic and external markets are imperatives towards understanding rural-urban interaction (Evans, 1990, UNDP/UNCHS, 1995).

Urban function in rural development is based on the concept that rural towns could mediate between the big ‘parasitic’ cities and agricultural areas and therefore facilitate the commercialization of agricultural system (Johnson, 1970). The approach promoted a more balanced spatial urban hierarchy of towns in developing countries in order to achieve selective decentralization of productive investments to foster rural development (Rondinelli and Ruddle, 1978; Rondinelli, 1979; Rondinelli, 1985; Belsky and Karaska, 1990). The towns in this network are to serve not only as
centres of information and knowledge, but also as infrastructure and as
central places for production and marketing of supplies from the rural
areas. On the other hand, employment opportunity and factory-finished
products are ploughed back to the rural neighborhoods from the urban
employment for rural labour. Small towns were generally seen as playing
a positive role in development, as the points from which innovation and
modernization would trickle down to the rural populations. A highly
influential contribution to this positive view was the development of the
concept of “urban functions in rural development “ (Rondielli and Ruddle,
1978) The source opined that the most effective and rational spatial
strategy for promoting rural development was to develop a well
articulated, integrated and balanced urban hierarchy. This network of
small, medium sized and large urban centres was described as
“locationally efficient because it allowed clusters of services, facilities and
infrastructure that cannot be economically sustainable in villages and
hamlets to serve a widely dispersed population from an accessible central
place” (Rondineill, 1985).

Lipton (1977) observed that rural poor are dominated and often exploited
by powerful urban interests. The most important class conflict in the
Third World is the one that between the rural class and the urban class.
According to the Lipton (1977) the rural sector contains most of the
poverty and most of the low cost sources of potential advance, but the
urban sector contains most of the articulateness, organization and power”.
The earlier authors provided a useful account of the relative flows of
surpluses between rural and urban areas on descriptive and empirical
basis. However, Lipton (1977) criticized the assertion above that it was
mainly on the ground of his conceptualization of undifferentiated urban
and rural societies which does not take into account the existence of urban
poor and rural rich and the explanatory variable for such disparities.
Therefore, the focus of this study was to provide insights into the nature of
inter-development and socio-economic interactions between urban and
rural areas. This is germane to the suggestion towards policy framework
for urban-rural development interaction

CONCEPTUAL FRAMEWORK

This study was based on the concept of rural-urban interlink, and
how balanced development can be attained to make rural and urban
centres sustainable. As illustrated in the model of rural-urban interlink,
(Figure 1) rural areas are endowed with large parcels of land for
production and establishment of industries, produce plenty of food for
urban dwellers, sufficient manpower and larger market for manufactured
goods. Equally, the urban centres offer employment opportunities,
infrastructural facilities, administrative functions, markets and provision
of other services like postal, health and schools.

However, to achieve the desired rural-urban sustainability, the two areas
must strike some balance with regard to the functions and the services
each offers. As shown in figure 1 below, the urban and urban rural areas are connected to each other by economic, social, political and ecological factors. Once these factors operate in tandem with each other, then the desired rural-urban sustainability would have been achieved as indicated by the direction of the arrows.

The arrows also indicate how planning should be carried out. Policies should aim at integrating rural and urban areas simultaneously especially in relation to the potential of each area. These areas should be treated as one and not separate competing entities, because of the complimentary roles each area plays. This concept is applied in this study because of its relevance, as it shows a regular interlink that exist between Akure urban and its rural hinterland. For instance, Akure urban is centrally positioned as to have a direct link to all its hinterlands or rural settlements. This application is as directly demonstrated in figure 2 below: It is obvious that Akure urban cannot live or exist without the complementary rural region. Also the rural communities cannot as well operate or live in isolation of the needed complementary services from the urban area. In a nutshell, the expected shared services of Akure urban and its rural hinterlands will facilitate regional development and sustainable human settlements within the region. The justification for this study is that the foregoing literature review and conceptual framework revealed a major lacuna in literature in the sense that specifically related studies have not covered Akure region and contextually, previous researches failed to address practical application of the underlying concepts.

**FIGURE 1: CONCEPTUAL MODEL OF RURAL – URBAN INTERLINK**

Source: Mulongo et al, 2010
THE STUDY AREA

Akure, a typical traditional city in the South Western geo-political zone of Nigeria, is located on latitude 7° 17' North and Longitude 5° 14' East at a height of about 370m above the sea level as shown in figure 2. The city accommodated a population of 38,852 in 1952, 71,000 in 1961, 109,000 in 1980, and 112,000 in 1981; 114,000 in 1982; 117,000 in 1983; 120,000 in 1984 and 123,000 in 1985. This population of Akure rose to 239,124 in 1991 while it is currently estimated that by 2014, Akure city would reach the figure 375,425. This suggest a grim implication of rapid urbanization.

The sample frame for the study was 380,299 populations. 0.25% of 375,424 of Akure metropolis was taken which translated to 939 population and 2.5% of 4,874 the rural settlements was taken which translated to 122 population as sample size.

The Akure area, which is located in a gently undulating terrain surrounded by inselbergs, in underlain by granites, charnockites, quartzite, granite gneisses and migmatite gneisses (Olarewaju 1981). The granites occupy about 65% of the area. The migmatite and gneisses being

![Figure 2: Map of Akure urban area and its complementary Homeland](source: Authors' work, 2015)
the oldest rocks in the Nigerian basement complex rocks formations are both litho- and tectonostratigraphically basal to all superjacent lithologies and orogenic events (Rahman, 1976). The area is flanked in the north by Ikere Batholith and in the south by Idanre batholith. The drainage pattern in the area is dendritic and the major rivers are River Ala, River Owena and River Ogburugburu (Anifowose and Kolawole, 2012).

The Akure area, which is located in a gently undulating terrain surrounded by inselbergs, is underlain by granites, charnockites, quartzite, granite gneisses and migmatite gneisses (Olarewaju 1981). The granites occupy about 65% of the area. The migmatite and gneisses being the oldest rocks in the Nigerian basement complex rocks formations are both litho- and tectonostratigraphically basal to all superjacent lithologies and orogenic events (Rahman, 1976). The area is flanked in the north by Ikere Batholith and in the south by Idanre batholith. The drainage pattern in the area is dendritic and the major rivers are River Ala, River Owena and River Ogburugburu (Anifowose and Kolawole, 2012).

**METHODOLOGY**

The research made use of qualitative method of analysis. The evidence presented in this paper was therefore based on physical verification, oral history, participant observation and questionnaire administration by the authors. Akure urban area and four other rural settlements were purposively selected for the study. The selected rural communities are Oda, Iwoye, Aponmu and Igbatoro. The sample frame for the study was 380,299 population, with Akure urban constituting 375,424 and the combined for rural communities constituting 4,874%. 0.25% of 375,424 of Akure metropolis was taken which translated to 939 sample size. 2.5% of 4,874 the rural settlements was taken which translated to 122 population as sample size. The sample size of the study was 1,061 populations. Additional data were obtained from secondary sources, which were sources of the reviewed literatures, reviewed concepts and research gaps. Meanwhile some indicators were use in analyzing rural – urban disparity in the study area. Such indicators include access to improved health services, water, electricity, education, housing, transportation and industrialization. The study was conducted between 2014 and 2015 in order to draw comparative conclusions.

**FINDINGS AND DISCUSSIONS**

The study revealed a significant difference in the major socio-economic components of developments between urban and rural communities and the implication of the disparity:

From the above table, 85% and 89% of the total respondents in Akure urban area have access to improved health services, while 14% and 18% of the total respondents in Akure rural communities have access to improved
health services. This shows a clear disparity between urban and rural residents in terms of access to basic and improved health services in the region. Government hospitals and maternity centres are only provided in few of the rural settlements as in the case of Oda, Iwoye, Igbatoro and Aponmu respectively. Where the services are available, they are poorly staffed and have inadequate medical facilities. Critical health issues were reported to have been taken to the State Specialist Hospital at Akure or Federal Medical Centre Owo, which are far from these communities with a range of about 5 kilometres to 55 kilometres.

Table 1: Access to improved health services

<table>
<thead>
<tr>
<th>Year</th>
<th>Improved Health%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Urban</td>
</tr>
<tr>
<td></td>
<td>Frequency %</td>
</tr>
<tr>
<td>2014</td>
<td>79</td>
</tr>
<tr>
<td></td>
<td>85</td>
</tr>
<tr>
<td>2015</td>
<td>83</td>
</tr>
<tr>
<td></td>
<td>89</td>
</tr>
</tbody>
</table>

Source: Authors field surveys, 2014 and 2015

The study observed that in 2014, only 13% of the rural population had access to potable water while 65% of the Akure urban population had access to potable water. In 2015, the study also noticed that 62% of urban resident have access to potable water, while only 9% have access to portable water in the rural settlements of Akure. The implication of this is that urban residents are by 52% and 53% in 2014 and 2015 respectively have access to improved water than rural residents in the region. Realizing the fact that water is one of the most valuable natural resource that is vital to the existence of any form of life and overall socio-economic development. It was observed many of the urban residents depend on boreholes either public or private, rural residents depend on streams and in some cases hand-dug wells which are located in unkempt surroundings without any formal treatment. Rain water is also being used as substitute during raining season.

Table 2: Access to improved water supply

<table>
<thead>
<tr>
<th>Year</th>
<th>Improved Water %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Urban</td>
</tr>
<tr>
<td></td>
<td>Frequency %</td>
</tr>
<tr>
<td>2014</td>
<td>611</td>
</tr>
<tr>
<td></td>
<td>65</td>
</tr>
<tr>
<td>2015</td>
<td>583</td>
</tr>
<tr>
<td></td>
<td>62</td>
</tr>
</tbody>
</table>

Source: Authors field surveys, 2014 and 2015
Plate 1: A major source of water in the study area is hand-dug well. 

Table 3: Access to Improved Electricity

<table>
<thead>
<tr>
<th>Year</th>
<th>Urban Frequency</th>
<th>Improved Electricity %</th>
<th>Rural Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>611</td>
<td>65</td>
<td>16</td>
<td>13</td>
</tr>
<tr>
<td>2015</td>
<td>583</td>
<td>62</td>
<td>11</td>
<td>9</td>
</tr>
</tbody>
</table>

Source: Authors field survey 2014, 2015

As depicted in table 3 above, 611 and 583 respondents out of the total 939 respondents declared that they have access to improved electricity in Akure urban in 2014 and 2015 respectively. The percentages of these translated to 65% and 62% of the total residents of Akure urban. While in the rural settlements, 16 and 11 respondents attested that they have access to improved electricity in the rural settlements of Akure. The population of those that have access to improved electricity is translated to 13% and 9% in 2014 and 2015 respectively.

Generally, it shows that the challenge of electricity is a major challenge in the study area to the extent that less than average population have access to electricity in the Akure rural. In addition, Akure urban still surpasses rural area as 49% and 53% of its population having access to electricity than its rural settlements. Oral interview and visual observation also revealed that majority of the rural dwellers depend on lantern and in rare cases generating sets. As a result of this, the settlements are devoid of artisan services that can boost rural economy and make living
environment functional and efficient. However, few of the residents depend mainly on generators to supply electricity for their domestic use and economic activities.

Table 4: Access to Formal Education

<table>
<thead>
<tr>
<th>Year</th>
<th>Access to formal Education%</th>
<th>Rural</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Urban</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Frequency</td>
<td>%</td>
</tr>
<tr>
<td>2014</td>
<td>798</td>
<td>85</td>
</tr>
<tr>
<td>2015</td>
<td>802</td>
<td>85.4</td>
</tr>
</tbody>
</table>

Source: Authors field survey 2014, 2015

In 2014, 798 respondents out of total respondents of 939 had formal education in Akure urban. This figure represents 85% of the total population of Akure urban area. In 2015, 802 respondents out of total respondents of 939 have access to formal education, which represents 85.4% of the total population of Akure urban area. Whereas in 2014 only 36% of the rural dwellers had access to formal education. In the same vein, only 33% of the rural inhabitants have access to formal education. The implication of this is that Akure urban is by 49% and 52.4% of its population have access to formal education than its rural counterpart. This figure shows a wide disparity in access to formal education between urban dwellers and rural dwellers. There is no adult literacy school in the rural communities which could have further reduced the illiteracy level among adults, neither are there vocational schools that would have enhanced availability of skilled and trained artisans. In general, there are very few educational facilities in the community. There are few government primary and secondary schools in most of the rural settlements. However, few privately owned primary and secondary schools are found in the communities to complement the public schools in the rural settlements.

Table 5: Access to Improved Transportation

<table>
<thead>
<tr>
<th>Year</th>
<th>Access to Improved transportation %</th>
<th>Rural</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Urban</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Frequency</td>
<td>%</td>
</tr>
<tr>
<td>2014</td>
<td>822</td>
<td>88</td>
</tr>
<tr>
<td>2015</td>
<td>818</td>
<td>87</td>
</tr>
</tbody>
</table>

Source: Authors field survey 2014, 2015

A significant 88% of Akure urban area population had access to improved transportation in 2014 and 87% have access to improved transportation in 2015. In contrast to this, 36% and 23% of the 122 sampled rural population have access to improved transportation in 2014 and 2015 respectively. Direct observation also revealed that majority of the rural roads that link the rural settlements are in terrible states as revealed in plate 2 below. The road surfaces have been eroded by run offs, which has created gullies and potholes indiscriminately along the roads. Due to the terrible
conditions of roads, the dominant mode of transport in the study area is commercial motor cycle locally known as Okada. Most rural dwellers prefer this mode because it is the best available alternative due to its flexibility. Ordinarily, most of them would have preferred their personal vehicles for its convenience. Interaction with public bus/taxi operators revealed that they are reluctant to plying the rural roads due to their poor state.

Plate 2: Bad road condition along Igbatoro road – a major symptom of inadequate rural road infrastructure. Source: Field survey 2014

Table 6: Access to Improved Housing

<table>
<thead>
<tr>
<th>Year</th>
<th>Access to Improved Housing %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Urban</td>
</tr>
<tr>
<td></td>
<td>Frequency</td>
</tr>
<tr>
<td>2014</td>
<td>812</td>
</tr>
<tr>
<td>2015</td>
<td>820</td>
</tr>
</tbody>
</table>

Source: Authors field survey 2014, 2015

As depicted in the table 6 above, 812 and 820 respondents out the total of 939 respondents have access to improved housing in Akure urban area in 2014 and 2015 respectively. The study observed that housing structures in the rural areas of Akure are primarily characterized by obsolescence, substandard dimension with out-dated infrastructure where available except for few modern buildings. This inadequacy manifests both in qualitative and quantitative perspectives. This was further revealed through table 6 above as only 26% and 21% of rural dwellers have access to improved housing in 2014 and 2015 respectively. The quality of housing
in the rural areas as shown in plate 3, is very low. This is due to a number of factors, including quality building materials used for construction, inadequate technology, and poor planning standard. Thus, a large number of the housing stock in the rural areas has low relative habitability which has consequent effect on the state of health, socio-economic well-being and emotional stability of the residents. This shows that the level of technology of building construction in the rural areas is rudimentary. Furthermore, our direct assessment of rural housing maintenance level revealed that over 80.0% of buildings needed either minor or major repairs, out of which some are completely old and dilapidated, only few exhibited evidence of physical soundness, while roofing of some of the buildings examined are patched and leaking.

![Plate 3: Poor housing condition in the rural area of the study area. Source: Field survey, 2014](image)

### Table 7: Access to Improved Sanitation

<table>
<thead>
<tr>
<th>Year</th>
<th>Urban Access to Improved Sanitation %</th>
<th>Rural Access to Improved Sanitation %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>%</td>
</tr>
<tr>
<td>2014</td>
<td>830</td>
<td>88</td>
</tr>
<tr>
<td>2015</td>
<td>835</td>
<td>89</td>
</tr>
</tbody>
</table>

Source: Authors field survey 2014, 2015

As shown in table 7 above, 830 and 835 respondents out of total 939 respondents confirmed that they have access improved sanitation in Akure urban area in 2014 and 2015 respectively. These figures translated to 88% and 89% of Akure urban population that have access to improved sanitation. On the contrary, it was observed that only 18 and 17 respondents out of total of 122 respondents declared that they have access to improved sanitation in 2014 and 2015 respectively in the rural area of Akure. Oral interview and direct observations revealed that the most common means of sanitation in the rural area, is through the use of nearby
bush or dung-hills. This makes the area look dirty, unsightly and stinking. The method of feaces disposal is also generally absurd in the rural. The surrounding have become comfortable breeding grounds for rodents, flies, rats, mosquitoes and other dangerous animals that can contribute to the spreading of diseases and other related hazards in the environment. A good number of sampled houses have no bathroom facility and where available, they are detached and indecently organized in an unkempt situation. Only 15% and 14% of the sampled buildings have bathroom within, 85% and 86% have theirs outdoor. They are small enclosures usually made of bamboo and rusted iron-sheets or planks at the rural areas of Akure. A typical example is shown in the plate below.

Plate 4: The predominant bathroom at the rural areas of Akure

ECONOMIC PRODUCTION

Production processes in rural areas of the study area are also very primitive and crude as opposed to the situation in the urban area. This slows down food production processes and consequently increases food scarcity. There is high prevalence of destruction of surplus agricultural produce due to lack of modern shortage facilities. Relatively, economic productivity in the urban area of Akure maintain high potential than the situation in the sampled rural areas. This might be due to the fact that most of the financial institutions and infrastructural facilities that form the bedrock of economic development are based in the urban areas at the expense of the rural areas.
CONCLUSION

The study identified a significant bias in the distribution of public infrastructural facilities in favour of the urban counterpart while the rural interfaces are heavily underserved. The study identified lack of inter-community coordination and organizational capacity. It observed a dangerous declining trend in access to basic development infrastructure in both the urban and rural areas. Emerging from the study is the fact that obviously, no settlement can exist on its own without relying on the other. Therefore, to adequately bridge the current poverty gap and establish a sustainable interlink between the rural and urban inter-systems in Akure region of Ondo State, socio-economic, political and environmental systems must be effectively harmonized and incorporated into policy frameworks for regional development.

RECOMMENDATIONS

Based on the observed scenario of facilities available, there is need to develop public infrastructure and services master plan that will integrate the rural and urban areas since this will impact on the movements of goods and people. Urban –rural road network must take a central place in such master plan while the government must also take a bold step towards adequate intervention in solving the problem of qualitative housing that bedevils the rural communities around Akure urban area. Above is with the view to reducing the heavy incidence of rural poverty. Growth centres should be considered as complementary development model for the rural regions in several.

Institutional framework for rural populace must be strengthened by improving the flow of financial and information resources to the rural communities so as to make these areas mutually interdependent socio-economically. In addition, enhancement of the local economy in the area
under study through Capital Base Investment Programme (CBIP) that will provide employment opportunities for the jobless residents of the area would be imperative. This can be achieved through a synergy between Community Based Organizations (CBOs) and relevant governmental and non-governmental agencies in Ondo State and the Federal Republic of Nigeria.

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BARRIERS TO IMPLEMENTATION OF CONSTRUCTION INNOVATION AND MEASURES OF MITIGATING THESE BARRIERS

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Emphasis on the importance of innovation within the construction industry to a larger extent has received an increased call. The need for the construction industry to facilitate technological innovations in order to maintain a competitive edge in the market lower Construction cost, improve quality, maximize productivity and meet the infrastructure need of the economy has been further emphasized. Realization of this increased importance of innovation will be nullified if the barriers to implementation of innovation are not understudied with provisions of stringent measures to mitigate the barriers to innovation. This exploratory paper analyses the barriers to implementation of construction innovation in the construction industry and likewise proposes measures of reducing the barriers to construction innovation. The research methodology includes extensive literature review supported with and random interviews. In all thirty (30) contractors, clients and construction association professionals were contacted via structured interviews to ascertain the existence and severity of the barriers. Findings from the study revealed that some of the barriers to construction innovation include: industry barriers, organizational barriers, legislative and regulatory barriers amongst others. It is recommended that effective collaboration within the construction sector and its stakeholders should be fostered in order to facilitate construction innovation as evidenced from other industries. Moreover, the formulation and cooperation of governmental and institutional policies which does not suppress construction companies must be established.

Keywords: barriers to innovation, construction innovation, structured interview, literature review

INTRODUCTION

Emphasis on the importance of innovation within the construction industry to a larger extent has received an increased call. As a result, renowned institutions such as the European Commission (EC) report in 2010 acknowledged the contribution of innovation to national economic growth, competitiveness and bringing higher living standards. The report further stressed that innovation is at the heart of the modern knowledge-based economy. The construction industry has also been distinguished in literature by its conservative attitude to the adaptation of new products
process compared to other industries. This may be as a result of significant barriers preventing implementation and the use of innovative technology and materials in the construction sector of the economy. Implementation of innovation however within the construction industry will facilitate novelty in technology in order for the sector to maintain a competitive edge in the market, lower construction cost, improve quality, maximize productivity and meet the infrastructure need of the economy such road networks and buildings amongst others. This means the higher the levels of innovation in the construction industry, the greater the likelihood that it will increase its contribution to economic growth (Blayse and Manley, 2004). Realization of the importance of construction innovation will be nullified if the barriers to implementation of innovation are not understudied with provisions of rigorous measures to mitigate these obstacles. Without a proactive programme to encourage and facilitate the successful transfer of innovative technology from the drawing boards and laboratory to the market price, efficient new technology will continuously go wasted without enhancing it values. Therefore, the goal of this paper is to identify barriers that hinder implementation of construction innovation. The study reviewed a range of literature and categorised construction innovation barriers under a broad perspective of classifications. The review identified three main barriers to implementation construction namely: Industry-conservative attitude of the construction sector and lack of desire to implement innovation, Organizational- the internal inabilities and lack of capacities of firms, Legislative and regulatory- strict and complicated policy frame retarding implementation of innovation, framework. These are the key factors influencing the implementation of construction innovations. Deliberations on these barriers among academe and policy makers would foster a comprehensive approach to be design in order to avert and control these barriers. Similarly, research is needed in this area in order to explore the correlation of innovation and its determinants among others that will enable the full benefits of innovation to be accomplished within the sector.

STUDY OBJECTIVES

The objectives of this study are:

- To identify the barriers to implementation of construction innovation.
- To determine strategic measures to reduce these obstacles.
- To establish subsequent advantages of controlling barriers to implementation of construction innovation.

INNOVATION AND THE CONSTRUCTION INDUSTRY

Lots of definitions for innovation are captured in literature. Slaughter (1998) cited Okae-Adow et al. (2012) defined innovation as the actual use of nontrivial change and improvement in a process, product or system that
is novel to the institution developing the change. Dulaimi (2005) identifies innovation as the generation, development and implementation of ideas that novel to the firm practical and commercial benefits. Motwa (1999) similarly defined innovation as the process through which new ideas turn into new components of a Construction product that has economic value. In addition, Sexton and Barrett (2003) maintained that for innovation to be successful, new ideas should be followed by effective implementation and must improve overall organizational performance. Various studies including that of Nam and Tatum (1997) have stressed that the construction industry lagged behind in innovations. Kulatunga et al (2007) supported that an empirical study conducted by Reichstein et al (2005) using data from UK construction industry found that number of firms engaged in product or process innovation in construction sector is lesser than other sectors. Further, it was found that the construction firms are faced with barriers emanating from either internal or external environment and are less engaged research and development (R&D) activities. Seasden and Manseau (2001) pointed that R&D activity has been positively correlated with the relative innovativeness of various industrial sectors. Construction firms in the recent era are keen on innovation due to the increase in labour charges and also as means of being competitive in the international markets (Nam and Tatum 1997). Dubios and Gadde (2002) stressed that the construction industry is characterized by a loosely coupled system which impede innovation activities within the sector.

**BARRIERS TO CONSTRUCTION INNOVATION**

Nam and Tatum (1997) acknowledged that innovation within the construction industry lagged far below average compared to other sectors. This innovation gap within the construction sector is due to significant barriers that hold its implementation. Woodhead and Downes (2001) however defined barriers in the context of innovations as the constraints and limitations that retard or avoid new ways of working. Stewart et al. (2004) summarized these barriers into three levels namely: industry, organizational and Legislative and Regulatory. The next section highlights on the categorised barriers in construction innovation:

**Industry Barriers**

Industry barriers to innovation are those activities and deeds that obstruct change with the sector. Dulaimi et al (2002) argued that these innovative problems within the construction industry is like a result of poor rates of investment in research and development, fragmented supply chains and lack of co-ordination between academia and the industry in research activities. The activities within the construction industry are fragmented with a long chain of bureaucratic routes which daunt innovation process as a result. Blayse and Manley (2004) supported that the construction industry requires a strong industry relationship if innovation is to be increased. This relationship is crucial for construction innovation (Aderson
and Manseau, 1999; Mizzo and Dewick, 2002; Dubois and Gadde, 2002). According to Blayse and Manley (2004), this relationship will ease knowledge flows through interaction and transaction between the firm, stakeholders and all individuals. Industry barriers to construction innovation are likely to be minimised via this industry relationship. Miozzo and Dewick (2004) supported this with a call for stronger inter-organizational cooperation as a way of enhancing construction innovation within the industry and reducing its associated barriers. Nam and Tatum (1997) cited in Dulaimi (2005) found that that some barriers within the construction sector may be due the conservatism attitude of professionals clinging to an accepted industry practice and norms in fulfilling client’s need; changes are taken as a threat, and slack resources are rarely permitted. The unusually long lifespan of the construction products are also viewed as a barrier to innovation as it compels the client to stick to known methods rather than being radically innovative thereby decreasing client’s awareness on a new product (Blayse and Manley 2004). As a result, most customers develop the fear of change of a goods or method this further act as a barrier to implementation of new products within the sector.

**Organizational Barriers**

Storey (2000) points that barriers to construction innovation that relate macroeconomic level includes organizational barriers and cultures, communication, resources, team dynamic and individual personality traits amongst others. Firms form integral part of enhancing an innovated technique or product as such when they are short of supply resources such as people, time, money and supply of information will not sustain innovation and will tend to act as a barrier within a firm. Implementing an innovation requires that resources be available and workable. Individual attitudinal barriers reside within organizational members but also may stem in part from the organization’s climate. Fear of risk and failure and intolerance of uncertainty and ambiguity traits of team members within an organization have the potential to create conflict thus stifling implementation. Differences in needs, perceptions and values are example of this barriers as confirmed by Hage and Dewer in their early study in 1973, that values of organization elicits who favour an innovation are predictive of innovation than are structural organizational variables. The tangible and intangible culture inhibited within an organization promotes the implementation of innovation, as such when there is an adverse culture attitude will then act as a barrier to novelty. Further unclear communication structure among teams on an innovative programme also act as an obstacle to the successful delivery of that innovation. As a result, innovative ideas which may not be managed prudently to gain expected outcomes will lack implementation.

**Legislative and Regulatory Barriers**

These are restrictions that are imposed by legislatures and government agencies through specific statutes, Legislative regulations, policies and programs. Andres and Per (2010) emphasized that this category of the barrier includes the legal framework, government agency’s policy,
standard contracts, procurement procedures, laws amongst others which affect implementation of construction innovation. Regulation can put a constraint on an intended innovation of a product by a firm or a technique by the industry. Dubois and Gadde (2002) observed that generally there has been a negative influence internationally, with many government regulations and industry standards hampering innovation. This assertion was supported by Gann and Salter (2000) that government regulatory policies exert a strong influence on demand and plays an important part in technological change. An early studies by Bowle in 1960, cited in Ling (2003) provided evidence to that restrictions imposed by regulations have been a hindrance to the construction innovation for a long time. Benmansour and Hogg (2004) argued that inappropriate regulation may also discourage research efforts by firms and distort the choice of technologies that are exploited and adopted. Although local building regulation is the political responsibility of the local government, these regulations are formally enacted and enforced by elected representatives. The technical complexity of such standard suggests that local building officials exercise considerable influence in proposing and evaluating alternative sets of standards thereby acting as a constraint on innovation. Bureaucracy in the regulatory agencies charged with adopting standards usually acts as barrier and sometimes slay away the desire to innovate by firms and industries.

RESEARCH METHODS

In order to get relevant information to address the study objectives by encountering minimum limitations, the qualitative method was adapted. The qualitative method proved suitable for this study, due to its consideration in attitudinal measurement based on opinions, views and perceptions. Further, the method also provided means of contacting and receiving first-hand in-depth information from all the sets of respondents to via interviews. Contractors, Clients (individuals and firms) and Associations within the construction industry were the targeted populations operating within the central capital city of Ghana. Face-to-face interpersonal structured interviews were conducted with these set of respondents selected through purposive sampling technique to establish primary data consisting their perception and views on the study. The interview engaged each respondent for the duration of about five to ten minutes but was later extended to fifteen minutes. This became necessary as the responds from the initially interviewed questions were not entirely covered. Interviewees were asked during the interview session to identify main barriers to implementation of construction innovation, comment on the impact of innovation on their activities, how these barriers would be mitigated among others. The interview section adapted the structured format which was guided by an interview guide in the form of open-ended questions. A total of fifteen (15) structured interviews were conducted out of the total thirty (30) contacts among the respondents with five (5) from Contractors, Clients and Professional Associations within the industry.
FINDINGS AND DISCUSSIONS

In order to be guided by the primary purpose of the research, interviews were asked to identify the main barriers to construction innovation. In response to the question from the perspective of the contractors who were classified from medium and small-sized firms, the answers were undoubtedly varied. Barriers to implementation of construction innovation meant different things to different people. To some it was about obstacle such as severe political interferences to novelty from the central Government on non-affiliated political firms; “...other class of contractors also stressed that the associated high risk and cost implication posed as a barrier to implementation of construction innovation. Also some contractor’s remarked that new designs and products usually act as barriers in their function due to its unfamiliarity within the sector. Response from individual industry clients revealed some of the barriers to construction innovation as poor rate of customer knowledge on newly innovated products and techniques which further brings about trepidation of change by the consumer to adapt to new changes hence causing barrier to implementation. Other client firms also remarked that one crucial barrier to implementation of construction innovation is the varying needs of the industry consumers. Early studies by Winch (2003) supported this assertion that clients and users within and construction industry play key roles in promoting innovation.

Responses from Professional Association members within the sector confirmed the existence of some construction barriers which includes disintegration nature of the construction industry. Further, some consultants remarked that disintegration the sector discourage continuity of innovation process. Dubios and Gadde (2002) acknowledged the relationship endemic in construction as loose couplings and not fostering innovation within the sector. Barlow (2000) further explained that the construction process is usually managed by dividing work into discrete packages, which are purchased sequentially and then completed by specialists. This implies that construction project workflows are susceptible to an interruption which tends barriers. Some argued that the identifiable barrier is the lack of Governmental support in the form of funds to firms that intend to be innovative. Access to the loan facility to innovate new products or improved on an existing product are serious issues to the industry and affects the implementation of innovation. Other professionals also reiterated that the construction sector lacked a body coordinates facilitates innovation activity. Further, some experts also stressed that perceived unadventurous attitude of the entire construction industry is a barrier in itself.”

What measures must be instituted to reduce barriers to implementation of construction innovations?

Respondents emphatically expressed their candid and feasible measures that must be instituted in order to reduce and curtail the occurrence of these barriers. Contractors interviewed remarked that since innovation projects involve huge sums of investment, there must be ease of accessing
credit facilities to sponsor innovation projects. Similarly, political linkages to firms must be disassociated since such act brings about the unnecessary retardation of implementation of innovation in the industry. Both individual / organizational clients generally responded to this question that there must be lots of customer awareness of both potential technique and product within the sector to encourage trust in such products. Once the trust and confidence have been established on the viability and features. As a result, the awareness of the product or technique, it will increase the desire to implement such innovation. Response from the perspective of professional association members suggests that there must be formulation and cooperation of Governmental and institutional policies which does not suppress construction companies to embark on innovation projects. Besides, the industry must endeavour to organize educational and training programs on innovation for stakeholders within the sector to contribute to their knowledge. Such integrated programmes, as stressed by some industry professional members, will enlighten the horizon of firms and individual who intends to innovate. Koskela and Vrijhoef (2001) however agreed that a complete revision of the concept of the traditional construction management practice must embark because of its deficiencies and non-flexibility. This is because in the traditional construction management their lots of hierarchies which have consequence role on innovation and also managers do not have greater autonomy due to its long chain of authorities. Dubois and Gadde (2002) cited in Blayse and Manley (2002) has called for tighter couplings among firms and individuals in order to establish a favourable atmosphere to embark construction innovation. This will help reduce the level of perceived notion that the industry is conservative to innovation and could do little so that project teams, construction firms, individuals and stakeholders will be encouraged to implement their innovations. According to Blayse and Manley (2004), in order to foster construction innovation, there must be and integrated approaches to construction projects due to the fragmented nature of the industry. Further, there must be the improvement of knowledge flows by developing more intensive industry relationships to offset any anticipated disadvantages.

CONCLUSION

The goal of the study was to explore into significant barriers to implementation of construction innovation and their possible mitigation measures. The dynamic and strategic environment that the construction industry operate with its competitive and rapid innovations that emanate from other industries obliged this study to explore into barriers that hold-up implementation of construction innovations. Review of this study has shown that the various definition of innovation study categorised construction barriers into two main classifications; namely barriers emanating from the industry, organization and the legislation and regulation governing the environment that industry operates. The study wrap-up that, the construction the barriers as a result of the industry
originated from the fragmented and the bureaucratic nature and loosely coupling system that the industry has been characterised with (Dubios and Gadde (2002). Organization barriers to innovation were as a result of the inhibited tangible and intangible cultures of the firm that deter the implementation of innovation. The last categorised barrier to innovation is legislation, and regulatory barriers which arise as a result of stringent policy enacted by central government and its agencies that hinders construction innovation. Such laws may include procurement policy and laws, standard contracts among others.

Measures construed from the study to reduce construction innovation barriers:

There must be an inherited culture within the organization depicting its desire to embark on innovation projects. Blayse and Manley (2004) argued that in order to foster construction innovation, there must be integrated approaches to construction projects due to the fragmented nature of the industry. Further, there must be improvement of knowledge flows by developing more intensive industry relationships to offset any anticipated disadvantages Dubios and Gadde (2002) found that the fragmented and the bureaucratic nature and loosely coupling system that the industry is as a result of its inability to innovate rapidly. Further political linkages to firms must be separated from firms/industry to avert any impact on the implementation of innovation. Central Government must formulate policies that will stimulate innovation programmes within the sector to facilitate implementation. Intensive consumer awareness must be instituted to enlighten stakeholders about new products and techniques thereby increasing confidence and the desire to implement that innovation.

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BUDGETARY ALLOCATION TO THE HOUSING SECTOR AND THE IMPACT ON PRICES OF SOME BUILDING MATERIALS

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This research evaluates budgetary allocations to the housing sector and the impact on prices of some building materials. Using data obtained from Lokoja metropolis in (Kogi State) of Nigeria as well as the statistical technique of regression, set at 95% confidence level, it establishes as follows: significant relationships exist between the prices of (blocks, sand and cement) and the budget for housing sector, recording R-square values that were between (64.25-55.31)%. Further linear regression equations between the parameters of (% change in prices of block, sand and cement) and (the % changes in budgets for housing) were not however significant, recording R-square values that were between (0.37-3.27)%. Exponential transpositions of the linear equations were not significantly different from the initial ones. The research concludes that % increases in budgetary allocations to the housing sector do not account for the % increases in the prices of the materials. Other economic factors outside the tested parameters are likely to account for the changes in prices. The research recommends further studies which explore the influence of macro-economic variables on the prices of building materials and budgetary allocations.

Keywords: budgetary allocation, building material, housing sector, price determinants

INTRODUCTION

The sustenance and survival of public and private organization are based on efficient budgetary systems and allocations. Capital budgets in particular provide the means through which physical infrastructure developments are achieved. Adebayo (1981), has contended that budgets remain the main measure by which the essential resources of men and materials are articulated for the accomplishment of almost all government goals. Perhaps is it no exaggeration to say that budgeting is synonymous with management since both are concerned with systematic intelligent planning and control of resources. According to Umoren (1994), budgets

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are plans for a given period on a proposed expenditure with clearly defined means for financing the expenditure. Buhari (1993) and Onwusonye (2010), have observed that physical infrastructure development by its nature is capital intensive and that budgetary allocations provide the financial means of meeting the capital intensive demands. Physical infrastructure development is beginning to be understood in terms of the housing stock and quality as well as the place of the housing subsector in national economy and development. Adeniyi (1985) has posited that shelter is second to food, in man’s hierarchy of needs. UNDP (2010), has noted that housing is a universal basic need, and constitutes a key component of the economy of nations and that lack of it, is one of the worst forms of poverty. Aribigbola (2009), has opined that conceptual differences exist between housing and shelter, the concept of housing transcends shelter. Apochi and Achuenu (2002) headings provide an excellent basis for discussion on the constituents that makes up for good housing: water, adequate space, functional layout and the availability of amenities.

The housing subsector is however bedevilled by a plethora of problems. Mosaku (1997) and the National Housing Programme. NHP (1991) have identified acute shortages in stock and unsatisfactory quality conditions. These occurrences are attributable to futility of associated policies on past housing programmes; colonial, post-independence (1960-1979), the second republic (1979-1983) and the period (1991-2000). Olutah (2000), has also indicated that there were severe inadequacies in quantitative and qualitative terms. Asiodu (2001), reiterated that there were shortfalls in projected targets for housing units. Alufohai (2011), has observed that the Nigerian housing deficit is about 17 million units. The shortages according to Akumazi (2011) are put at about 16 million units. 720,000 units are required yearly to meet the millennium goal on housing. A gap of N56 million trillion existed for the estimated mortgage financing.

Ghana’s statistical service (2000) and the local government desert (1999) cited in Yalley et-al (2010), indicated that Ghana, also suffers from acute shortage of housing and that the problem is not different from other developing countries. Statistics showed that the increases in the housing were unable to keep pace with an increase in population which was at a rate of 2.7 per annum.

The shortages in housing stock, according to Nwuba (2002) are mainly due to escalations in the prices of building materials. Alagidede (2012), has posited that the construction sector is one of the important sectors in any economy. It is a key barometer of the health of the economy because of its strong linkage to cyclical fluctuations in the economy. The construction sector is critical as government’s policy of stimulating the economy works through spending on physical infrastructure. The sector can thus be used for governments counter cyclical macroeconomic policy. Increasing the level of capital stock through improving physical assets in a recession would counter the effects of the fall in output, smooth economic cycles and put the economy in a steady state of growth.
Based upon guidance and revelations it would seem reasonable to postulate that distortions in macro-economic stability impacts on prices of goods and services. This in turn influences budgetary allocations by government for physical infrastructure development, the housing sector inclusive. There is therefore a need for these deficiencies that have been observed to be addressed for several reasons: The declarations of the first united nations centre for human settlement conference, habitat I (1976) held in Vancouver, Canada and habitat II Istanbul, Turkey gave credence for the commitments of government, world over to address the problems associated with housing sector. There is a need for ambitious housing programme that requires concerted actions by all tiers of government, other public and private towards addressing, the shortages and dilapidated situations of housing (Asiodu, 2001). The housing/construction sector contributes a great to the gross domestic products (GDP), (Mogbo, 2001). Housing requires a great deal of capital outlay which beyond the capacity of the medium/low income groups (Akumazi 2011). There is a need to explore an emerging and prevailing public private initiative for housing procurement (Mogbo 2001 and Ibrahim 2011). The percentage contribution of Building Materials to total cost of building is between 50-60% (National Housing Policy 1991 and Mac-Barango 2003).

There is therefore an urgent need to understand through this research the influence of the prices of building materials on budgetary allocations and subsequently on the housing sector. This research begins to contribute to this agenda by undertaking a review on the elements of macro stability with a view to evaluating its impact on the prices of the selected building materials and consequentially on the budgetary allocations to the housing sector. This it is able to achieve through the appraisals of existing relationships between: Price regimes and budgetary allocation (ii) Percentage increases in the prices of the building materials (cement, sand and blocks) and the percentages in budgets for housing. The scope of the research is as follows: The location, Kogi State of Nigeria lies between Longitudes 7.56N and Latitudes 6.57E. Lokoja, the administrative headquarters is a conference town between two rivers, Niger and Benue (prominent ones in Africa). The conference status has enhanced its economic potentials. The following scope and assumptions define the limits and bounds within which the results of the research hold: The period of the study is between 2000-2007. The price regimes were obtained for prices of some common building materials (cement, sand and blocks). The assumptions are that prices obtained from vendors of building materials are true representations of prevailing situations. Prices are determined by the forces of demand and supply induced by macroeconomic elements. The structure of the paper is as follows: First it elucidates on issues and factors which influence macro-economic stability, this led to the formulation of other pertinent questions such as: Do fluctuations in prices lead to inflation. (ii) How do changes in prices influence budgetary regime. (iii) To what extent do changes in prices of building materials influence both the total as well as the capital budgetary allocations to the housing sector, under the period of the review. Second, it undertakes a review of related
literature on the links and interlinks between elements of macroeconomic stability, price fluctuations and budgetary regimes for the housing sector. It also draws from the results of previous works. Mogbo’s research works (2001) on budgets for public utilities in Lagos State, Nigeria and the construction sector and economic growth of Nigeria (1981-1995) serve as relevant examples. Wali’s (2005) research, establishes that there were significant relationships between, (i) the cost of sand as well as that of cement and budgets for housing. (ii) There were no significant relationships between annual variations in the cost of sand as well as that of cement and annual variations in budgets for housing in Niger state of Nigeria, within the period (1994-2004). Idiake’s (2011) research establishes that increases in the pump of diesel (Ago), could be used to predict the prices of building materials and its effect on the construction industry. Third the paper summarizes methodology. Finally the research draws conclusion and offers recommendations.

**BUDGETARY ALLOCATION AND PHYSICAL INFRASTRUCTURE DEVELOPMENT**

Financing of physical infrastructure for public housing sector is substantially through budgetary allocations. The budget is a management and analytic tool that aids in financial appropriations. The budget is a planned statement of expenditure and revenue as well a means of control within a period. According to Bozemmann and Strauss man (1982) budgeting is an economic analytic process, which is between competing and often countervailing forces on issues of centralization and decentralization, autonomy and independence, macro and micro politics. Adetola (1999), reveals that at the micro economic level, the analytic process of budgeting is about converting of a company's plans and objectives into quantitative and monetary terms, which aids in the planning and control of income and expenditure. The analytic process of budgeting according to Umoren (1994) ensures that actual spending generally coincide quite closely with budgetary appropriations that is achieved through a plan of financial operations. Dikko (1999), elucidates that the analytic process of budgeting at the macro-economic level involves reviews of the impact of macro-economic variables of exchange rate, interest rates, duties and taxes, location peculiarities, population, land constraints, equipments’ etc on the preparation of a proper realistic and useful capital estimates. According to Mogbo (2001), wrong appraisals of the constituents’ during a budgeting exercise for infrastructure in the public sector, is a major cause of poor performance that arises from inadequate budgeting and that budgetary financing correlates with physical infrastructure. Anyadike (2002), also articulates reviews emphasizing that budgetary planning is a tool for rational allocation of financial resources and further reiterates that allocation exercise through the adoption of models from a good basis for the selective implementation of competing development programmes to achieve set objectives. Alagidede (2012) has observed that government can through its policies, either retard
or stimulate the economy. This it is able to achieve through spending on physical infrastructure. The pace and pattern of business investment in the construction sector is critical, the sector establishes a number of intersectoral linkages of the economy and produces multiplier effects.

**BUDGETARY ALLOCATION, BUILDING PRICE DETERMINANTS AND THE HOUSING SECTOR**

Budgetary allocations involve an analytic review process that translates the requirements and needs of the housing sector to financial and economic terms: Alagidede (2012), posits that the needs and requirement of the physical construction sector are labour, material and equipment which translate the techno-economic specifications produced, by the architectural, engineering and design services into concrete physical entities. Anyadike (2000), posits that a thorough analysis of constituents’ of projects and their resources requirements form a good basis for budgetary allocation and also cautions that budgetary allocation should not be undertaken without appropriate plans for continuous funding to completion. Mogbo (2001), links inadequate budgeting by the public sector to the low level of implementation of infrastructural development and emphasises that the poor performance is caused by budget deficit, there is therefore a need for the citizens to avoid unplanned spending especially those knowledgeable enough in the art of budgetary allocations. Ofereh (2006), asserts that uncompleted projects and alright abandonment are some of consequential effects which the lack of connectivity between the budget sizes and projects, they are expected to finance can cause. Issues on prices, quantity supplied, demand of materials, monetary and exchange rates policies on prices and their impact on budgets for future requirements are extensively reviewed by (Ayeni 1986, cited in Jagboro 1992). Mogbo’s assertion (1992), forms an excellent basis for discussion on economic and financial issues and variables that should be considered as useful parameters that influence budgetary allocations and capital funding to the housing sector: Derived revenue, anticipated revenue, gross national product (GNP) and gross domestic product (GDP), the final cost/m2 of previous project cost, past final and initial construction cost and time trends, the population to be served, the percent and past trends of the population for housing stock. The National housing policy (1991), highlights an array of factors: which included the following: high demand for building materials, massive importation of building materials and scarcity of building materials as the causative factors that are responsible for the escalations and the upward trends in the price mechanism of building materials and construction cost. Nwuba (2002), articulates literature on the issues that led to the escalation in the continuous upward trends in prices of building materials. There is an excellent basis for undertaking a literature review in Ajanlekoko (1990), Nwuba (1994) and federal office of statistics FOS (1997) cited in Nwuba (2002), on issues connected with the impact of the structure adjustment (SAP), on the escalating costs of construction. Onibokun, 1990 cited in Nwuba (2002),
observes that it is the high cost of building materials and other inputs that slow down the rate of housing supply. Lilly and Wai’s (2001) headings form an excellent basis for discussion of some other factors that are responsible for the upward trends in materials cost and their impact on economy: High demand for building materials relative to supply, instability of the economy and the regular increase in inflation. Yalley et-al (2010), have revealed from a survey on housing values conducted in Sekondi-takoradi metropolis, that population and prices of buildings, especially cement are factors affecting housing delivery. Issues concerning the interrelation between the economic variables, of prices of building materials and budgetary allocations are extensively reviewed elsewhere. See, for example, the assertion of Okongwu 1986 cited in Mogbo’s (2001), on the budget as a fiscal instrument for the management and planning of an economy, and the inherent influence of oil market and foreign exchange regimes on budgeting. Wong (2008), Simonson (2008) and the bureau for labour statistics USA (2008) cited in Idiake (2011), also provide an excellent basis for review of the impact of the increases in the price of diesel (Ago) on the prices of building materials and by extension its effect of the Malaysian economy. Reasonable inferences could be drawn from Idiake’s (2011), caution and advice to the Nigerian Government that fuel price hike policies should be implemented with restrain as to prevent rises in the prices of building materials. The advice draws from the Malaysian experience and the results of his research work which establishes significant correlations between increases in prices of diesel (Ago) and the prices of building materials in Nigeria (1990-2009). Mosaku, (1997), provides headings that explain the occurrence and consequences of inflationary trends: cost overrun, inability to meet output targets and reduction in effective demands. According to Nwuba (2004), shortages in housing supply, difficulties in forecasting and planning, frequent variations in contract prices are some of the consequent impacts of the upward trends in prices of building materials. Government can either stimulate the economy to growth or retardation through macro-economic policies. This it is able to achieve, according to Alagidele (2012), through policies which increase the level of capital stock in a recession or reduce spending on physical infrastructure to maintain smooth economic cycles. Hendershott et-al (2007) have stressed that lending at high interests, short payback period, inflation, multiple taxation and the escalating costs of materials and labour are impediments to the facilitation of access to decent affordable housing.

PUBLIC PRIVATE INITIATIVES & BUDGETARY ALLOCATIONS

The adoption of public private initiatives provides an alternative option for infrastructure procurement. Mogbo (2001), has suggested that public private procurement models will minimize the burden of financial stress government face, arising from demands for increased budgetary allocations. Apochi and Achuenu’s headings (2001), provide an excellent
basis for review of the various kinds of partnership that can be used in the provision of housing: Financial, site and service franching/concession (provision of services) partnership and build own operate partnerships. Public private initiatives provide alternative and comprehensive means of housing procurement. Kiwumulo 1996 cited in Lawal and Sanusi (2002), provides an excellent guidance of the components of a housing strategy in Uganda. These acts as an enabler for sustainable provision of housing following the government’s inability to continuing meet the housing requirement. The procurement process for PPP projects varies according to the model that is used. Cartlidge (2009), provides headings for the current PPP models, and further reiterates that the private finance initiative, is the most widely used, most controversial and best known form of ppp, currently accounting for approximately 80% of all expenditure on ppp’s in the UK construction sector. The attempts to contain the infrastructure deficits by immediate past and present governments at various levels/tiers in Nigeria encouraged the introduction of public-private partnerships (ppps) as a way of promoting active sector involvement in the provision of public infrastructure and services. (Ibrahim 2011).

RESEARCH METHODS

The research analyzed data, that is collected through field survey it used statistical technique which forms the basis for inferential as well as descriptive analysis of parameters. The research adopts the technique of regression for the testing of the parameters of the established relationship which were between budgetary allocations to the housing sector as dependent (variables) and the prices of building materials of cement sand and blocks as independent (variables). Considerable research works in terms of literature review have been done on infrastructural development, however limited studies have adopted the same techniques for exploring relationships between resource allocations (budgetary) and economic trends, as this one. See, for example, the assertions of Mogbo (2001), Frank (2003) and Oforeh 2006 cited in Akintayo et-al (2011), on paucity of the researched field, as well as findings on the subject of budgetary financings which links infrastructural development to level of execution. Idiake (2003), adopts the technique of regression in establishing relationships between the Gross domestic product (GDP) and the rising prices of material and labour. Mac-Barango (2011), adopts it in establishing relationships between demographics and the prices of cement. A common observation of the parameters of the relationships of both studies is the existence of natural linearity between and amongst them. This condition provides an excellent basis in generic terms for the applicability of regression as an analytic technique. See, [Koutsonyiannis (1977), Lipsey (1983) and Cartlidge (2009)]. This research work however adopts regression technique as applied in previous ones which explored relationships of resources allocations of budgetary parameters and economic variables, which affected the level of infrastructural development, have direct bearing on the housing sector. See, for example.
Mogbo’s research (1992), suggested parameters for allocating funds to the construction of housing unit also Madaki’s work (2011) on mortgage funding for housing loans and the determinant demographic variables. This research work, therefore considers the technique very appropriate.

The research adopts both primary and secondary sources for the collection of data. The primary source was used to obtain data for the prices of the sampled building materials (cement, sand and blocks) from vendors in Lokoja, metropolis, Kogi State of Nigeria; for the period 1994-2004. Secondary source was used to collect data for the period (1994-2004), for the parameters of the budgetary allocations which included the total budget for the State, the total budget for the housing sector and the total capital budget, these were obtained from the ministry of planning and budget, Lokoja. The mean values of the parameters obtained for the period (1994-2004) for both the budgetary and the prices formed the basis for the analysis of the data. The research employs the statistical package for social sciences SPSS version 17.0, for the classification and analysis of data. Linear relationships were established from the tested parameters, which show the degree of correlation between the variables. Transpositions of the linear equations derived forms tested the parameters to their exponential formats. Quadratic and cubic were also made.

**PRESENTATION OF RESEARCH DATA, RESULTS AND DISCUSSION**

Table 1: Raw data values of the budgetary allocations and the prices of the building materials.

<table>
<thead>
<tr>
<th>Year</th>
<th>TOTAL BUDGET</th>
<th>HOUSING BUDGET</th>
<th>PERCENTAGE (%)</th>
<th>cost of 225mm block</th>
<th>cost of sand per M³</th>
<th>cost of cement per 50kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994</td>
<td>307,775,400.00</td>
<td>25,000,000.00</td>
<td>8.12</td>
<td>20</td>
<td>650</td>
<td>265</td>
</tr>
<tr>
<td>1995</td>
<td>679,704,615.00</td>
<td>40,300,000.00</td>
<td>5.93</td>
<td>25</td>
<td>680</td>
<td>390</td>
</tr>
<tr>
<td>1996</td>
<td>923,949,037.00</td>
<td>45,000,000.00</td>
<td>4.87</td>
<td>25</td>
<td>850</td>
<td>445</td>
</tr>
<tr>
<td>1997</td>
<td>943,196,298.00</td>
<td>54,750,000.00</td>
<td>7.10</td>
<td>28</td>
<td>945</td>
<td>460</td>
</tr>
<tr>
<td>1998</td>
<td>1,538,900,415.00</td>
<td>109,256,224.00</td>
<td>7.10</td>
<td>30</td>
<td>1200</td>
<td>480</td>
</tr>
<tr>
<td>1999</td>
<td>1,707,534,000.00</td>
<td>136,750,000.00</td>
<td>8.00</td>
<td>30</td>
<td>1450</td>
<td>500</td>
</tr>
<tr>
<td>2000</td>
<td>11,090,419,263.00</td>
<td>796,500,000.00</td>
<td>7.19</td>
<td>35</td>
<td>1750</td>
<td>550</td>
</tr>
<tr>
<td>2001</td>
<td>13,294,565,030.00</td>
<td>624,027,886.00</td>
<td>4.69</td>
<td>45</td>
<td>1800</td>
<td>700</td>
</tr>
<tr>
<td>2002</td>
<td>15,498,710,803.00</td>
<td>451,555,772.00</td>
<td>2.91</td>
<td>55</td>
<td>1950</td>
<td>950</td>
</tr>
<tr>
<td>2003</td>
<td>0,490,126,623.00</td>
<td>320,620,000.00</td>
<td>3.06</td>
<td>65</td>
<td>2250</td>
<td>1100</td>
</tr>
<tr>
<td>2004</td>
<td>5,336,534,305.00</td>
<td>1,642,000,000.00</td>
<td>10.71</td>
<td>70</td>
<td>2400</td>
<td>1500</td>
</tr>
</tbody>
</table>

Source: Ministry of budget and planning, Lokoja, Kogi State and market survey
Table 2: Presents the results of linear equations of the tested parameters. (the budgetary values and prices of building materials).

<table>
<thead>
<tr>
<th>EXP VARIABLES</th>
<th>RESULTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-AXIS</td>
<td>Y-AXIS</td>
</tr>
<tr>
<td>1</td>
<td>price of block housing budget</td>
</tr>
<tr>
<td>2</td>
<td>price of sand housing budget</td>
</tr>
<tr>
<td>3</td>
<td>price of cement housing budget</td>
</tr>
<tr>
<td>4</td>
<td>% change in p.block % change in h.bud.</td>
</tr>
<tr>
<td>5</td>
<td>% change in p.sand % change in h.bud</td>
</tr>
<tr>
<td>6</td>
<td>% change in p.cem % change in h.bud</td>
</tr>
</tbody>
</table>

Source: Authors field survey and the ministry of budget and planning, Lokoja, Kogi State (Nigeria)

Tables 3: below shows the results of the established relationships between the tested parameters. Equations in Exponential formats.

<table>
<thead>
<tr>
<th>S/N</th>
<th>Model</th>
<th>Variable</th>
<th>X</th>
<th>Regression equation</th>
<th>R-Sq</th>
<th>Fcal</th>
<th>Ftab</th>
<th>Pvalve</th>
<th>Strength</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Quadratic</td>
<td>Price of block</td>
<td>Housing budget</td>
<td>$y = 25.60 + 0.04x - 1.13x^2 \times 10^{-5}$</td>
<td>58.21</td>
<td>5.57</td>
<td>4.46</td>
<td>0.03</td>
<td>Strong</td>
<td>significant</td>
</tr>
<tr>
<td>2</td>
<td>Cubic</td>
<td>Price of block</td>
<td>Housing budget</td>
<td>$y = 12.86 + 0.24x - 0.0004x^2 - 1.69x^3 \times 10^{-7}$</td>
<td>92.96</td>
<td>30.82</td>
<td>4.35</td>
<td>0.00</td>
<td>very strong</td>
<td>significant</td>
</tr>
<tr>
<td>3</td>
<td>Quadratic</td>
<td>Price of sand</td>
<td>Housing budget</td>
<td>$y = 838.55 + 2.46x - 0.000948x^2$</td>
<td>73.65</td>
<td>11.18</td>
<td>4.46</td>
<td>0.01</td>
<td>Very strong</td>
<td>significant</td>
</tr>
<tr>
<td>4</td>
<td>Cubic</td>
<td>Price of sand</td>
<td>Housing budget</td>
<td>$y = 444.35 + 8.54x - 0.013x^2 + 5.23x^3 \times 10^{-6}$</td>
<td>96.08</td>
<td>57.11</td>
<td>4.35</td>
<td>0.00</td>
<td>very strong</td>
<td>significant</td>
</tr>
<tr>
<td>5</td>
<td>Quadratic</td>
<td>Price of cement</td>
<td>Housing budget</td>
<td>$y = 426.15 + 0.66x - 6.73x^2 \times 10^{-4}$</td>
<td>64.49</td>
<td>7.26</td>
<td>4.46</td>
<td>0.02</td>
<td>Strong</td>
<td>significant</td>
</tr>
<tr>
<td>6</td>
<td>Cubic</td>
<td>Price of cement</td>
<td>Housing budget</td>
<td>$y = 180.84 + 4.44x - 0.0076x^2 + 3.25x^3 \times 10^{-6}$</td>
<td>94.66</td>
<td>41.35</td>
<td>4.35</td>
<td>0.00</td>
<td>very strong</td>
<td>significant</td>
</tr>
</tbody>
</table>

Source: Values of raw data from Field survey and ministry of budget and planning.

Table 4: below shows the results of the regression analysis between the percentage changes in the prices of block/No, sand/m3 and cement/50kg versus the percentage changes in budgetary allocations to housing.
<table>
<thead>
<tr>
<th>S/No</th>
<th>Model</th>
<th>Variable</th>
<th>Regression equation</th>
<th>R2 %</th>
<th>F Cal</th>
<th>F Tab</th>
<th>P value</th>
<th>Strength</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Linear</td>
<td>% change in Price of block</td>
<td>Y= 12.43 -0.005x</td>
<td>1.00</td>
<td>0.07</td>
<td>5.12</td>
<td>0.85</td>
<td>weak</td>
<td>not significant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>% change in Housing budget</td>
<td>Y= 13.34</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Quadratic</td>
<td>% change in Price of block</td>
<td>-0.108x +0.00023x^2</td>
<td>14.63</td>
<td>0.69</td>
<td>4.46</td>
<td>0.53</td>
<td>weak</td>
<td>not significant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>% change in Housing budget</td>
<td>Y= 13.04</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Cubic</td>
<td>% change in Price of block</td>
<td>+ 0.00079x -9.75x 10^-7</td>
<td>20.30</td>
<td>0.59</td>
<td>4.35</td>
<td>0.64</td>
<td>weak</td>
<td>not significant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>% change in Housing budget</td>
<td>Y= 12.91 + 0.15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Linear</td>
<td>% change in Price of sand</td>
<td>Y= 12.81 + 0.0086x</td>
<td>3.27</td>
<td>0.30</td>
<td>5.12</td>
<td>0.60</td>
<td>weak</td>
<td>not significant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>% change in Housing budget</td>
<td>Y= 12.38 + 0.0576x</td>
<td>7.89</td>
<td>0.34</td>
<td>4.46</td>
<td>0.72</td>
<td>weak</td>
<td>not significant</td>
</tr>
<tr>
<td>5.</td>
<td>Quadratic</td>
<td>% change in Price of sand</td>
<td>Y= 12.91 + 0.15</td>
<td>35.00</td>
<td>1.27</td>
<td>4.35</td>
<td>0.36</td>
<td>weak</td>
<td>not significant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>% change in Housing budget</td>
<td>Y= 17.01 + 0.0059x</td>
<td>0.37</td>
<td>0.03</td>
<td>5.12</td>
<td>0.86</td>
<td>Weak</td>
<td>not significant</td>
</tr>
<tr>
<td>6.</td>
<td>Cubic</td>
<td>% change in Price of sand</td>
<td>Y= 15.95 - 0.078 + 0.0013x^2 -2.34x^3 x 10^-8</td>
<td>12.76</td>
<td>0.34</td>
<td>4.35</td>
<td>0.80</td>
<td>Weak</td>
<td>not significant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>% change in Housing budget</td>
<td>Y= 16.66 + 0.0458 - 8.95 x 10^-5</td>
<td>1.12</td>
<td>0.05</td>
<td>4.46</td>
<td>1.00</td>
<td>Weak</td>
<td>not significant</td>
</tr>
</tbody>
</table>

**DESCRIPTIVE ANALYSIS**

Figures (1-2) show the interrelationships between the parameters tested (i) The percentage contribution of housing budget to the total state budget and (ii) the budgetary allocation to the housing sector and the price trends of block, sand and cement over the research period (1994-2004). The charts indicate that years 2004 and 2002 recorded the highest and lowest budgetary allocation to the housing sector respectively. The interrelationship between the price trends of the building materials (block, sand and cement) and the budgetary allocation to the housing sector established the same trends; a gradual and steady trend from the year 1994 to 2000. The prices maintained sharper increases from the years 2000 to 2004, the budgetary allocations however dropped from 2000, and had a sharp decrease until 2003 and a sharp increase in 2004.
DISCUSSIONS OF THE RESEARCH FINDINGS

The research establishes (1) equations of relationships between (a) the budgetary allocations to housing sector and the prices of block, sand and cement within the research period. (b) Relationships between the percentage (%) changes in budgetary allocations to the housing sector and the percentage (%) changes in the prices of block, sand and cement within the research period. (2) The linear equations of GROUP A relationships (see table 1) are in the form: (a) \( y = 28.14 + 0.025x \), (b) \( y = 1051.73 + 1.00x \), (c) \( y = 441.30 + 0.56x \) for budgetary allocation to the housing sector and the prices of block, sand and cement respectively. (3) The linear equations of the Group B relationships (see table 4) are in the form: (a) \( y = 12.43 - 0.005x \), (b) \( y = 12.81 + 0.008x \), (c) \( y = 17.01 + 0.0059x \) for % changes in budgetary allocations to housing sector and % changes in the prices of block, sand and cement respectively. (4) All the Group (A) equations indicated positive relationships between the parameters, whilst group (B), equations indicated either positive or negative relationships between the parameters. (5) The R-square values of the equations indicated values that were between (0.37-64.25), for Group A, equations all indicated positive correlations between the parameters. All Group B equations indicated negative correlation between the parameters. The equations derived from Group A relationships (that is between the parameters of budgetary allocations and (the prices of the block, sand and cement) were all strong & significant, while the equations of Group B, relationships, between the parameters of % changes in the prices of block, sand and cement and % changes in budgetary allocations, were weak and not significant. (6) The transpositions of the linear regressions equations to exponential formats, quadratic and cubic did not yield results that showed significant departure from the linear equations. (7) The derived linear equations, of the Group A, relationships (i.e. between the prices of block, cement, sand and budgetary allocations) have good predictive functions. The budgetary allocations to the housing sector can be predicted using values of the prices of the building materials. The predictive functions of the Group B, relationships were however all weak. Percentage changes (%), in prices of block, sand and cement cannot be used to predict budgetary allocations to the housing sector. Generally the values of the observed relationships from fig (1), see appendices maintained upward and downward trends in same directions, these trends were intandem with the inferential statistics of tested parameters. Increases in prices should ordinarily have corresponding increases in budgetary allocations. The interrelationship between the % changes in the budgetary allocations in the prices of the materials and % changes in the budgetary allocations for the housing sector, from fig (2), see appendices however showed haphazard trends, recording sharp falls and rises over the years. Generally, the rise and fall trends of the parameters were in the opposite directions this trend is intandem with the results of the established inferential linear equations of these parameters, which established that there were no significant relationships between %
changes in prices of the building materials and % changes in budgetary allocations.

CONCLUSION

The research concludes that housing plays a pivotal role in physical infrastructure development of an economy. There exist inadequacies in the quantity and quality of housing relative to demand. Research concluded that budgetary allocation to housing does not affect the prices of the building materials (block, sand and cement); increases in budgetary allocations to the housing sector are not responsible for the observed increases in prices and consequent shortages in housing stock. % changes in housing budgetary allocations are not likely to lead to % changes in prices of the building materials. Other economic variables (rather than increases in budgetary allocations) could be responsible for such increases in prices of these materials. Based on the results and conclusions drawn, the research recommends further exploratory study on relationships between (i) budgetary allocations to other sectors and the prices of building materials (ii) Budgetary allocations to the housing sector, demographics and other economic variables. The results of this research are in agreement with those of Wali (2005), which also established that increases in prices of sand and cement, should ordinarily lead to increases in budgetary allocation. The results of Idiakese's research (2011), is also suggestive that increases in prices irrespective of the causative factors could lead to distortions in macroeconomic stability and consequently increases in budgetary construction.

REFERENCES


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UNDP (2010): Human development report Palgrave Macmillian P 229


APPENDICES

Fig. 1: Budgetary allocations for housing and the prices of building materials in Kogi State (Nigeria)

Fig. 2: Percentage changes in housing budgetary allocations and the prices of building materials in Kogi State (Nigeria)
CAPACITY BUILDING FOR NIGERIAN ARCHITECTURAL EDUCATORS

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The quality, quantity and effectiveness of architectural educators are some of the major determinants of the successful implementation of architectural curriculum. By implication these affect the attainment of architectural educational goals in both the universities and polytechnics - the institutions that run programmes leading to the award of degrees/diplomas, particularly in Nigeria. However, a review of some studies shows that the quality, quantity and effectiveness of the educators in Nigerian schools of architecture are inadequate/ not meeting the challenges of contemporary development, especially in the area of Information and Communication Technology, number of Ph.D. holders and Pedagogy. This paper, based on a review of existing researches, is advocating for capacity building for the educators as a panacea for the problems of training of architects in Nigeria to meet up with the challenges of the 21st century. In order to achieve this purpose, the paper reviews concepts of capacity building and some studies carried out in Nigeria on quality, quantity and effectiveness of architectural educators. The paper concludes by emphasizing on the need for capacity building for the upgrading of the educators so as to facilitate the attainment of the educational goals for both internal and external validation in order to meet the challenges.

Keywords: architectural educator, capacity building, contemporary development, curriculum, school of architecture

INTRODUCTION

For any organization, institution or even a nation to function effectively, there must be human and material resources. But among these resources, human resources are the most paramount, since other resources cannot be utilized without human beings. For this reason, these human beings who constitute the human resources in an organization, institution or nation must be well trained, informed and groomed. The act of training, educating and grooming of human resources connotes capacity building. (Odionye, 2014)

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From the above quotation it can be inferred that human resources harness the material resources in all aspects of human endeavour, especially education, where the teacher is the most critical factor in the educational system. Generally, teaching, planning, managing, counselling, discipline, instructing and evaluating are part of the professional roles of the teachers (Abdullahi & Ibrahim 2007). Summarily, to the teacher (lecturer) at the tertiary education, teaching, research and social services are some of the major roles that he/she is expected to carry out.

As stated above, at every level of educational system the teacher is its backbone and the main determinant of the quality of outcome in education all over the world (Duruh, 2008; Iwuagwu, 2006). This has been supported by Uyouko & Okposin (2008) when they opined that, “The teacher is the key person in the nation’s education enterprise whose quality of training could mar or improve the education results.” Thus, the quality of teachers dictates the pace (standard) of the country’s education system.” (Ekaeba, 2008). Furthermore, it is worth noting that without good teachers there can be no good engineers, no good lawyers and architects as well (Ekaeba, 2008), who by their number, quality and effectiveness can make a difference in producing highly skilled manpower to bring about a good humane and orderly built environment” (Lawal, Aniya and Tauheed 2007). This statement has been supported by the report of a study carried out by UNICEF (2001) in collaboration with Federal Ministry of Education, in which it was declared that of all inputs that go into education, the teacher is the most important (Ekaeba, 2008, Fafunwa 1998 cited in Sofoluwe, 2000). Also, a recent study carried out by the World Bank cited (FME, 2008), unfolds that “the quality of the learning outcomes in Nigeria is poor and one of the major causes of this is that the teacher quality is inadequate.” It also reveals that the quality of teachers affects students’ performances more than anything else. It is not only the quality that determines the success of educational outcome but also the quantity (Tanner and Tanner, 1975 cited in Abdulsalam, 2002). In other words, consideration has to be given to both quality and quantity of teachers if educational goals are to be achieved. Adesola (2008) added that Nigeria not only lacks quality teachers, but the quantity of teachers is also inadequate, especially in the Nigerian tertiary institutions, particularly the universities.

Therefore, one of the major things to be done in order to improve the situation is to find a way of enhancing the quality of teachers so as to ensure expertise in the area of knowledge and specialized skills. This could be done by way of encouragement through sponsorship to professional and academic workshops, seminars and conferences in order to enhance professional performance (Duruh, 2008). While to Uyouko & Okposin, (2008) the situation can be improved if a strategy is employed in “maintaining adequate level of competence academically and professionally as well as keeping abreast of trends and developments in the field, including getting actively involved in research including teaching and learning are essential element for effectiveness of our teachers.”
Iwuagwu (2006) summed it up that teacher competence could only be achieved and maintained by rigorous and continuous study. From the foregoing, it is clear that for the continued effective performance of the teacher, there is need for further training and retraining and continued professional development. These necessitates the need for capacity building as good education needs constant refreshing, a task that is vital in updating knowledge for global competition.

Thus, the purpose of this paper is to establish the need for capacity building for architectural educators in the Nigerian schools of architecture using secondary data from relevant studies and to make suggestions on how to accomplish successful capacity building for the educators in order to address the challenges of the 21st century. The paper sets the scene by reviewing the concept of capacity building. It further reviews the role of architectural educators in relation to the current situation of the educators in the Nigerian schools of architecture. This review unfolds inadequacy in terms of both the quality and quantity and the paper goes further to offer suggestions on how to make capacity building successful. It concludes by emphasizing on need for the capacity building in order for the educators to cope with the challenges of the 21st Century.

ARCHITECTURAL EDUCATORS IN PERSPECTIVE

As cited earlier (in the Introduction), the teacher is the backbone of any educational setting, without which educational goals cannot be achieved. This is also applicable in the case of architectural education, hence according to Olotuah (2000):

...Architect-educators are the direct and principal executors of an academic programme. For the architectural programme to meet its set objectives skilful and qualified architects have to be employed to teach. As professionals they are supposed to possess competence in the field of architecture and the skill and experience necessary to impart knowledge to the students. Aside from a thorough knowledge of the subject matter, they require the skill necessary to kindle students’ interest in what they are being taught. (And that) ... He has to be abreast of the applications of technology to contemporary architecture and the implications on architectural education.

From the above quotation, two sets of criteria can be deduced to assess quality of architectural educators. The first is competence in the field of architecture and the second is acquisition of teaching methodology (pedagogy) and application of technology in architectural education like Information and Communication Technology (ICT). This is applicable when assessing an architectural educator as an individual. However, when it comes to assessing quantity and quality of teachers as human resource in a school of architecture both the National Universities Commission
Abubakar and Suleman (NUC) and National Board for Technical Education (NBTE) being the regulating agencies established to oversee both the universities’ and polytechnics’ programmes in Nigeria have an established scale in assessing the quality and quantity of teachers, usually used for accreditation purposes. Teachers’ quantity is measured in terms of teacher-student ratio while quality is measured in terms of academic qualifications, spread in terms of status.

Abubakar (2007 & 2008), in two separate studies comes up with similar results indicating that quality and quantity of architectural educators fall short of the benchmark in most of the Nigerian schools of architecture. Summarily, regarding the quantity, the studies unfold that in both the polytechnics and universities where architectural programmes are being run, the teacher/student ratio in most of the schools of architecture falls below the 1/15 minimum requirement as provided by regulating agencies (i.e. NUC and NBTE). This is an indication that the required quantity of lecturers is not met in most schools of architecture. The studies go further, to highlight that the number of architectural educators with teaching qualification is not adequate (less than 10% have acquired teaching qualification), even though this is not a compulsory requirement but it goes a long way in enhancing the quality of teaching. As for the number of PhD holders, it is also inadequate (falls within the range of 1-4%). This has resulted in lack of upward movement to more senior positions such as professorship as the PhD has become a prerequisite for promotion to senior positions, particularly, from Senior Lecturer to Reader and Professor, thus resulting in not meeting up with spread and making the lecturers in each of the schools having a pyramidal shape instead of the inverted pyramid. The Study further revealed that the number of registered architects with the Nigerian Institute of Architects (NIA)/Architects Registration Council of Nigeria (ARCON) is less than 50%; most of who lack adequate knowledge of ICT (Abubakar, 2008).

Furthermore, Baiyewu, Jolaoso and Onolaja (2007) opined that several educators that are charged with the responsibility of imparting knowledge to the students, though they possess paper qualifications, lack the necessary skills required to impart the knowledge in favourable, conducive, objective and enjoyable manner.

Bearing the above in mind, the need for capacity building in all aspects of architectural education cannot be overemphasized. Below are suggestions for successful capacity building for architectural educators towards meeting the challenges of the 21st Century.

**CONCEPT OF CAPACITY BUILDING**

Capacity Building for Staff (CBS) (2008) defined capacity building as “the enhancement, upgrading and strengthening of the ability of individuals and organizations to perform functions effectively, efficiently and sustainably.” Both the individuals and organizations are captured. In
other words, capacity building is for the benefit of both individuals and organizations towards the achievement of the individuals’ goals of career development by acquiring the knowledge and skills, which will lead to the achievement of organizational goals. Consequently, any organization that wants to survive the challenges posed by changes must employ capacity building as a means not only of survival but of adapting and thriving in global competitions. To Lawal, Aniy a and Tauheed (2007), “the concept of capacity building is used to describe a situation in which there is marked absence of required capacity and effectiveness in any organization. It is about developing strategies toward meeting the organization’s effectiveness.” They see capacity building both as a product and a process. As a product because it is used to describe the absence of required capacity and effectiveness in any organization; a drop in knowledge and skills of human resource, which is the driving force in any organization, without which the vision and mission of the organization may not be realized; and as a process, because it goes about developing strategies towards the achievement of the organizational goals.

Three inferences can be made from the above definitions. The first is that capacity building is dynamic, i.e. it is a process that moves and changes with time and also involves a continuous development and effective use of human resources. The second is that human resource is the focal point of capacity building. Finally, consideration of the organizational structure always plays a major role in the selection of strategies for capacity building. (CBD, 2008)

Training and continuous professional development are usually the most popular strategy used for capacity building (CBD, 2008).

**Training**

Atiomo (2000) defines training as “the process of acquiring knowledge, skill and attitude for the sole purpose of executing a specific or present job more effectively and efficiently. It suggests that the scope and range of knowledge, skills and attitudes acquisition is narrow and limited in nature during training activities.”

The method of training can be broadly categorized into two, i.e. on-the-job training and off-the-job training. Atiomo (2000) succinctly defines them as follows:

- **On-the-job training:** this is training given in the normal work situation in the attitude/knowledge/skill behaviour pattern appropriate to a task or job. It may constitute the whole of the training or be combined with off-the-job training and/or further education.

- **Off-the-job training:** training in the attitude/knowledge/skill behaviour pattern required for a task, job or occupation away from the normal work situation and day-to-day pressures. It is normally only part of the whole training programme and is usually combined with on-the-job training and/or further education.
Though training is required to upgrade the performance of lecturers at the tertiary level of education, architectural educators in particular; training alone cannot serve in the enhancement or upgrading of teachers, it has to be supported by professional development that is long term and continuous, which has to be purposeful and well-coordinated for it to be successful. (Budget Office of the Federation: Federal Ministry of Education 2009-2011 MTSS Strategic Session, 2008).

Continuing Professional Development (CPD)

CPD covers a wide spectrum of activities and includes anything carried out to progress, assist or enhance educators’ professionalism. In planning CPD activities, major emphasis should be given to the need of individual educators. However, the institutional, local and national priorities of school must be considered while considering the individual's needs, CPD should lay emphasis on developmental needs, maximize strengths and enable all educators at the end meet up with the challenges of teaching in the 21st Century.

CPD serves both as supporting instruments to educators as well as equipping them with the knowledge required to keep pace with a rapidly changing educational and professional environment.

As stated above, CPD covers a wide spectrum of activities (wide variety of areas), which range from subject-specific programmes, to behaviour management and learning and teaching technique, to information technology skills, to personal development issues (Teaching in Scotland, 2006). With regards to the CPD of tertiary educators, its objectives are to provide educators at all levels with on-going training, and ensure continuity between initial and on-going training (University of Valencia, 2008).

Capacity building process is cyclical that involves five stages; each of which play a major role in determining its success or failure. The stages are as follows:

1. identification of the CPD needs
2. design the CPD programme
3. The acquisition of the skills, knowledge and/or the correct attitude
4. the transfer of learning i.e. Implementation of what is learnt
5. evacuation i.e. feedback (University of Valencia, 2008).

The first stage which is identification has to do with the understanding of short-comings as a result of internal or external challenges posed on the organisation which may as a result be individual or organisational based. Having identified the need, the next stage is to design the CPD programmes that should be focused, purposeful, well-designed in accordance with the need. The third stage is implementation of the programme with a view to acquisition of skills, knowledge, etc. The fourth stage, is putting into practice what is learnt in carrying out teaching, research and community service. The final stage is evaluation after
Putting into practice what has been acquired; feedback is received based on which process will continue with or without modification depending on the level of success of the programme. This is expected to be continuous CPD activities as the challenges will continue within any educational organisation, due to dynamism.

Based on the foregoing, the training aspect of the CB is usually designed with the aim to address specific need to address immediate requirement towards enhancing performance of architectural educators as teachers and researchers and once the specific knowledge and skills are acquired, is discontinued, its duration can be short or long term – acquisition of PhD. While the CPD is usually designed to expose architectural educators to the current trends and challenges within the architectural practice and is mostly of short term duration and is continued in nature. Consequently, training and CPD are planned organizational effort concerned with helping an employee (teacher) acquire specific skills, knowledge, concepts, aptitudes, and behaviours to enable him/her perform more efficiently on his present job, that is, to improve on the performance – capacity building (Peretomode and Peretomode, 2001).

**SUGGESTIONS FOR SUCCESSFUL CAPACITY BUILDING FOR ARCHITECTURAL EDUCATORS IN NIGERIAN SCHOOLS OF ARCHITECTURE**

From the above review, it can be inferred that both the quantity and quality of architectural educators in the Nigerian schools of architecture require capacity building. Furthermore, the review on the concept of capacity building has shown the different strategies that can be used towards enhancement, upgrading and strengthening of architectural educators and the schools to perform and function effectively, efficiently and sustainably. In view of this the following suggestions are made:

The suggestions are categorised into two for effective implementation, i.e. short term and long term.

The short term suggestions are as follows:

1. Each school of architecture should carry out in-house study through action research in order to identify its areas of human resource deficiency so as to plan strategies to address them.
2. Having done that an in-house training should be arranged to address issues that have to do with methodology, curriculum design, and so on, this can be handled in-house within the university.
3. Inter-school architecture researches should be organized within the country.
4. As part of the CPD, some of the capital projects within the university should be carried out by the departments so that both the educators
and the students will use the projects to avail themselves of the current happenings in practice

5. Each school of architecture should draw up a strategy on how to make sure those members that are not registered with the NIA/ARCON do so by organising seminars and using the university projects to get them exposed to practice. Thereafter, they can sit for the NIA examinations so that they can be registered and become better equipped to face the challenge of moulding the architects of the 21st Century.

6. ICT knowledge, especially Computer Aided Drafting and Design (CADD) should be made mandatory for all educators.

7. Educators should be encouraged to enrol for postgraduate diploma in education as this will not only expose them to pedagogy, but acquaint them with the importance and relevance of curriculum renewal and the skills for the renewal.

The long term suggestions are as follows:

1. Those lecturers who do not have PhDs and are yet to enrol should do so immediately. The Association of Architectural Educators in Nigerian (AARCHES) should make adequate arrangement to ensure that there are adequate staff and facilities in the first generation schools of architecture in order to admit all those that do not have PhD.

2. To keep abreast with current trends in practice, the school should find a way of offering consultancy services outside the university, without hindering the academic activities.

3. AARCHES should from time to time be organizing workshops and training with the aim of improving the capacity of its educators.

4. Universities should be sponsoring educators to attend international conferences with a view to transferring what they have acquired to those that have not attended, in order to keep abreast with happenings around the globe, so that training of the architect will not lay emphasis on local environment but also the international arena, especially with the current trend of globalization.

5. AARCHES, NIA/ARCON and the government should work hand in hand towards coming up with how funding should be carried out.

Most importantly, Lecturers, as stakeholders, should be consulted in designing the capacity building programme with a view to making the CBP learner-based, be it training or continuous professional development. In other words, the educators should be taken along in designing training and continuous professional development programmes in order to serve their various needs, which has to take cognisance of the department, university philosophy (need) and that of the country at large.
CONCLUSION
Designing capacity building for architectural educators that will address their need requires commitment from the entire stakeholders i.e. educators, administrators, practitioners and proprietors (government) that own the institutions running architectural education in Nigeria. As shown above, to achieve the desired need they have to come together with sincerity of purpose, adequately plan and strategize, effectively implement and evaluate from time to time, so as to have feedback to know the extent to which desired/targeted goals and objectives are being achieved. This may serve as an indicator for the need for review/modification/adjustment and so on. With these in place, it is the belief of the authors that capacity building that is well structured, will serve as a panacea to some of the problems affecting architectural educators in Nigeria by equipping them to face the challenges of the 21st century.

REFERENCES


COMBATING THE IMPACT OF COLLAPSE OF BUILDING STRUCTURES IN LAGOS ISLAND, LAGOS STATE, NIGERIA

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This study appraised the incessant building collapse in Lagos Island over the years; by determining, its nature, trend, causes and impact on the environment, lives and properties of the study area, possible reduction and preventive recommendations are being proffered to combat the impact. The specific objectives to achieve this included examining the trend of urbanisation and building construction in Lagos Island; Identifying and examining the various causes of building collapse in Lagos Island; Identifying and examining the impact of building collapse on the environment, lives and properties; Proffering and developing appropriate framework, action plans with recommendations towards the reduction and prevention of building collapse impact on the environment, lives and properties of the people of in Lagos Island. The data for this research were obtained from both primary and secondary sources obtained from the study area through observation and questionnaire administration, literatures and interview and focus discussion group sessions with staff of the building construction regulatory agencies. Through systematic random sampling, both descriptive and inferential statistics were used for the data analysis and presentation. The study showed that most of the building sampled were designed by draughtsman and not registered Architects hence and constructed by “quacks” without adequate building construction knowledge and qualification; there was no adequate site visit before, during and after construction of building and its certification for occupation by qualified stakeholders and government officials. Most of the buildings were built hurriedly without quality construction materials to meet the profit schedule of the 20 – 30 years of the development and management agreement. These unwholesome trends degenerate into urban crises, chaos, housing shortage and incessant building collapse causing loss of several lives and properties, loss of jobs and empowering economic activities . This paper discusses combating the impact of building collapse, hence an efficient and effective integration between government and private stakeholders to plan and prepare against reoccurrence of building collapse and reducing and managing its impact in Lagos Island.

Keywords: building collapse, building construction, building demand, building supply, migration, urbanisation

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INTRODUCTION

Buildings are structures which (ought to) serve as shelters for man, his properties and activities. They must be properly planned, designed and erected to obtain the desired satisfaction from the environment (Ayanrinola and Olalusi 2004). Building or housing as the case may be expressed as structures such as houses, churches, schools or factories among others that have roof and walls where people gather or use for one activity or the other (Durojaiye 2007). Most cities are facing a population explosion from rapid rural – urban migration that is threatening every governmental effort in providing housing for the people. The high rate of urbanisation and poverty in the urban centres of Nigeria accounts for the small quantity and poor quality of housing in the country. This is due to the alarming rate of migration into the city centres that the supply of housing, both qualitatively and quantitatively, is very far from meeting the aspirations and need of the fast growing population. Yet, every human being requires a decent housing for living and working. It is paramount in every human being to live full of comfort, security, physical and mental development without limit of possible mishaps of building collapse or failure associated with his place of abode. A collapse building anywhere in the world is a serious problem because of the time, energy, resources wasted especially possible loss of lives and properties. The incessant building collapse recently is a familiar occurrence that is fast becoming a menace to our environment, lives and properties. Though a world phenomenon, it has come to stay at our door post because it is getting more rampant and devastating in developing countries like Nigeria and urbanized cities of the world like Lagos Island. Either in part or whole, the result and menace of building collapse is not reflected only in wasted effort or investment but also of loss of properties and lives. Various buildings have collapsed due to various reasons in the past years in Lagos State and this will go a long way to tell us the seriousness to which we need to address the situation. Durojaiye (2007).

Many people have attributed the causes of building collapse to many things. Building failure and collapse is an unacceptable difference between expected and observed performance, it can be considered as occurring when that component can no longer be relied upon to fulfil its principal functions. Hence, building failure structurally affects both the outlook and structural stability of the building. Building failures in Nigeria have been attributed to:

i. Design faults (50%),
ii. Faults on construction site (40%) and
iii. Product failure (10%) (Oyewande, 1992).

However, in most cases, building collapse have resulted mostly from shoddy construction practices such as hasty construction, lack of proper supervision of work in progress, use of quack to handle design and construction and ultimately the use of low quality building materials. All
these could be linked to greed, carelessness and/or even ignorance which must therefore be vigorously addressed to reduce the apprehension of imminent danger associated with building collapse. Between 1980 and 1999 as recorded by Chinwokwu (1999) 176 lives were lost in Lagos State due to building collapse.

Lagos is a fast growing city with attendant problems of housing supply in terms of quality and quantity. This shortage is due to the inability of housing production to meet the demand, and the ever-increasing influx of people into the city. As a result of this coupled with the dearth of qualified professionals, the city growth is largely uncontrolled with a consequent housing deterioration and slum condition, traffic congestion, unreliable service provision and “development chase” rather than “development control”. The resultant failures in employment, liveability, manageability and serviceability, has put tremendous pressure not only on existing housing but on all facilities and amenities available too (Omolabi 2007). It is worthy to note that Lagos Island has continued to grow tremendously due to pronounced migration and industrialisation, however, this growth is not commensurate with the provision of some infrastructures to support the population. Every year, there is depletion in the existing houses and housing stock while the population is increasing at an alarming rate. It is as a result of the foregoing that this paper focuses on the appraisal of building collapse in Lagos Island with a view of identifying its nature, trend, causes and impact on the environment, lives and properties of the study area, possible reduction and preventive recommendations are being proffered to combat the impact.

**RESEARCH METHODOLOGY**

These statements of problems were looked into accordingly.

- What are the factors responsible for the increase in building constructions and redevelopment in Lagos Island in the recent years?
- What is the life span of a building before it may probably collapse?
- Why are most of the collapsed buildings located in the populated and commercial area of Lagos Island around Isale eko/Idumota area of Lagos state?
- At what stage and conditions are these buildings when they collapsed?
- Are professional in the building industry involved in any collapsed building and at what level of involvement?
- Why do developers and owners greedily engage cheap supervision and use low quality materials for construction?
- Why do developers develop buildings without adequate approvals and documentation?
- What are the roles and responsibility of the various public agencies in monitoring and regulating building constructions such as the
architects and engineers in the building and structural design and certification of the building, planning authority in the approval and monitoring of the building construction, the material testing and standard organisation to certify the quality of materials used?

- Why have both the public and private stakeholders in the building industry not learnt a lesson or more from the past earlier collapsed buildings to avert recurrence of another collapse such prosecution of offenders and defaulters?

- What impacts of threat and insecurity of which building is next to collapse have on the people their lives and properties and the possible protection that could be provided for them?

With these statements of problem, the focus on the appraisal of incessant building collapse in Lagos Island with a view of identifying the causes and impact on the people and the environment so as to proffer a possible solution for its reduction and prevention were looked into adequately.

**Primary data sources: - Questionnaires.**

Both quantitative and qualitative data were sourced for this research, from both primary and secondary sources. Primary data was sourced from the field, two sets of questionnaires with observation method. Secondary data was collected through an extensive literature review.

The first set of questionnaires contained questions on socio-economic profile of selected households, housing characteristics, effects of building collapse on the lives and properties of the people within the study area. This was served on household heads that have been living within the areas for at least ten years. The second set of questionnaire, namely the stakeholders’ questionnaire contained general specific questions that were asked which revolved around the goals and objectives of these selected actors, the owners of the building, developers of the buildings, the occupiers of the building and the building regulatory agencies staffs. Systematic random sampling technique was adopted to administer the questionnaires.

Figure 1: Satellite imagery showing total/partial building collapse sites within Lagos Island.

Source: LASPPDA GIS unit Feb 2008.
The study focal point is centred on the 17 recently reported building collapse cases in Lagos Island between 2005 and 2011 as shown in the table 1 below. A total of 21 streets were thus selected involving these reported cases where a total of 165 questionnaires were administered to the people on the basis of one household per every 5th building on each street. Since the streets have varying lengths and houses, thus every house at 100m interval was selected for this survey to ensure even and fair coverage of the main possible affected streets with building collapse cases and other streets around the building collapse sites affected by the collapse. This is where the rate and pattern of building construction is on the increase in most instances than every other place in Lagos State. This is the area with highest rate and level of activities and interaction between humans and the environment and this affects the physical development of Lagos Island. The 17 reported identified building collapse (figure 1) sites in Lagos Island were assessed to ascertain the impact of such collapse on the environment and the actions taken by the government and other stakeholders after the collapse on such sites. The Government Agencies involved with building development regulation such as Development Control units, Lagos State Physical Planning and Development Authority (LAPPDA) were consulted to get information on the roles played in curbing the building menace. Interviews and personal contacts were conducted with private and public sector developers, and focus discussion group forum was held at various points to determine their opinion about building collapse and its implications. Also the historical growth, development and heritage of Lagos Island were ascertained too.

Table 1. Reported Cases Of Building Collapse In Lagos Island.

<table>
<thead>
<tr>
<th>Address Of Building Collapse Site</th>
<th>Year Of Collapse</th>
</tr>
</thead>
<tbody>
<tr>
<td>71 Agoro Str</td>
<td>17th June 2007</td>
</tr>
<tr>
<td>338, Ergaton Str</td>
<td>16th June 2007</td>
</tr>
<tr>
<td>17 Idushagbe Str</td>
<td>23rd August 2007</td>
</tr>
<tr>
<td>3 Liadi Str</td>
<td>2007</td>
</tr>
<tr>
<td>45/47 Martinas Str</td>
<td>20th September 2007</td>
</tr>
<tr>
<td>38 Idumagbo Avenue</td>
<td>May 2007</td>
</tr>
<tr>
<td>77, Aroloya</td>
<td>24th December 2007</td>
</tr>
<tr>
<td>28, Seriki Str</td>
<td>2007</td>
</tr>
<tr>
<td>6 Princess Str</td>
<td>2005</td>
</tr>
<tr>
<td>6, 8, 9, 10 Okepopo Str</td>
<td>13th February 2008</td>
</tr>
<tr>
<td>15, 17 Nnamdi Azikwe</td>
<td>October 2007</td>
</tr>
<tr>
<td>4 Mogaji Str</td>
<td>July 2011</td>
</tr>
</tbody>
</table>

Source LASPPDA GIS unit feb 2008 and field survey 2013.

Secondary sources and literature review

A number of literatures exist on housing, its production, distribution, maintenance and management in line with building collapse, prevention, remedies and management strategies in Nigeria and the world at large. Efforts therefore in this research was made to review as many relevant documented literatures so as to determine the most relevant impact of
Urbanisation is the agglomeration of people in urban areas. It is a process and it is continuous, initiated by a lot of dynamic interactions (Olatubara 2004). It is caused by urban growth which, could be due to natural population growth, reclassification of urban and rural system and rural-urban migration. Urbanization is a natural process that will ultimately occur. However, the concern here is not only the absolute level of urbanisation but also its rate of growth. The rapid rate of urbanisation in developing countries brings about several problems for the urban centres. Significant among the problems are those of overloading of existing facilities thereby causing traffic congestion, inadequate housing leading to creation of slums, pollution in all its ramifications, etc. Urbanisation is inevitable because urban centres are engines of economic growth and development, serving as centres of entertainment; diffusion of innovations and power performing administrative, religious, educational, and cultural and leisure services, employment and educational opportunities, attracting an ever growing number of immigrants. Housing problems are hardly divorced from planning, especially in urban areas where planning policies are not only comatose but hardly take cognisance of the rapidity of urban growth, necessitating the corresponding higher demand for land by various land use activities. The location of people and activities across the city as well as the pattern of change are not the results of broad amorphous forces operating beyond human comprehension (Agbola, T. 1998).

Hence, more people and activity moves in causing overpopulation and utilization of amenities increasing demand for indiscriminate production of building ultimately causing incessant collapse. Building collapse is now a familiar occurrence even to the layman on the street in Nigeria. When part or whole body of the structure has failed and suddenly gave way, the building as a result of this failure, could not meet the purpose for which it was intended, the building is said to have collapsed. The occurrences of building collapse in the country nowadays especially in recent times have reached very disgraceful and embarrassing levels which are certainly unacceptable. This failure may be primarily traced to lack of sufficiency in mechanical quality of materials chosen and used, poor structural design or poor construction technology, or a combination of more than one of these. Building should be well designed and efficiently constructed to prevent collapse. Building collapse has also been observed to cut across building categories including private, corporate or public (Adeyemo, J. 2003).

In Lagos, statistics have shown that 76%, 12% and 12% are respectively private, corporate and government public building that have been involved in the past building collapses. This indicates that privately owned and developed buildings are more prone to the incessant building collapse syndrome than the corporate and government buildings. Building collapse could occur with or without warning, from design and/or construction faults. The building design stage involves the production of the working
drawing and the approval of the design plans. Design faults could occur at varying degrees, from improper site investigation, inaccurate design assumption, calculations and detailing, incorrect material specification and the inability of Town Planning Authority to maintain competent staff that would countercheck the correctness of the documents submitted for building design plan approval (Lagos State Government 2006). It has been observed and asserted that building fail mainly because of ignorance, negligence and greed. If a critical analysis of any building whether major or minor collapse, there would be none that would escape one or combination of the above stated three reasons. Building collapses are due to poor construction work through the use of substandard materials such as unwashed gravel, contractor not following structural Engineer’s aggregates ratio of cement and sand. Also inadequate compaction of concrete and faulty sequence of operation by the contractor can lead to collapse of the building. In view of the above, the National Council Of Housing and Urban Development worked with the relevant construction professionals and other stakeholders in construction industry to structure this first ever Building Code for the country. A Building Code is the minimum acceptable standard used to regulate the design, construction and maintenance of buildings for purpose of protecting the health, safety, and general welfare of the building’s users.

Buildings, like all structures, are designed to support certain loads without deforming excessively. The loads are the weights of people and objects, the weight of rain and snow and the pressure of wind--called live loads--and the dead load of the building itself. With buildings of a few floors, strength generally accompanies sufficient rigidity, and the design is mainly that of a roof that will keep the weather out while spanning large open spaces. With tall buildings of many floors, the roof is a minor matter, and the support of the weight of the building itself is the main consideration. Like long bridges, tall buildings are subject to catastrophic collapse. The causes of building collapse can be classified under general headings to facilitate analysis. These headings are:

- Bad Design
- Faulty Construction
- Foundation Failure
- Extraordinary Loads
- Unexpected Failure Modes
- Combination of Causes

Bad design does not mean only errors of computation, but a failure to take into account the loads the structure will be called upon to carry, erroneous theories, reliance on inaccurate data, ignorance of the effects of repeated or impulsive stresses, and improper choice of materials or misunderstanding of their properties. The engineer is responsible for these failures, which are created at the drawing board. Faulty construction has been the most important cause of structural failure. The engineer is also at fault here, if
inspection has been lax. This includes the use of salty sand to make concrete, the substitution of inferior steel for that specified, bad riveting or even improper tightening torque of nuts, excessive use of the drift pin to make holes line up, bad welds, and other practices well known to the construction worker.

Even an excellently designed and constructed structure will not stand on a bad foundation. Although the structure will carry its loads, the earth beneath it may not. The Leaning Tower of Pisa is a famous example of bad foundations, but there are many others. The old armoury in St. Paul, Minnesota, sank 20 feet or more into soft clay, but did not collapse. The displacements due to bad foundations may alter the stress distribution significantly. This was such a problem with railway bridges in America that statically-determinate trusses were greatly preferred, since they were not subject to this danger. Extraordinary loads are often natural, such as repeated heavy snowfalls, or the shaking of an earthquake, or the winds of a hurricane. A building that is intended to stand for some years should be able to meet these challenges. A flimsy flexible structure may avoid destruction in an earthquake, while a solid masonry building would be destroyed. Earthquakes may cause foundation problems when moist filled land liquefies.

Unexpected failure modes are the most complex of the reasons for collapse, and we have recently had a good example. Any new type of structure is subject to unexpected failure, until its properties are well understood. Suspension bridges seemed the answer to bridging large gaps. Everything was supported by a strong cable in tension, a reliable and understood member. However, sad experience showed that the bridge deck was capable of galloping and twisting without restraint from the supporting cables. Ellet’s bridge at Wheeling collapsed in the 1840’s, and the Tacoma Narrows bridge in the 1940’s, from this cause.

**STUDY AREA**

Lagos Island Local Government Area (LGA) is one of the 20 LGAs in Lagos State of Nigeria. Lagos Island Local Government Area, the premier local government area in Nigeria and the former seat of the Federal Government, before movement to Abuja in 1992, is located in the southwestern part of Lagos state. It was the state capital until 1972 when the capital was moved to Ikeja. Geographically, Creeks and Lagoons bound the area. It is bounded by the Third Mainland Bridge, laying over the Lagos Lagoon and Lagos Five Cowries Creek Island, which separates it from its neighbours, the Port Novo Creek that merged with Badagry. In the North, it is bounded by the Homo Creek forming the water bodies of Apapa wharf. The significance and growth of Lagos Island is due partly to its historical, cultural, socio-economic and political background as the former seat of the Local, State and National Governments. The area also owes its growth and development to European influence via those who settled around neighbouring Islands of Ikoyi and Victoria. The commercial centre
of Lagos State remains Lagos Island, which is connected to the mainland by three bridges: Carter, Eko and Third Mainland Bridge. Lagos Island Population is 209,437 people with 108,057 males and 101,380 females based on the 2006 national population census. It is an extensive area of 509.02 hectares. Lagos Island acquired the administrative and commercial centre of the Country thus becoming a growth point that attracted people everywhere into Lagos this increase the demand and desire for physical development and building construction at an unprecedented rate that the development control and building agencies cannot meet up with the monitoring hence the incessant building collapse resulting from quack rush building work.

DATA PRESENTATION AND ANALYSIS

This section presents the analysed data obtained from household questionnaire as well as questionnaire for land allocation agencies, private property developers and planning authorities. It discusses the views of these major stakeholders on how building collapse affects the people. This is in addition to baseline information, which covers socio-economic as well as housing characteristics of the respondents/responding officers surveyed.

Table 2: House maintenance in Lagos Island

<table>
<thead>
<tr>
<th>Maintenance Agency</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Developer</td>
<td>4</td>
<td>1.88</td>
</tr>
<tr>
<td>Private Developer</td>
<td>12</td>
<td>7.54</td>
</tr>
<tr>
<td>Individual Tenant</td>
<td>130</td>
<td>79.24</td>
</tr>
<tr>
<td>Others</td>
<td>19</td>
<td>11.34</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>165</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Source: Field Survey, 2013

Lagos Island houses are maintained regularly as observed from Table 2, that, 1.88% of the respondents have their houses maintained by the public developers, private developers maintains 7.45% houses, 79.24% of respondents houses were maintained by the direct individual self (direct occupant), only 11.34% of the respondents houses were maintained by other mean. From family group discussion it was gathered that the this incidence might be as a result of the directive order of the Lagos State Government, that all residents of Government allotted Residential Estates should re-paint their houses directly within a stipulated period or have it painted for at a government fixed amount. Hence, most people especially house owners made use of the upgrading beautification and landscaping of Lagos Island to renovate and maintain their houses regularly. Owners that cannot afford such high maintenance cost tend to spread it on their tenant or lease the house for redevelopment to private developers for a certain number of years. However it was noted that this house maintenance was done by quacks and not professionals as consulted and hired by the owners basically for cost reduction at the expense of quality.
Table 3: Building condition in Lagos Island

<table>
<thead>
<tr>
<th>Building Condition</th>
<th>Frequency</th>
<th>Percentage %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>23</td>
<td>34.67</td>
</tr>
<tr>
<td>Fair</td>
<td>9</td>
<td>45.28</td>
</tr>
<tr>
<td>Bad</td>
<td>75</td>
<td>6.03</td>
</tr>
<tr>
<td>Dilapidated</td>
<td>56</td>
<td>13.99</td>
</tr>
<tr>
<td>Total</td>
<td>165</td>
<td>100%</td>
</tr>
</tbody>
</table>

Source: Field Survey, 2013

As observed from Table 3, only 34.67% of the sampled buildings are considered very good, 28.67% buildings were considered good, in fair condition were 45.28% buildings, and while only 6.03% building were bad, 13.99% building were in dilapidated condition. The Incidences might be also as a result of the overpopulation and over utilization of infrastructure and building use which over stretches these facilities to the maximum breaking (break down) point of dilapidation.

Table 4: Number of months spent to acquire building approval in Lagos Island

<table>
<thead>
<tr>
<th>Time Taken (months)</th>
<th>No of Respondents</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 3</td>
<td>46</td>
<td>27.6</td>
</tr>
<tr>
<td>4 – 6</td>
<td>11</td>
<td>6.5</td>
</tr>
<tr>
<td>7 – 9</td>
<td>37</td>
<td>22.6</td>
</tr>
<tr>
<td>10 – 12</td>
<td>18</td>
<td>11.4</td>
</tr>
<tr>
<td>Above 12</td>
<td>53</td>
<td>31.9</td>
</tr>
<tr>
<td>Total</td>
<td>165</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Source: Field Survey, 2013

The numbers of months taken to acquire residential approval by respondents are contained in Table 4. Of the 165 respondents (27.6%) claimed to have acquired their residential approval between one to three months. Another 6.5 per cent respondents acquired theirs between 4-6 months, 7 to 9 months (22.6%), 10-12 months weeks (11.4%), and more than 12 months are (31.97%).

Table 5: Change in building use in Lagos Island

<table>
<thead>
<tr>
<th>Change in Use</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No to change in use</td>
<td>63</td>
<td>38.11</td>
</tr>
<tr>
<td>Yes to change in use</td>
<td>102</td>
<td>61.89</td>
</tr>
<tr>
<td>Total</td>
<td>165</td>
<td>100%</td>
</tr>
</tbody>
</table>

Source: Field Survey, 2013

From Table 5, it is observed that in Lagos Island, some buildings have undergone changes from one use to another, while some have retained their original residential use. 38.11% of the respondents admitted that their apartments had not been changed from one use to another, while 61.89% respondents said their apartments had been changed from its initial use before. The high incidence occurrence to change of use might be connected to the fact that most houses are family houses that is usually
difficult to make every member of the family agree or consent to any form of change in the use or selling off the house which may “wipe out” the family name and genealogy from Lagos Island in the next future, such houses are left as heritage and reference point for generations. Houses with change of use might be as a result of families that could agree to the change in saving the house from being isolated and deserted since nobody wants to stay there again, they have moved out hence the high consideration for economic value of the house through the change of use brought about by high demand and financial consideration.

Table 6: Analysis of building plan approval in Lagos Island 2000 - 2010

<table>
<thead>
<tr>
<th>Year</th>
<th>No of Application</th>
<th>No Approved</th>
<th>No Disapproved</th>
<th>No of outstanding</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>26</td>
<td>15 (57.6%)</td>
<td>11 (42.4%)</td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td>30</td>
<td>22 (73.3%)</td>
<td>8 (26.7%)</td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td>32</td>
<td>13 (40.6%)</td>
<td>19 (59.4%)</td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td>36</td>
<td>15 (41.6%)</td>
<td>21 (58.4%)</td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td>51</td>
<td>25 (49%)</td>
<td>26 (51%)</td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td>41</td>
<td>24 (58.5%)</td>
<td>17 (41.5%)</td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>36</td>
<td>19 (52.7%)</td>
<td>17 (47.3)</td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>32</td>
<td>15 (46.8%)</td>
<td>17 (53.2%)</td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>56</td>
<td>8 (14.2%)</td>
<td>40 (71.6%)</td>
<td>8 (14.2%)</td>
</tr>
<tr>
<td>2009</td>
<td>35</td>
<td>17 (48.5%)</td>
<td>12 (34.3%)</td>
<td>6 (17.2%)</td>
</tr>
<tr>
<td>2010</td>
<td>48</td>
<td>14 (29.2%)</td>
<td>3 (6.3%)</td>
<td>31 (64.5%)</td>
</tr>
</tbody>
</table>

Source: Eko Town Planning District office 2013

From the analyses above the followings were deduced and found out as reasons for the incessant building collapse in Lagos Island.

- It was observed that the impact of the various professional bodies in the building industry was not felt effectively in the area of building design, construction and maintenance.

- The survey showed that most of the building sampled were designed by draughtsmen and not registered Architects hence; there was no adequate site visit and investigations before design of building.

- During construction too, there was no monitoring to ensure compliance to design. This may be as a result of inadequate machineries for effective site visit monitoring and in accessibility of Lagos Island tiny road network.

- Most of the buildings were built hurriedly to meet the profit schedule of the years of the development agreement with ownership family. Hence the developers often do not wait for appropriate documentation and building plan approval from the relevant authority.

- It was found out these developers either builds with Bank loans or the deposit of intending tenants on first come basis, such builds the building with low standard materials and within the shortest period to minimise expenses and maximize profit.
THE IMPACT OF BUILDING COLLAPSE.

The response from the official of government agency during the interview session showed that the collapsing buildings are due to old age and over use, lack of adequate building maintenance, poor quality building materials use at the time of construction coupled with lack of adequate supervision by professional. The agency responsible for the removal of the dilapidated buildings lack machineries; human and mechanical required for the job. Accessibility to identified building is hard and difficult for effective monitoring and implementation of policies. The cumbersome bureaucracy of the ministry also contributed to the inappropriate action to be taken to avert the building collapse cases in Lagos Island. The official responded that over 1000 houses have been marked for demolition between 2007 to date (2013) out of which less than 50 buildings have been demolished by the State Government for public interest.

The unprecedented population increase in Lagos Island have given rise to weighty environmental problems; poor layout and substantial of construction of building, acute shortage of housing facilities, lack of appropriate development plan, incompatible development among others which consequently have brought about haphazard and illegal development. Lagos has experienced a faster growth than any other urban centre in the country, due to the attraction of population as a result of the enhanced socio-economic and political status. However, the failure of the Lagos State Government to implement the approved master plan 1980 to 2000 portrayed Lagos negatively hence the beginning of the degeneration as reflected as follows:

- Acute shortage of housing facilities and poor condition
- Acute traffic congestion both vehicular and pedestrian
- Sprawling, street trading activities
- Poor infrastructural facilities, such as inadequate parking space and facilities, inefficient public transportation systems and inefficient public communal utilities and amenities.
- Poor environmental sanitation manifested by perpetual heaps of refuse everywhere coupled with poor drainage systems.
- Uncontrollable streets miscreants resulting from loss of job since due to the collapse of their office building.

ACTIVITIES OF LAGOS STATE PHYSICAL PLANNING AND DEVELOPMENT AUTHORITY 

Durojaiye (2007) gave a detailed insight into the role of Development control and the Lagos State Physical and Development Authority in managing the causes and effects of building collapse in Lagos State as a whole. In realization of the challenges posed by high rate of physical developments occasioned by population growth and the transformation of
Lagos into a mega city, the State Government enacted the law to provide for the administration of physical planning, urban and regional development in Lagos State in the year 2005. This resulted into administrative restructuring of existing development control agency and which culminated into the establishment of Lagos State Physical Planning and Development Authority (LASPPDA).

LASPPDA was established to execute all physical planning and development matters in Lagos State in line with Urban and Regional Planning Decree 88 of 1992 in which part of its provisions made it mandatory for all developers both private and public to seek for approval before any developmental activity or before a building operation can take place. Developmental activities entails plans to build new house, rebuilding operations, structural alterations of or addition to building and other operations normally undertaken by a person caring out business as a builder.

The Development Permit Department of LASPPDA is responsible for approval of building proposals. Between January 1999 and March 2007, a total of 38,179 building plan applications were registered while 26,115 were approved and 2,494 plans were disapproved. A total of 9,750 are pending. In the same vein, the Physical Development and Monitoring Department is directly responsible for the physical on site monitoring of developmental activities in the state. Between January 1999 and March 2006, a total of 142,705 contravention notices, 44,340 demolitions notices, 39,046 stop work order and 26,271 quit notices had been served all over Lagos State. Furthermore within the observed years, a total of 1,265 were demolished while 1,172 and 1,795 structures had been partly demolished and sealed respectively. There is a huge gap between the figures of building plans approved between January 1999 and March 2007 by the Development Permit Department (26,115), and the contravention notices (142,705) served within the same period. These figures have implications. This implies that a significant number of developers do not apply for building permit in the state and do not take into consideration the authority’s activities before embarking on development. Another reason that is attributable to this problem is the lack of adequate enlightenment by the public.

With the magnitude of cases of collapse buildings over the years, and the 17 reported cases that occurred between 2007 to date (2013), it is evident that the Physical Planning and Development Authority is faced with a lot of externalities in checking the incessant buildings collapse in Lagos State. Findings from LASPPDA, show that the Authority, even though, has been restructured to meet the ever growing challenges of physical developmental demands of the State, it is saddled with inadequate funding as well as inadequate manpower and equipment particularly in the Physical Development and Monitoring Department (PDMD) (now known as Stage certification and Physical development department SCPD) to monitor physical developmental activities in various Local Government Areas of Lagos State. This lack of adequate monitoring has encouraged
prospective developers in illegal development. Other inadequacies that culminated from lack of proper monitoring of physical developments by the Authority include the following:

a) Non-engagement of competent professional by developers from the conceptual stage.
b) Optimizing benefits or profit by both the developers and the contractors
c) The use of substandard building materials for construction.
d) Construction of buildings in some cases that is contrary to the design that is originally approved.
e) Lack of proper maintenance of the existing structures.

All these factors culminated from poor design and specifications with intent to safe cost at the expense of structural stability. Furthermore the Development Permit Department of the agency is saddled with long administrative bureaucracies in ensuring quick approval of building plans particularly for those building plan proposals that is approvable. This is contrary to operation 30-30 put in place to ensure that development permit is granted to prospective developers within 30 days of application and registration based on submission of statutory documents and payment of assessment fees. According to Olaseni (2005), the obsolete Lagos Metropolitan Plan (1980 - 2000), various District Plans that emanated from the master plan and the charting sheets used for controlling individual proposals are in hard copy but ought to be in soft copy. The medium of presentation does not allow for quick review, update and amendment of information as the case may be.

Another problem that the Authority is saddled with is inadequate funding, particularly in the area of improvement of the Geographic Information System base of the Authority to monitor physical and space related developmental activities within the state and to generate maps of various kinds and present such at whatever scale, precision and medium for use in spatial analysis. This has hindered the smooth running of the authority activities in ensuring effective development control management. The collapse rate of building in Nigeria is directly proportional to the age of building and this is further worsened by building material quality.

CONCLUSIONS AND RECOMMENDATIONS

This research has been able to put into perspective, the effects of the building collapse as recorded in Lagos Island on its lives, properties and environment. It further discussed the efforts of various governmental agencies involved in monitoring building development in Lagos State. It examines the problems of the agency among which bothers on ineffective
geographic information system bases, poor funding of the authority, lack of effective monitoring of physical development activities in the state as well as poor staff strength and these problems put together have been advanced to play a major role in incessant collapse of building in Lagos State.

The ever increasing population arising from the influx of people from different parts of the world into Lagos has put much pressure on the available facilities and housing stock. This has posed a lot of challenge to the both public and private housing provision and management stakeholders. The pattern of urban decay in the world seems to follow similar trends through the stages of city development. As cities grow from its inception to old age and even death, the urban housing stock, infrastructure, amenities and services deteriorate to various stages of disrepair that may signal obsolete scene if necessary action is not taken. This phenomenon which emanated from cities in the post-industrial revolution era in developed countries is also common to urban centres in developing countries like Nigeria. Unfortunately, this ugly situation is further aggravated by the soaring demand for accommodation resulting from the teeming population who move into the urban centres for better employment and improved living condition. These unwholesome trends degenerate into urban crises, chaos and incessant building collapse. Experts say that building collapse is essentially due to weak foundations, structural inadequate, poor construction, illegal or non-engineered renovations, while several factors, including greed, incompetence and corruption, are at the root of the recurrence of the problems.

The Ministry of Physical Planning and Urban Development can help in reducing the negative impact of building collapse on the environment by given adequate consideration to effective residential development supply and control in Lagos Island. The extent to which the Ministry can achieve this goal will be a function of the quality of development control strategies adopted. All levels of government should play active roles in housing provision instead of assigning the responsibility to the organized private sector. This is because the goals of the government and that of the private sector differ markedly. For the private sector, profit maximization is the most important while for the public sector human welfare is paramount. If human welfare is the focus of the public sector, then environmental issues such as building development and collapse will be given adequate consideration. However, the principles of pricing, affordability, cost recovery and explicability should be given adequate consideration by the public sector. The need to create and ensure the existence of an orderly and safe living environment in Lagos State provides the basis for the regulation and control of physical development through the audit of physical development projects. This function involves the monitoring and evaluation of existing projects both on-going and completed with a view to determine their level of compliance or otherwise with acceptable standards, as provided in the existing laws and regulations with particular regards to their physical status as well as their impacts on the built environment.
During the period under preview, the ministry took proactive measures in the area of physical development audit by transforming the former enforcement and compliance department to the physical development audit department. The intervention of this department on the one hand, is through the investigation and resolution of complaints sent by the general public and others CDA’s at various levels. On the other hand, physical evaluation of existing on-going and completed are carried out to determine their level of compliance otherwise these activities enabled the prevention and management of hundreds of crisis situation which would have created further challenges such as collapse of buildings, blockage of access roads, traffic congestion, flooding etc.

The strategies employed in the exercise of this function include.

- Physical inspection of sites to assess and ascertain actual situation with arrangement of meetings between the stakeholders involved on complaints and physical developments project under consideration with a view to bringing about amicable resolutions.
- Recommendation of such resolutions to government to assist in taking appropriate decision.
- Implementation of government decisions based on the aforementioned recommendations.

**PICTURE ESSAY**

Plate 1: Showing condition of Buildings in Lagos Island (field survey 2013)
Plate 2: Showing a demolished building by the State Government for the security of lives (field survey 2013)

Plate 3: Showing a collapsed building (it’s building condition before and after) in Lagos Island (field survey 2013)

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Iyanda


COMPARATIVE COST ANALYSIS OF WALL CLADDING MATERIALS

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Wall is a principal component in building construction. Cost data statistics for pretender planning/investment appraisal analysis as it relates to alternative choice of cladding materials (sandcrete blocks, concrete blocks or timber) are seldom readily available. This research examines the cost relationships between sandcrete blocks and timber as alternative wall cladding materials. Using rates from synthesized bills of quantities, and the statistical tool of percentile, it establishes and compares cost profiles of the elemental components of buildings constructed in both materials. Research findings establish as follows: (i) Buildings constructed of timber are about 6% more expensive that those constructed in sandcrete blocks. Electrical component installation reveals a percentage cost of 6.8% and 5.9% respectively for block and timber claddings respectively. It is recommended that improvement be made to cost data compilation, on periodic basis for the both types of claddings.

Keywords: cladding material, cost analysis, sandcrete block, timber panel

INTRODUCTION

Wall is a principal component in building construction. Sandcrete block is the conventional and predominant material used as masonry wall cladding material in Nigeria and other countries in West African sub-region. (Agyei 2011, Nwogu and Ganiyu 2012, Abankwa 2012). There is however an array of problems which affect the utilization of sandcrete blocks as wall cladding material, ranging from the existence of paucity of cost data information to the selection of cost effective and alternative cladding materials that are eco-friendly and sustainable. Ogbonyomi (1998) and Olateju (1999) cited in Olaoye and Izam (2004) have observed, increases in cost of cement as well as shortages in supply relative to its demand. According to Ajanlekoko (2001), the shortages in supply are responsible for the galloping cost of cement over the years. Laryea (2012) has also observed inflationary trends and fluctuations in the prices of cement, a principal material used in the construction of sandcrete blocks. Avery (1983) and Smith et-al (1983) have posited that paucity of cost data information, affects cost forecasting adjustment for location variations and inflationary trends for broadly similar work or work with distinctly different characteristics. According to Atinuke (2010), paucity of cost data information

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affects cost data forecasting, adjustment for location differences. The occurrence of paucity of cost data information poses serious challenges to construction researchers and cost data management.

The pivotal role of wall as a principal component in building construction is also beginning to be better and appreciated in terms: of cement a principal material used for the construction of sandcrete blocks and the consequential impacts on the environmental. See, the elucidations of Indian Cement industry (2005), on the hazardous nature of the production process of cement on the environment.

Agenda 21 (2001), has noted that the physical environment and the construction sector are linked principally by the demands made by the latter on global natural resources, and this assumes huge environmental significance with the rapid growth in global, population and the attendant implications for natural resources. This is especially the case with housing and infrastructure, which are very resource intensive. The call and desire for sustainable construction is in realization of the construction industry’s capacity to make a significant contribution to environmental sustainability because of the enormous demands it exerts on global resources. This coupled with the emergence and the utilization of eco-friendly construction practices as observed by (future foundations 2002) and the emerging opportunities in innovation in materials and technologies for sustainable construction in developing countries as reiterated by Agenda 21 (2001), emphasizes an urgent need for the research to understand and establish the factors that promote/enhance or inhibit the use of various cladding materials in wall construction. This is achieved through a rigorous review and cost profile analysis of cladding materials which culminated in the revelations of some selection criteria and parameters for the construction of wall components, that are cost effective, adopting economic or as well as environmentally friendly and socially acceptable processes. Issues connected with the sustainability benefits of wood, low energy, low CO₂ emission and low life cycle cost are extensively dealt with in John et-al (2006). Issues bordering on the low usage of timber as well cladding are well articulated by (Okereke 2005 and Abankwa 2012). There is a relevant literature review which discusses the escalating cost of conventional building materials and the need for alternatives (Fawale et-al 2012).

This research begins to contribute to this agenda through its findings, using as case studies, buildings in Port Harcourt situated in the Niger Delta region of Nigeria. The research highlights cost profile analysis of building components constructed in sandcrete block and timber as cladding materials, see (appendix for the detail design plans sections and facades) of the buildings, which are fundamentally load bearing walls. The research also offers results of early works, which provide background knowledge. See for example, Dayyau (1994), from study and review on block work and concrete in Nigerian housing constructions established that the combined cost of block work and concrete of a 3-bedroom flat had a 27% contribution to initial total cost. Yusuf (2004) from a study on cost profile of ground and first floor of a four flats two bedroom residential building established that the wall component had a 9% contribution to total cost. Ogundiran and Adereji’s (2000) research on comparative cost
analysis between sandcrete block wall and expanded polystyrene (EPS) material established that the wall and facial component of EPS has a lower value than the conventional sandcrete block recording 32% cost differential.

The structure of the paper is as follows: First its background gives an insight into previous studies on walls in housing construction. Second, it provides a review on the characteristics of wall, categorization of wall cladding constructions, selection criteria for cladding materials, sandcrete block walls, timber walls, innovations in cladding materials, the measurement and costing of cladding materials. The reviews provided the basis for probing and provided answers to pertinent issues like, are there differentials in the initial total cost of wall components constructed in timber and sandcrete blocks? What cladding material established a higher cost? What are the percentage contributions of wall component. Constructed in timber and sandcrete block cladding materials to initial total cost? What are the percentage contributions of various elements both for timber and sandcrete block cladding materials to their various initial total costs? Third, the paper summarizes the methodology adopted for the research. Finally the research draws conclusion, using results of early studies, the findings form reviews and case study as basis. It also offers recommendation.

LITERATURE REVIEW

Innovations and alternative wall cladding materials

Ideally, the combination of all environmental economic and social factors give a description of a material, and thus help in decision-making process regarding the selection of the material suitable for building. (Abey Sundara et-al 2009, Bechio et-al 2009 cited in Adedeji 2011). Advancement in materials innovations and technology however offers a broader spectrum of selection and choice of alternative materials. Based upon this guidance the paper offers further articulated views on the advantages, properties and indications which assist in the selection of alternative materials. (see, for example, (FAO, 2002) on the life cycle assessment of building and the advantages of wood over other synthetic materials. IKP (1999), cited in Townsend and Wagner (2002), for environmental indicators used for the assessment of the advantages of wood-based products (lingo-cellulosic raw materials bonded in organic binders for the production of mineral-bounded composite panels. Orisabinn (2007), cited in Adedeji (2011), for cement-bounded composite panels produced from palm kernel over conventional sandcrete blocks. (See, Fawale et-al 2012, on experimental evidences of the thermal, sound and energy efficiency as properties which influence strawbale as a cladding material for wall construction. (See, Smith 1992, and Neville 1995 on rice husk Ash (RHA) and pulverized Fuel Ash (PFA), and Sugar Baggase Ash (SCBA) as alternative to cement). The reviews of Homes (2003), Downton (2003) and Adedeji (2007) provide relevant headings for other properties: fire resistance, moisture pest resistance and low cost which influence the search and selection for alternative materials for wall claddings. Issues on thermal property, availability and ease of construction as the relative edges of strawbale over other conventional
walling materials (sandcrete blocks), are extensively dealt with elsewhere. See Harvest homes 2004, cited in Fawale et-al 2013. The challenges which sandcrete block wall face overheated building interiors and the interrelated requirements are well articulated by (Nwogu and Ganiyu, 2012). There is need for further development in the conventional technologies used for building construction. See, for example articulation of Ghosh 2012, cited in Ogundiran and Adedeji 2012 on expanded polystyrene initiatives, and the inefficiency, resource wastefulness and limitations of conventional building materials. There is a skewed and concentrated emphasis towards laboratory testing of the structural and other properties of traditional materials which usually form the basis of research into alternative construction materials. There are however other economic attributes which also govern the assessment and selection process of alternative construction materials such as: utility cost and the potential consumer’s needs, transportation, future maintenance cost, sociological perspectives and the predispositions of the end users (Anibogu 1999). The derivable advantages of alternative materials from innovations notwithstanding, Fawale et-al (2012), posited that the choice of building construction materials is governed by the properties of the materials that are pertinent to what the builder has in mind.

Cladding materials for wall construction

Wall, is one of the components in building construction. Walls are any continuous vertical members, whose length and height are both much larger than the thickness (UNESCO 2008). Walls as illustrated by UNESCO 2008, can be classified according to load bearing and non load bearing. Load bearing walls support the weight of the roof and any upper floors. In non load bearing walls, the cladding materials are attached to a framework and the cladding sheets/panels do not support the structure of the building. Walls are further classified according to the materials used for their construction. The common types are sandcrete blocks, concrete blocks bricks, reinforced concrete, stones and timber. The characteristics and properties of materials influence, the selection of cladding materials for wall construction. These properties are discussed in Mitchell’s Series 1977. The primary function of walls are to resist rain penetration, resist wind pressure, give required degree of thermal and sound insulation that suits the type, provide sufficient opening for natural daylight ventilation and aesthetically pleasant (UNESCO 2008). Seeley (1995)’s headings are good examples of functional requirements of walls: Division of spaces into convenient size, keep out dust and rain, provide shade, coolness, privacy, shelter and protection and in certain cases provide support for upper floors and roof, structurally load bearing and provide spaces for windows and doors. Other variables, aside the physical and chemical properties influence the selection of cladding materials for wall construction. Adedeji (2011)’s headings form an excellent basis for these variables: Design criteria, purpose of the building, the location of the building (climate and geographical), the time factor in construction the availability of the materials, innovations and the cost effectiveness. See also Rowley 1999)’s postulation, on the building fabric; interior, indoor space and external environment and Ashbel (2000)’s comment on the influence of the thermal environment on architectural
expression. Seeley’s (1995) headings form an excellent basis for a review of what constitutes a good choice for wall cladding materials: strength, resistance to dampness, insulation, sound insulation, fire resistance, internal fire spread, compartmentalization, external fire spread and stairways. Also Evert (1978), Nwokoye (1987), Ground (1988) and Jagboro (1992) as cited in Mac-Barango (2003), offers a good basis for discussion on the considerations of the variables of serviceability, safety and aesthetics and economics and how they influence the choice of material. The consideration in innovation, technology advancement and cost economics are other potent factors which can influence the choice of alternative materials for wall cladding. See (Mac-Barango 2006). Issues bordering on condensation risk on wall panels are extensively reviewed and articulated in (Nwankwo 1999).

**Sandcrete block wall**

Sandcrete blocks are the predominant wall cladding materials in Nigeria (Mac-Barango 2011). Sandcrete blocks are made from a mixture of sand, cement and water (Oyekan, 2007). In order to achieve the functional requirements of sandcrete blocks, the size of sandcrete blocks, the specification and quality, loading systems of the building and the construction details become relevant factors. Standard organization of Nigeria SON (2004) documentation provides good headings, both for the manufacture and use of sandcrete blocks in Nigeria. BS 4729, cited in Jackson (1991), on dimensional classification of sandcrete block, offers a relevant example of how sizes of block influence the attainment of functional requirement. The loading system (load bearing or non loading bearing), walling are determinants of what size (thickness) of sandcrete wall, will be adopted (Seeley 1995). Issues of functional requirements of sandcrete blocks as they relate to quality are dealt with in (Mac-Barango 2011). Admixtures, such as sugar and sawdust can cause variations in compressive strength and setting time of sandcrete blocks (See, Ashworth 1980), and paramaswam (1979) cited in Oyekan 2007). The quality of sandcrete block wall construction starts with the manufacturing process. A step by step process approach is as articulated by (Oyekan, 2007). Fire resistance, thermal conductivity, sound resistance and absorption aesthetics are also issues of functional requirement. The Nigerian industrial standard, NIS (2007), prescribes requisite minimum standards which sandcrete blocks used for wall construction are to meet. Abdullahi 2005 cited in Anosike and Oyebade (2011)’s articulation identifies consistency in production methods and properties as quality determinants of sandcrete blocks. Variations and inconsistency in quality leads to substandard blocks and development of cracks.

**Sandcrete block wall construction**

Blocks are laid in some acceptable bonding patterns with mortar for the construction of walls. Seeley (1995) and Mac-Barango (2003), offer a detail explanation of the physical and mental efforts exerted towards block work construction process. Basic tools are used in the construction process of block work. These tools with usage by mason and labours ensure that essentials as pointing, neatness of joints, perpendicularity and horizontally of block work courses are maintained (Watson 1986). The essence of bedding and jointing and bounding blocks in mortar is to give maximum strength and adequate
distribution of loads over the wall. (Seeley, 1995). UNESCO (2008), summaries and articulates the method of constructing a wall with sandcrete block. This involves a step by step approach, which commences with the formation of corners or end coarse used as reference lines to construct the straight lines of walls that are bonded with mortar. The blocks are arranged in regular patterns.

**Timber as a constructional material**

Timber is wood that is cut for use in building. Timber is used in the production of wall, floor roof and joinery generally (Emitt 2005). The functional requirement of timber walls are: fire safety, resistance to the passage of sound, insulation and aesthetics (Cheng, 2000). The building regulations for England and Wales and the building standards for Scotland provide the functional requirements of timber in terms of fire resistance (TF 2000 project). Timber, as a building material has advantages, which are spelt out in Gregory 1984, Nolan and Whitelaw 1990, cited in Adedeji and Ogunsote (2004). Botanically trees are grouped into two classifications: Hardwoods or Softwoods. (Seeley 1995). The size and shape of their leaves, are further distinguishing characteristics. Emit and Gorse (2005), provide a description of the internal structure and arrangement of timber cells. The conversion of wood to timber consist of an array of processes, Seeley (1995) provides the relevant headings: fuelling of trees, cutting trees trucks into logs, scantlings into smaller units and into further smaller units of boards and seasoning. According to Seeley (1995), seasonings consist of drying out the free water content from the cell walls. Air seasoning and Kiln seasoning are two principal methods. The seasoning of timber checks defects which affects the strength. The principal defects are identified as physical, fungal attacks. The various heading that fall under these two major types of defects are listed and described by Seeley (1995). The preservative treatment of timber eliminates or minimizes these defects (Abankwa 2005). Seeley (1995), outlines the principal protective liquids, and reveals further the preservation methods, the potency and efficiency of pressure method over non pressure methods. Abankwa (2005), provides a relevant example of pressure impregnation as executed by wood Dapul treatment company limited, Ghana. Ansell (2013) presents further articulated literature on impregnation coating process and performance of timber, using nano based materials. Seeley (1995), gives a detailed description of the constructional details of wall cladding materials in timber. The cladding materials are fixed to timber frame members and components through some jointing techniques. The vertical components are the studies which are nailed with simple butt joints to top and bottom rails. Noggins are horizontal members inserted between bracing with wood based materials provide extra rigidity of the frame. Sheathing board nailed to the timber studwork is used as the covering material.

**The measurement and costing of cladding materials for wall construction**

Cartlidge (2009) provides relevant headings for the measurement and costing of building elements, wall cladding materials inclusive: Taking-off of quantities from design drawings, the preparation of bills of quantities, and the conversion
of the estimates to a tender sum. Measurement and costing provides a good basis for analysis of alternatives for construction methods, equipment and materials (Bledsoe 2002). Standardized measurement rules and conventions provide a uniform basis for the evaluation and analysis of alternatives materials. These issues are well articulated by the RICS (2007), for building works in the United Kingdom (UK), the standard method of measurement SMM 7 (1988) and the Building and Engineering Standard Method of Measurement BESMM (2003) in Nigeria. The derived quantities from the application of the rules of the standard method of measurement are converted into an estimate. There is an excellent guidance for undertaking an Estimating Process in McCaffer and Baldwin (1984) Akintoye (2000) and Bledsoe 2002. Cartlidge (2009) and Laryea et-al (2012), provide relevant guidelines for derivation of a final estimate. Geddes (1996) and Holroyd (2000), have emphasized that cost estimates must be as accurate as possible; observing further that understanding the basic types of estimates, the purpose of the estimates, the sources of data and the level of details of the drawings are requisite factors towards the determination of the final estimate. Obtaining cost data information is an important process in the comparison of cost of different projects or construction components. Ashworth’s (1980) headings form an excellent basis for discussion on the various forms of cost data information. Catalogues of vendors, periodicals of construction cost data and indices, manuals for estimating guides and digest of actual project cost. The factors which influence the specific mode of collection and the limitations sources of cost information are also highlighted. Hendrickson (2008) and Atinuke (2010) have revealed the usefulness and applicability of cost data information for management decision making. The detailed procedures to be adopted are well articulated by Aqua Group (2007), which include establishing a budget, producing approximate (preliminary estimates), element unit quantities estimates, approximate quantities estimates and accurate quantities estimates, cost plan, development of the cost plan and life cycle costing.

The bill of quantities is a readily used cost data information technique for the comparison of timber and sandcrete blocks as wall cladding materials in the research location. The relative accuracy and details of its content, the analytic processes involved in its production and its usage as uniform basis of tender are issues that are well articulated by JUPP (1984), Cartlidge (2009) and Aqua Group (2007). The above advantages notwithstanding, cost estimates derived from bills of quantities have inherent limitations. (Robertson 1973, Middleton et-al 1982 and Musa et-al 2011. The bill of quantities in its traditional form has little function beyond its contractual purpose and is usually a hypothetical construct and not necessarily a fully accurate description of reality (Higgin and Joseph, cited in Smith 1982). Adrian (1982), however postulated that the observed limitations are not peculiar to BOQ as a cost estimating technique and submits that no procedure or mathematical technique is without its flaw or is able to guarantee perfect estimates. The BOQ does provide a basis for cost data information without prejudices, to the opinions as it relates to accuracy levels of its cost data information. The Royal institute of chartered surveyors RICS (1990), working committee on cost information and data services
emphasized the need for more research that defines the cost/price relationships in construction.

**RESEARCH METHODOLOGY**

The research discusses the cost and selection between wall cladding materials of sandcrete blocks and timber, the essence is to appraise the tender price which the client will have to pay for the alternative materials. Wilson’s (1982), research on selection and the evaluation of possible design alternatives offers a relevant insight to micro cost based research technique. Smith 1982, Middleton et-al (1982) postulated that the adoption and usage of bill of quantities as cost tools is however limited. Middleton et-al (1982) have observed that the bill of quantities as a document contains mass information which is swallowed up in the processing to satisfy its primary function, the resultant document whilst constraining all, reveals nothing. Smith 1982, concludes that the bill of quantities in its traditional form has little function beyond its contractual purposes. Redesigned documentation techniques could be set up, which would be of greater direct and immediate use. The statistical tool of percentile was considered appropriate because of its capability, in establishing reasonable results for proportions when comparisons are made between various entities. Cost data information is relevant to the delivery of quantity surveying services (Morrison 1984 and Matipa et-al 2008 cited in Atinuke 2010).

The research adopts a case study approach, comparing costs, between sandcrete block and timber as wall cladding materials. This involved the design, preparation of bills of quantities and the analysis of the data from the various summary of cost, obtained from both wall cladding types. Using designs of residential buildings having same gross floor area, the research examines the effect changes in wall cladding material have on the overall building cost as well as elements costs. The data for the research was generated from the design, measurement and the costing of the two design types (sandcrete block and timber cladding walls). Bills of quantities were prepared from designs of building constructed of the two wall types. See appendices, for the designs and constructional details in figs (2, 3 and 4) the buildings used as basis for the preparation of BOQ. The results are for only initial costs of the two cladding materials; analysis on cost-in use (the ultimate cost) is beyond the cost scope of this research. The total cost is exclusive of preliminaries. Using the rates obtained from the synthesized bills of quantities, prices by professional quantity surveying firms in Port Harcourt metropolis (situate in the Niger Delta region of Nigeria), the research analyzed the impact of two types of cladding materials and their cost implications (both the overall as well as elemental or component initial costs).

The research also established the unit cost per square metre of gross floor area, from the overall building cost as well as the elemental costs. The measures and procedures taken to enhance the reliability of cost are that, same standard method of measurements were adopted and applied for the derivation of quantities from the designs of the two wall cladding types. The rates used for the analysis are the mean values from the totals. The relative abundance and
the potentials of timber as a building material informed its choice for the research. The choice of sandcrete blocks is derived on its commonality in usage as a building material in the research location and Nigeria. The studies, of Mac-Barango (2012), Adegbehinghe (2012) and Achuenu (2012) form a good basis for the computational technique – the statistical tool of percentile adopted for this research. Graphs in forms of chart indicated the trend in overall costs as well as the elemental costs for both buildings constructed in the different cladding materials. The empirical validity of the research findings are based on some assumptions and limitations. Both designs have same floor area; this is to allow cost comparisons of both cladding materials to be carried out on a uniform basis. The specifications, as contained in the bills of quantities and on the drawing formed the basis for the synthesized rates. The comparisons are for only initial construction costs for both wall cladding materials. The finishing cost element includes (rendering and painting) for sandcrete block wall and smothering treating and polishing in the case of timber wall cladding. Olusola and Ikpo’s (2000) articulations on the hierarchical definition of total reveals that life cycle cost / total cost is a discounted lump sum at a given time and that the hierarchical division of cost are often classified as initial cost (that is costs up to the defects liability period) and running cost. This research draws from the hierarchical division and its limitations to initial costs. See table 1 below, for the comparisons of various cost parameters of the wall cladding materials.

ANALYSIS AND DISCUSSION OF RESULTS

Table 1: Comparison of initial cost parameters: of wall cladding materials constructed in sandcrete block and timber using mean values of rates obtained from synthesized (BOQ).

<table>
<thead>
<tr>
<th>S/NO</th>
<th>BUILDING ELEMENT</th>
<th>TOTAL COST OF CLADDING MATERIALS</th>
<th>COST/M2 OF GROSS FLOOR OF ELEMENTS</th>
<th>ELEMENTAL COST EXPRESSED AS A % OF TOTAL COST</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>BLOCK WALL COST</td>
<td>TIMBER WALL Cost</td>
<td>BLOCK WALL</td>
</tr>
<tr>
<td>1</td>
<td>Sub-structure</td>
<td>1,105,754.22</td>
<td>1,072,420.88</td>
<td>10,238.47</td>
</tr>
<tr>
<td>2</td>
<td>Walls</td>
<td>639,789.86</td>
<td>705,316.29</td>
<td>5,923.98</td>
</tr>
<tr>
<td>3</td>
<td>Roofing</td>
<td>895,647.15</td>
<td>893,917.69</td>
<td>8,293.03</td>
</tr>
<tr>
<td>4</td>
<td>Electrical Installations</td>
<td>251,088.65</td>
<td>219,914.82</td>
<td>2,324.89</td>
</tr>
<tr>
<td>5</td>
<td>Sanitary Installations</td>
<td>196,854.24</td>
<td>189,358.13</td>
<td>1,822.72</td>
</tr>
<tr>
<td>6</td>
<td>Doors</td>
<td>91,229.59</td>
<td>141,738.53</td>
<td>844.71</td>
</tr>
<tr>
<td>7</td>
<td>Windows</td>
<td>187,965.31</td>
<td>200,094.07</td>
<td>1,740.42</td>
</tr>
<tr>
<td>8</td>
<td>Finishing</td>
<td>281,472.38</td>
<td>273,738.82</td>
<td>2,606.23</td>
</tr>
<tr>
<td></td>
<td>Total Cost/Unit</td>
<td>N3,649,801.40</td>
<td>N3,703,499.53</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Cost / Sq.m</td>
<td>33,794.46</td>
<td>34,291.66</td>
<td>33,794.50</td>
</tr>
</tbody>
</table>
DISCUSSION OF FINDINGS

The comparison between the two wall cladding materials established the following results. (a) The overall building designed in timber cladding material established the sum of N3,703,499.53, whilst the design in sandcrete block wall established the sum of N3,649,801.40. (b) The timber and sandcrete block cladding materials recorded cost per square metre of N34,29.66 and N33,794.50 respectively. (c) The wall cladding material in timber recorded an higher overall cost than that of the sandcrete block. (d) The overall cost differential between timber and sandcrete block cladding materials is about 6%. (e) The cost differential in wall component constructed in timber and sandcrete block cladding materials is about 9%. Timber cladding material had a cost value of N705,316.29, whilst the sandcrete block had a lower cost value of N639,789.86. (f) The elemental cost of wall constructed in timber cladding material expressed as a % of total cost is 19%, whilst that of sandcrete block cladding material is 18%. (g) The elemental cost differences between wall cladding materials constructed in timber and sandcrete block expressed in percentages established values that were between (0.20-1.50); however the percentage contributions to total cost of the various elements (substructure, wall roofing, electrical installations, sanitary installations, doors, windows and finishings), as presented in table 1 is between (3.90 to 5.20)% and (2.50 to 3.30)% for wall cladding materials in timber and sandcrete block respectively.

Figure 1: Cost trends and pattern between Timber and Sandcrete Block cladding materials.

Descriptive Analysis: see figure 1 below, indicates the cost trends/pattern between the various elements of the designs of the two different wall cladding materials (timber and sandcrete block); this is in resonance with the presentations in table 1, both in terms of monetary and percentage values of components. The percentage contribution of the wall component, to the initial total cost in both cladding (timber and sandcrete block as established in the
research would seem relatively on the high side when compared with the results of other previous similar works. Yusuf's (2004) work on cost profile of residential buildings and Mac-Barango's (2006) research on an analysis of material and labour contents of 4 bedroom bungalow established that the percentage contributions to wall component constructed in sandcrete block to total cost were 9% and 7.49% respectively. The relative high cost of the wall component of this research when expressed as a percentage of total cost could be explained by some factor, the inclusion of the concrete works and its associated reinforcement bars and formwork under the wall component. This relative high cost notwithstanding they do serve as a basis for probe and guide for comparison between various cladding materials for wall construction, with necessary adjustments.

CONCLUSION

The research concludes that differences exist between the initial total costs of timber and sandcrete block as wall cladding materials for residential buildings. Buildings constructed of timber recorded higher cost; leading to a cost differential of 6%. There also exists cost differentials in the elemental components of the buildings constructed with the two types of wall cladding; timber wall recorded a cost about 9% higher than that of sandcrete block. The elemental costs differentials is between (0.20 to 1.50) expressed as a % of total cost depending on the component involved. Admittedly it would seem in appropriate to overgeneralize the outcome of the cost comparison. This is principally due to the impact location/climatic conditions could have on whole life costing when these materials are used for construction, nevertheless, they do serve as relevant basis for exploration between the alternative cladding materials. The research recommends further exploratory studies on alternative innovative cladding materials using functional, environmental and cost economics as relevant ranking parameters.

REFERENCES


APPENDIX

SECTION A-A FOR BLOCK WALL

GROUND FLOOR PLAN FOR TIMBER WALL

SECTION A-A FOR TIMBER WALL
CONCEPTUAL COST CONTINGENCY ESTIMATION MODEL: A RISK MODELLING APPROACH

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The application of knowledge and application of risk in project management is limited in some domains. To this end, the estimation of cost contingency for developmental projects is challenging because, it is mainly based on historical data which to a great extent is full of subjectivity, dwelling greatly on experience and organizational process asset. To date however, the built environment lacks standardized methods to be adopted in the estimation of cost contingency, further hampered by the lack of understanding and application of risk methods. In response to the above challenge, a systematic risk methodology for the estimating of cost contingency based on empirical judgment has been the driving force behind this research. The failure mode effect analysis (FMEA) and the theory of evidence are presented as qualitative and quantitative risk tools respectively. The research adopted quantitative methods with data gathered through structured questionnaires distributed to built-environment professionals based on the theoretical framework. Analysis of data gathered revealed that, the most significant factors that affect cost contingency are incomplete scope definition, scope changes which results in scope creep, delayed payment problems, differing site conditions and economic instability. Based on the work sections, the substructure, essential building services and finishes identified as work sections with high severity classes and propensity to scope changes. To this end, a four stage conceptual model was developed which translated into a 3-phase implemented model. The process selects high priority risk and work sections based on the data sources and hypotheses to generate the mass, belief and plausibility based on the Dempster’s combination hypotheses. The model was tested and evaluated using an action exercise which found values to be realistic in comparison to the actual closing account figures of completed projects.

Keywords: cost risk, hypertext pre-processor, mass, project specific risk, plausibility, systemic risk

INTRODUCTION

Risks and uncertainty are two misconstrued terminologies. Whereas risk refers to quantifiable uncertainty outcomes, uncertainty refers to

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unquantifiable uncertain future outcomes (Hollmann, 2007). The concept of risk and uncertainty in project management has been construed by many practitioners as a rather congruent analogy. Since risk is a dynamic event which takes place within a complex network of numerous interconnected cause and effect loop which generate feedback within the project system, a systemized framework can be used to predict its effect (Rodrigus, 2001). Perminova et al (2008) holds that the strategies for treating risk cannot be applied holistically to the management of uncertainty on project. Traditional risk management is associated with planning and taking measures to mitigate “known known” (quantifiable certain risk systemic) and “known unknown” (unquantifiable certain risk systemic) risk on a project. The concept of uncertainty management which is rather associated with “unknown unknown” (unquantifiable uncertain risk project specific) risk of the project is very difficult to predict. Over the years however, the risk identification process for estimation of cost contingency is more analytical towards systemic risk (known-unknown) at the neglect of project specific risk (unknown unknown).

According to Ali (2005), most firms have adopted a rule of thumb which is applied during estimation to take care of risk in relation to project cost. Patrascu (1988), revealed that this method takes the least time and effort and is currently the most popular and unambiguous method applied by estimators. In the case where the project goes to tender, subjectivity of the various tender sums submitted has a reflection on the contingency sum thus, resulting in the tenders submitting different contingency sums. Gunhan and Arditi (2007) from Touran (2003), stated that one of the simplest methods of estimating contingency margins for construction projects is to consider a percentage of the estimated contract value such as 10% across the entire project typically derived from intuition, past experience and historical data, organizational process asset, enterprise environmental factors and expert judgment.

Thompson and Perry (1992), hold that the deterministic method however does not justify the degree of confidence that the contingency will provide against cost overruns thus, making it very difficult to defend figures generated from this method. Hartman (2000), postulated that this method is an unscientific approach and a reason why so many projects are over budget. According to Lhee et al (2009), applying deterministic approaches in determining contingency such as a fixed percentage of the project cost is not appropriate because it provides an arbitrary value based on only project cost. This method of estimating cost contingencies should be restricted to preliminary design cost estimates such as blue sky estimates, feasibility estimates or order of magnitude estimates.

**Theoretical framework**

Over the years, various risk models have been developed including the probability theory, fuzzy logic theory, analytical hierarchical process, decision theory, sensitivity analysis, additive models, system dynamics, expected monetary values (EMV), multivariate statistical models, simulation, artificial Neural Networks (ANNs), theory of constraints
amongst others. The theoretical framework for the above work is based on the Dempster-Shafer theory (DST), also known as the theory of belief functions, a mathematical theory of evidence, and a generalization of the Bayesian theory of subjective probability. Noklov et al (2008), holds that whereas Bayesian theory requires probabilities for each question of interest, belief function permits the use of degrees of belief for one question on the probabilities for related questions. Rakowsky (2007), underscored that DST is a mathematical theory of evidence concept that is built around degrees of belief rather than probabilities. It is based on scenarios that contain the system of hypotheses, pieces of evidence and data sources. The hypotheses are possible states of elements (singleton) of the frame of discernment, which is given by the finite universal set $\Omega$. The set of all subset of $\Omega$ is its power set $\mathcal{P}(\Omega)$. DST assumes qualitative relationship between a piece of evidence and hypotheses corresponds to a cause consequence chain. Rakowsky (2007) postulates that for the DST, data sources are people or organizations or any other entity that provides information for a scenario. Since the DST calculus describes the subjective viewpoint for an objective fact, data sources must be representative and free of bias.

According to Rakowsky (2007), based on data sources which are representative and free from bias, DST calculus is estimated by means of mapping:

$$m : \mathcal{P}(\Omega) \rightarrow [0,1]$$

(1)

With $m(A) > 0$ called the focal element.

The function $m$ is called the basic assignment and fulfils:

$$\sum_{A \subseteq \Omega} m(A) = 1$$

(2)

By creating the basic assignment function, several evidential functions can be created. A belief measure is given by the function $\text{bel}: m : \mathcal{P}(\Omega) \rightarrow [0,1]$. There is

$$\text{Bel}(A) = \sum_{B \in \Omega, B \neq \emptyset} m(B)$$

(3)

$$\text{Bel}(\neg A) = 1 - \text{Pl}(A), \text{Pl}(A) = 1 - \text{bel}(\neg A)$$

(4)

With $\text{bel}(\neg A) \leq \text{pl}(\neg A)$

Uncertainty is construed as the difference between $\text{pl}(\neg A)$ and $\text{bel}(\neg A)$

The counterpart of belief is plausibility measure

$$\text{pl} : \mathcal{P}(\Omega) \rightarrow [0,1]$$

with
Pl(A) = \sum_{A \cap B \neq \emptyset} m(B) = 1 \quad (5)

The measure of pl(A) is not understood as the complement of bel(A). Only
\{A \cap \emptyset | m(A) > 0 \} \neq \emptyset \rightarrow bel(A) \leq pl(A) \quad (6)

Thus the difference between Pl(A)-bel(A) describes the evidential interval range which represents the uncertainty concerning the set A.

The above research uses the failure mode effect analysis (FMEA) as a qualitative tool and the evidential reasoning method as a quantitative tool. In the application of the FMEA, risk priority numbers (RPN) are determined using the likelihood of occurrence of a risk, the possible impact if it occurs and the detectability of a risk prior to its occurrence. With respect to the DST, the mass, belief and plausibility functions are estimated based on various data sources calculated using probabilistic analysis of these hypotheses.

**Empirical review and Conceptual Framework**

Ali (2005), holds that the method of estimating using risk analysis with a systematic methodology such as risk identification, risk analysis, risk quantification and risk monitoring and control as applied to cost estimation is ideal; with risk identification carried out to identify factors that may affect project cost. Risk measurement and assessment are tools of risk analysis and quantification carried out to determine the maximum risk allowance and average risk allowance for each risk factor. The maximum and average risk allowances are then used to calculate the base contingencies. Keith (2007), proposed with various tools, a risk management framework of risk identification, risk analysis, risk mitigation and plan, risk allocation and risk monitoring and control for the cost risk management process. Keith (2007), holds brainstorming, scenario planning, expert interviews, Delphi methods and influence diagramming were strong risk identification tools.

Fig 1: Conceptual framework

Adopted and modified from Holman (2007)
The conceptual framework for the above research for the estimation of contingency is depicted in figure 1. The process is an integrated team effort of risk management planning, resulting in risk identification for the purpose of developing a risk breakdown structure. Due to the peculiar nature of the various risk categorizations, there is the need to use empirically based models. These would help parametrically systemic project risk through the application of historical antecedent.

Ideally, cost risk analysis should commence at the concept formation stage, evolving to the project implementation stage through an unending cyclical evolitional with cost planning, cost forecasting, cost estimating and the financial treatment of cost risk. Along the same cyclical evolution, the risk management process commences with risk management planning process through risk quantification evolving to risk update of secondary and residual risk. The above cost risk process is rather through, evolitional and systematic, intertwined to cover the entire risk framework. Taking a cue from Hollmann (2007), the initial risk identification process is to categorize risk into endogenous (systemic) and or exogenous (project specific) risk. Hollmann (2007), postulates that whereas the best approach to measuring systemic risk is by the use of empirically based parametric models, an expected monetary value can be deduced from Monte Carlo Simulation for the estimation of project specific risk. Based on data hypothesis, project specific risk would be modelled contemporaneously with systemic risk based on evidential reasoning methods.

**RESEARCH METHOD**

The main objective of this paper is to:

1. Determine Using FMEA to select the most significant factors affecting project cost contingency
2. Conduct FMEA on work sections prone to high scope changes
3. Develop a conceptual model for the estimation of project cost contingency.

**Population**

This paper is based on the quantitative methodological research procedures. Based on the review of related literature and review of the professional practice, a survey questionnaire was designed and administered to stakeholders and professionals in the built environment working on developmental projects in Ghana aimed at achieving the research objectives. A sample size of 184 was determined using the statistical relation by Kumar (1999); Clarke and Cook (1998). In all, 204 questionnaires were distributed with a total of 118 (57.8%) questionnaire retrieved.

**Questionnaire design and data collection**

Based on the theoretical framework, the first question of the survey instrument listed 31 risk factors, identified during literature affecting
project cost contingency for respondents to rate on a scale of 1 to 10. The second question of the instrument sought to collect data on the extent to which cost variability occurs on the various work sections of a project. In both questions, respondents were to develop their basic belief assignment on the scenarios based on experience, historical antecedent and field knowledge. These hypotheses are the likelihood of occurrence (L) of a risk factor, possible severity effect (I) of risk and detectability/hideability of the risk. Each of these concepts is expressed as a concept integer between 1 to 10, with 1= low probability/severity/impact and 10= high probability/severity/impact.

DATA ANALYSIS AND DISCUSSIONS

Data analysis was undertaken based on the theoretical framework, using FMEA as a qualitative risk tool and evidential reasoning method as a quantitative risk using probabilistic risk analysis. Based on the basic belief assignment of the respondents that likelihood of occurrence (L) of a risk factor, possible severity effect (I) of risk and detectability/hideability (D) of the risk, the Risk Priority Numbers (RPN) were estimated as follows and displayed in tables 1 and 2:

\[ RPN = \text{severity} \times \text{hideability} \times \text{likelihood} \]  

Example: 
for delayed payment problem 
\[ 7.32 \times 7.08 \times 5.2 = 269.99 \]  
RPN

for finishes  
\[ = 7.65 \times 7.64 \times 7.75 = 452.96 \]  
RPN

The RPN for the risk factors and the work sections are displayed in tables 2 and 3 respectively.

Quantitative risk analysis begun with the estimation of the risk of occurrence of each factor as:

\[ \text{Risk} = L \times I \]  

Example: the risk estimate for inclement weather  
\[ 4.06 \times 8.6 = 0.35 \]  

Using the evidential reasoning method, the probabilistic estimation of risk was used to estimate the masses of the various risks/:

The Probability of a Risk factor/work sections = 
\[ \frac{\text{Risk} \text{.}}{\Sigma \text{Overall risk}} \] 

\[ \text{(9)} \]
Example of the estimated probabilistic estimate for quality of works = $0.19/10.51= 0.0177$

Where 10.79 is the summation of all risk = $0.23 + 0.21 + 0.35 + \ldots + 0.19 + 0.24$

**Table 1: Qualitative and Quantitative Risk Analysis-Factors Affecting Cost Contingency Factors**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>Possible Risk Factor</th>
<th>QUALITATIVE ANALYSIS</th>
<th>QUANTITATIVE ANALYSIS</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L</td>
<td>I</td>
<td>D</td>
<td>RPN</td>
</tr>
<tr>
<td>A Natural/ Environmental Risk</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Floods</td>
<td>3.42</td>
<td>6.87</td>
<td>8.6</td>
</tr>
<tr>
<td>2</td>
<td>Earthquakes, volcanic, landslides</td>
<td>2.83</td>
<td>7.49</td>
<td>8.87</td>
</tr>
<tr>
<td>3</td>
<td>Inclement weather</td>
<td>4.08</td>
<td>8.6</td>
<td>8.53</td>
</tr>
<tr>
<td>B Technical Risk</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Design Failure/ Defective design</td>
<td>5.46</td>
<td>7.08</td>
<td>6.88</td>
</tr>
<tr>
<td>5</td>
<td>Human resource management challenges</td>
<td>4.68</td>
<td>4.72</td>
<td>4.31</td>
</tr>
<tr>
<td>6</td>
<td>Equipment Failure</td>
<td>4.49</td>
<td>5.02</td>
<td>4.37</td>
</tr>
<tr>
<td>C Economic Risk</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Material supply challenges</td>
<td>4.5</td>
<td>5.14</td>
<td>5.23</td>
</tr>
<tr>
<td>8</td>
<td>Labor Supply challenges</td>
<td>4.2</td>
<td>4.88</td>
<td>4.68</td>
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<tr>
<td>9</td>
<td>Equipment availability challenges</td>
<td>3.72</td>
<td>4.87</td>
<td>4.63</td>
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<tr>
<td>10</td>
<td>Equipment productivity</td>
<td>4.09</td>
<td>5.08</td>
<td>4.74</td>
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<tr>
<td>11</td>
<td>Market conditions</td>
<td>5.3</td>
<td>6.41</td>
<td>5.62</td>
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<td>D Financial Risk</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Interest rate challenge</td>
<td>5.57</td>
<td>7.1</td>
<td>6.66</td>
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<td>13</td>
<td>Delayed payment problems</td>
<td>7.32</td>
<td>7.08</td>
<td>5.2</td>
</tr>
<tr>
<td>14</td>
<td>Inflation/micro economic indicators</td>
<td>7.09</td>
<td>7.81</td>
<td>6.02</td>
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<td>Global economic pressure</td>
<td>6.13</td>
<td>6.13</td>
<td>5.96</td>
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<td>E Design Risk</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Differing site conditions</td>
<td>7.08</td>
<td>7.57</td>
<td>7.9</td>
</tr>
<tr>
<td>17</td>
<td>Design completeness or status</td>
<td>8.03</td>
<td>8.59</td>
<td>7.52</td>
</tr>
<tr>
<td>18</td>
<td>Changes scope</td>
<td>8.52</td>
<td>8.96</td>
<td>7.2</td>
</tr>
<tr>
<td>19</td>
<td>Project complexity</td>
<td>6.09</td>
<td>4.88</td>
<td>6.52</td>
</tr>
<tr>
<td>20</td>
<td>Incomplete scope definition</td>
<td>8.62</td>
<td>8.93</td>
<td>5.8</td>
</tr>
<tr>
<td>21</td>
<td>Construction technology</td>
<td>5.07</td>
<td>4.72</td>
<td>6.37</td>
</tr>
<tr>
<td>22</td>
<td>Changes in specification</td>
<td>6.55</td>
<td>6.26</td>
<td>5.57</td>
</tr>
<tr>
<td>23</td>
<td>Estimation errors/ method</td>
<td>5.81</td>
<td>5.15</td>
<td>3.87</td>
</tr>
<tr>
<td>F Governmental/Social Risk</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Contractual/procurement related</td>
<td>5.6</td>
<td>5.21</td>
<td>4.16</td>
</tr>
<tr>
<td>25</td>
<td>Governmental influence/intervention</td>
<td>9.3</td>
<td>4.88</td>
<td>4.68</td>
</tr>
<tr>
<td>26</td>
<td>Legislative/statutory</td>
<td>5.04</td>
<td>4.37</td>
<td>4.72</td>
</tr>
<tr>
<td>27</td>
<td>Customary rights and litigation</td>
<td>4.25</td>
<td>3.63</td>
<td>4.31</td>
</tr>
<tr>
<td>G Construction Risk</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Defects in supervision</td>
<td>6.67</td>
<td>3.92</td>
<td>4.52</td>
</tr>
<tr>
<td>29</td>
<td>Safety</td>
<td>4.87</td>
<td>4.58</td>
<td>3.85</td>
</tr>
<tr>
<td>30</td>
<td>Quality of work</td>
<td>4.57</td>
<td>4.06</td>
<td>3.76</td>
</tr>
<tr>
<td>31</td>
<td>Location</td>
<td>5.22</td>
<td>4.68</td>
<td>4.6</td>
</tr>
</tbody>
</table>

$L=$ likelihood, $I=$ impact, $D=$ detectability, $PR=$ Probability of risk
Table 2: Qualitative and Quantitative Risk Analysis- Work Sections Prone to High Scope Changes

<table>
<thead>
<tr>
<th>ITEM</th>
<th>Possible Risk Factor</th>
<th>QUALITATIVE ANALYSIS</th>
<th>QUANTITATIVE ANALYSIS</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>L</td>
<td>I</td>
<td>D</td>
</tr>
<tr>
<td>1</td>
<td>Substructure</td>
<td>7.93</td>
<td>7.94</td>
<td>8.06</td>
</tr>
<tr>
<td>2</td>
<td>Floor space designation</td>
<td>5.4</td>
<td>5.4</td>
<td>5.40</td>
</tr>
<tr>
<td>3</td>
<td>Structural framework</td>
<td>6.02</td>
<td>6.98</td>
<td>6.02</td>
</tr>
<tr>
<td>4</td>
<td>Block work</td>
<td>6.85</td>
<td>6.85</td>
<td>6.85</td>
</tr>
<tr>
<td>5</td>
<td>Carpentry</td>
<td>5.02</td>
<td>5.02</td>
<td>5.02</td>
</tr>
<tr>
<td>6</td>
<td>Joinery</td>
<td>5.44</td>
<td>5.44</td>
<td>5.44</td>
</tr>
<tr>
<td>7</td>
<td>Roofing</td>
<td>6.49</td>
<td>6.49</td>
<td>6.49</td>
</tr>
<tr>
<td>8</td>
<td>Finishes</td>
<td>7.65</td>
<td>7.64</td>
<td>7.75</td>
</tr>
<tr>
<td>9</td>
<td>Electrical and IT</td>
<td>7.83</td>
<td>7.9</td>
<td>7.90</td>
</tr>
<tr>
<td>10</td>
<td>Mechanical installations</td>
<td>7.89</td>
<td>7.86</td>
<td>7.77</td>
</tr>
<tr>
<td>11</td>
<td>External works</td>
<td>6.83</td>
<td>6.82</td>
<td>6.78</td>
</tr>
<tr>
<td>12</td>
<td>Furniture/ Fenestration/ Installations</td>
<td>6.83</td>
<td>6.82</td>
<td>6.78</td>
</tr>
</tbody>
</table>

HR= highly relevant, VR= very relevant, MR= moderately relevant

Table 1, 2 displays the RPN, estimated risk and likelihood of work sections yielding to scope changes

Consequent to the above, an FMEA was conducted using the failure mode, failure cause, failure effect, severity class, failure detection method and compensation features of the scope factors affecting contingencies as depicted in table 2 below. Failure mode in terms of cost overruns can be deduced from changes in substructure primarily due to sudden varied eruption in substructure conditions resulting from uncertainties in geotechnical conditions. Failure mode for essential building services can be attributed to the use of prime cost sums in the contract documentations resulting from late design development. Failure mode for finishes could be resulted from scope creep and changes in taste of the client during construction works. Failure mode in substructure has a failure effect of changes in substructure designs, changes in ground works with the end effect of variations in relation to substructure, changes in specifications, and etc. The failure effect of building services is introduction of many new items into the work which results in undue delays in the work and unbudgeted variations which has an end effect of inadequacy in contingency sum.

Data analysis using FMEA prioritized differing site condition, design completeness and status, changes in scope, incomplete scope definition, changes in specifications, delayed payment problems and micro economic indicators as the critical risk factors affecting cost contingency. From table
2, the substructure, essential building services and finishes were identified as the main work sections prone to high scope changes and scope creep.

Table 3. FMEA on Factors Affecting Scope Management:

<table>
<thead>
<tr>
<th>Failure Mode No</th>
<th>Identification of Item</th>
<th>Failure Mode</th>
<th>Failure Cause</th>
<th>Failure Effects</th>
<th>Severity Class</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>E.17</td>
<td>Substructure</td>
<td>Failure mode</td>
<td>A. Changes in substructure work quantities and cost due to variations</td>
<td>A. Changes in substructure designs</td>
<td>2</td>
<td>A. Baseline lack of information.</td>
</tr>
<tr>
<td>D.13</td>
<td>Electrical and IT</td>
<td>Failure mode</td>
<td>A. Changes in specification of finishes</td>
<td>A. High scope creep resulting from changes in design or requirements</td>
<td>3</td>
<td>A. Changes in final floor, wall and ceiling finishes in comparison to construct the building</td>
</tr>
<tr>
<td>E.18</td>
<td>Mechanical installations</td>
<td>Failure mode</td>
<td>A. Changes in specification of finishes</td>
<td>A. High scope creep resulting from changes in design or requirements</td>
<td>3</td>
<td>A. Changes in final floor, wall and ceiling finishes in comparison to construct the building</td>
</tr>
<tr>
<td>E.26</td>
<td>Finishes</td>
<td>Failure mode</td>
<td>A. Changes in specification of finishes</td>
<td>A. High scope creep resulting from changes in design or requirements</td>
<td>3</td>
<td>A. Changes in final floor, wall and ceiling finishes in comparison to construct the building</td>
</tr>
</tbody>
</table>

PROPOSED CONSTRUCTION COST CONTINGENCY (CCC) MODEL

Based on the literature review and ethnographic studies, the stages of development of the above framework are broken into formulation (conceptual), implementation and evaluation stages, with direct interconnectivity in a feedback loop. On a broad spectrum, the CCC framework went through a systematic process of identifying significant factors for framework, establish relationship between the stages and factors, proposed framework development, testing of framework, validation reviews and, final documentation and recommendation for improvement. The conceptual model formulated conceived based on a myriad of virtual ideas were designed to consist of four parts including Ms CAD Inter-phase, Ms Master-Bill Inter-phase, Ms Project Primavera Interface and Ms Hyper text pre-processor Inter-phase. The above sections are linked together in an iterative and figuratively manner to enhance information flow as depicted in figure 4: information flow of the conceptual Model. The above process commences with project initiation through project scope planning and management, design development, cost modeling and risk management process. The risk management phase simulates risk identification, risk analysis, risk evaluation, risk response planning and review into an iterative process. The automated model is available at www.cccmodel.tk for further consideration.

Data entry and processing
The first stage of the above model is the development of a risk register with the cooperate effort of the project team. Buertey (2012b), posits that the most important aspect of project risk management is risk identification.
which commences contemporaneously with risk management planning. The process of risk identification brings to fore the need for risk categorization and the eventual development of a risk breakdown structure. During the process of risk identification, risk can be categorized as endogenous and exogenous risk, i.e. internal or external, enterprise environmental factors or organizational process asset.

Considering the predictability of the risk in relation to the project, a further sub-categorization is systemic and project specific groupings. As already discussed, systemic risk are related to the artifact of the system which can be predicted across projects while project specific has their impact varying by project. The essence of the risk breakdown structure is to enable further assessment of the risk based on their likelihood of occurrence, magnitude/consequence and detectability, to enable further risk response planning decision to be taken. Buertey et al (2012c), posits that risk identification results in description of risk as either systemic and project specific, endogenous and exogenous risk or known unknown risk or unknown un-known risk. The process of qualitative risk management of the above model aims at prioritizing the risk identified above for further quantitative analysis. By the use of the theoretical framework, FMEA, the risk priority number (RPN) for each risk is calculated by the model by multiplying the values of three concepts expressed as integers as depicted in figures 2 and 3. The three concepts expressed as integers are information on the likelihood of occurrence, possible impact and detectability of risk. The above forms the basis of selecting the most important risk for further risk analysis to continue (refer to section 5.0).

Fig 3: Data entry for risk factors affecting cost contingency
Fig 4: Qualitative risk analysis for risk prioritization

Data from the qualitative risk management process is forwarded to the next stage of the model for risk quantification to commence. Quantification of risk was undertaken using probabilistic risk analysis (PRA) where effect of risk was analyzed using probability estimation. The above process computes the quantitative risk values based on the theoretical framework for the research, the Evidential Reasoning Method (Dempster Shaffer Theory). The above computations enables a user to determine the magnitude of the impact of the various risk should they occur to enable further risk modeling and risk response planning to be effected. The magnitude of the quantitative risk values determines the risk response strategy to be adopted for the contingency estimation process. High impact risk determined by the system through probabilistic analysis would be modeled to the next stage for the basic belief and plausibility functions to be determined. Other less critical risk would receive the appropriate response attention. Subsequent of the risk management process, the integrated project parameters with respect to work sections are identified and entered into the model. The integrated project parameters include the critical factors that control the estimation process of the construction cost contingency. These data includes the estimated cost per work section (substructure, structural frame, masonry, carpentry, joinery, roof covering and car casing, finishes, electrical installations, plumbing/mechanical installation, external works and other sundry installations). Other data inserted includes the total estimated cost of the project, and a factor to take care of the enterprise environmental factors and organizational process asset.
Fig 5: Sequence of data entry and processing for implemented model

Information flow implemented model

At the process visualization stage, the integrated project parameters entered at the graphical user interface is now exported to the next stage for processing to begin. The proposed model, processes these data at the visualization stage and links up with other risk data sources to be processed into a matrix function which would finally result in the production of tables and graphical displays to be returned to the user at the visual interface of the model as depicted in figure 7. A thorough risk management framework for the estimation of project cost contingency estimation as depicted in the system architecture in figure 7 below. Risk identification for the process of contingency estimation must start as early as the project conception and ignition stage. This would help unveil all possible risk factors incident to the project adopting the appropriate risk categorization (exogenous and endogenous risk). Using a coherent risk breakdown structure, all possible risk related to the project can be discovered by the project team (Buertey et al, 2012b).
Using the appropriate quantitative and qualitative risk measurement tools, the impact of systemic and project specific risk could be estimated to enable the adoption of an appropriate financial treatment. The above would be the basis for the computation of the basic belief and plausibility values for appropriate risk response planning to be undertaken in relation to the extent of scope changes in relation to work sections. Concurrent to the above process, a comprehensive scope definition and cost modeling process would be critical for issues related to technology, specification, procurement and contract type to be adopted for the project. The procurement process for any construction project is not sacrosanct; every system may have some flaws and challenges associated with it. Owners always strive to provide adequate contingency through their representatives to address risk related issues and to provide a safeguard for the contractor, designer and owner to complete the project on budget.
Testing and validation of the model
As a means of testing the model, a pilot test was undertaken using a team of 10 cost engineers selected for an action exercise on nearly 100 projects. Forthwith, the model has been tried on a lot of projects and is available at www.cccmodel.tk for further consideration and review. Based on available historical data and their intrinsic basic belief assignment, each cost
engineer tested model based on their hypothetical project parameters. The pilot validation test was carried out to ascertain the validity of results generated from the model and to verify the usability and reality of the results obtained from the model. Quite imperatively, verifying the objectivity of results obtained from a model is one of the most difficult things to do. The essence of evidential reasoning theory is that the users define their own hypotheses and postulate their own basic belief assignment. The variability of data inserted with respect to the risk factors and work sections would result in variability of results depending on the source of data, pieces of evidence and hypotheses. The results revealed a contingency range of 17.5% to 28% which is consistent with what was gathered during data collection as the range of cost overruns in Ghana.

Limitation of developed model
No research based model is unlimited and for that matter sacrosanct in usage. The research has identified the following limitations with respect to the developed model:

- With the application of evidential reasoning method, it is possible to model multiple scenarios for a particular risk event for the possible introduction of Dempster-Shafer rule of combination to yield a combined basic assignment. This was however not included in the model development for the sake of simplicity. Thus the model takes into consideration only a single basic assignment, with a single assigned evidential weight, a single assigned belief, and single deducible plausibility.

- Different projects would require different risk breakdown structure and categorization. The extent to which a user can re-model the risk is to some extent limited.

- Due to the iterative reliance of the quantitative risk modeling on the qualitative analysis of the risk priority estimation, some level of inference of Bayesian estimation cannot be ruled out of the analysis. For the sake of simplicity, the model depends on the same set of data entered at the GUI for both quantitative analysis and qualitative. For more complex modeling, the above process would require different sets of data.

- The model does not depend on an inherent set of fixed set of variables. Each project would require that the user inserts different data for the modeling process making it ambiguous for users.

- The model developed is suitable for all projects building; civil engineering, heavy duty steel, etc provided the user has knowledge in risk analysis and estimation. It could be used with variability anywhere in the world after the key risk factors have been edited and other parameters incorporated. A key factor that determines the authenticity of the figures is the data source with respect to the basic
belief function related to likelihood of occurrence of a factor, its impact and detectability ranges.

SUMMARY AND CONCLUSION

The development of a framework for the estimation of cost contingency for construction projects, just like other models is to aid minimize if not eliminate, the deterministic nature of the estimation process in Ghana. From Buertey et al (2012a), it was evident that the level of knowledge and application of risk in professional work is limited. Hence, the challenge of most projects suffering from cost overruns.

This paper has reviewed qualitatively and quantitatively the most significant factors affecting project cost contingency. Qualitative risk analysis using risk priority numbers (FMEA) revealed incomplete scope definition, scope changes, differing site conditions, changes in specification and unstable economic indicators as strong factors that affect project cost contingencies. These factors were confirmed using the quantitative risk analysis through the determination of probability of risk. Based on work sections, the substructure was identified as the highest risk prone section with a probability of risk of 0.114. This was followed closely by mechanical installations, electrical services, and finishes with probabilities of risk 0.112, 0.111 and 0.105. The corresponding values from the risk priority numbers (RPN), confirmed these as high risk factors. Thus, the FMEA developed on the scope management of work section revealed these sections to have severity classes 2, 2R and 3 respectively.

In the light of the above analysis, these two parameters (risk factors and work sections) formed the basis for the development of the cost risk model. The framework comprises three stages- the formulation/conceptual stage, the implementation stage and the validation and testing stage. The formulation/conceptual stage is developed to inform stakeholders the abstraction of ideas culled from reviewed literature and in consultation with other experts on what can be done to develop a buoyant model. The implemented model is an extraction from the conceptual model to develop a model based on the available data and limitations of the research work. The implementation stage outlines activities which are taken to ensure that the model produces realistic results and it is accepted by all stakeholders to enable an appropriate implementation. The final stage of the above model is the evaluation stage. It subjects the model to scrutiny and criticism to ensure its ease of adaptability to the built environment. After evaluation if the model is found to be satisfactory, it is accepted and maintained; if it is found to be unsatisfactory, recommendations by evaluators are incorporated for review. The testing and evaluation process used a focused group and structured interviews for a plot exercise. It is imperative to note that the process of evaluation is an ongoing process and further recommendations would form a basis of future research work.
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CONSTRUCTION PROFESSIONALS’ PERCEPTION ON THE PROSPECT OF ADOPTING E.M.S ISO 14001 IN NIGERIAN CONSTRUCTION INDUSTRY

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The construction industry is one sector that contributes to the Development and Economic growth of any Nation, however, it is also one that has been characterized as having a tremendous Environmental impact. ISO 14001 Environmental management system is a globally recognized Management standard and is published by ISO to serve as a framework to limit such Environmental impact and also ensure regulatory compliance. This paper assesses the construction professionals’ perception on the prospect of ISO 14001 Environmental management systems in Nigerian Construction Industry. The paper employs both primary and secondary means to source for data. The primary data was collected through a well-structured questionnaire which was distributed to construction professionals, which includes: Architects, Builders, Estate surveyors, Engineers, Land surveyors, Quantity surveyors, and Town Planners. The secondary data was collected by reviewing relevant related literatures on the subject. Findings reveal that ISO 14001 is currently not practiced by most construction companies in Nigeria, but professionals are however optimistic that there is prospect and the practice will reduce the impact construction practices have on the environment. Further, implementing environmental law is the most prominent factor hindering the adoption of ISO 14001 environmental management system, followed by awareness on EMS by Construction firms, and also lack of proper motivation among practitioners in the industry, these barriers have also been directly responsible for low level of certification among construction firms. Recommendations include, stakeholders in the construction industry should work together to increase the level of awareness among practitioners and other stakeholders as well, the government should make it mandatory through the use of appropriate policies and other legislations for contractors and other practitioners in the industry to be ISO 14001 EMS certified.

Keywords: construction professional, environmental management system, ISO 14001

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INTRODUCTION
As the quest to ensure environmental sustainability and compliance continues to sweep across countries in both the developed and developing countries, concerns have been expressed by organizations seeking to check the link between development and its impact to the environment. Organizations have been under increasing pressure to minimize their environmental footprint and promote sustainable development. Key among these concerns has been the generation of hazardous waste on construction sites, Air quality, Climate change gases, Drinking water pollution, Landfill waste and Ozone depletion among others.

This is particular important in the case of the construction industry, which is seen as a conspicuous user of resources. Materials are derived from numerous sources and suppliers, and minimization of waste oftentimes presents particular problem. Construction also has a major impact on the environment in its consumption of energy, both directly and embodied in the materials that it uses. Ajatar (2000) outlines up to ten different adverse effects of construction activities on the environment. These include, among others, land misuse, existing site dereliction, habit destruction, misuse of natural resources, and so on. The large bulk of materials used consume a great deal of energy for transport. Taking into account both direct use and embodied energy, the construction industry consumes some significant amount of energy; Construction generates over 40 million tonnes of carbon dioxide which contributes to global warming from the greenhouse effect. Acid gases and oxides of nitrogen (NO2) are also produced, contributing to acid rain and photochemical smog production. Construction activities put a lot of pressure on the physical environment. For instance, according to Bokinni (2008), Buildings account for one fourth of the world’s wood harvest, two fifth of its material and energy consumption and one sixth of its fresh water usage. Dimson (1998) in Dahiru (2005) also observed that human habitats (buildings) contribute to environment crises through resources depletion, energy consumption air pollution and waste creation.

Environmental management system is a global standard that seeks to address some of the challenges posed by the activities of organizations, industries etc.

Adoption of ISO 14001 has also been shown to provide both tangible and intangible benefits to companies, such as: cost reductions and savings; improved communication; reduction in fines; improved corporate image; and improvement in operational processes, to name a few (Nee & Wahid, 2010; Ayarkwa Joshua, 2010; West & Manta, 1996; Maxwell, Rothenberg, Briscoe, & Marcus, 1997; Chandrashekar, Dougless, & Avery, 1999; Nattrass & Altmare, 1999; Zingale & Himes, 1999; Darnall, Gallagher, Andrews, & Amaral.

ISO 14001 has been adopted in most South African companies; the standard is presently served by SABS (South African bureau of standards) to about 14 different companies/ industries with building and civil
industries inclusive. Although SABS ISO 14001 is voluntary in South Africa, most companies are motivated by the fact that it helps them save cost and it increases their business opportunities and companies would rather want their public image increased and be seen as environmentally and socially responsible. SABS (2005).

This paper aims at examining the perception of construction professionals about the prospect of adopting ISO 14001 in the construction industry in Nigeria. Part of the research objectives were to:

1. To study existing literatures on adoption and implementation of ISO 14001 as it relates to the construction industry.
2. Find out if construction professionals adopt ISO 14001 for their companies and the reasons why they do so.
3. Identify factors militating against its adoption and the perceived benefit of ISO 14001 to the construction industry in Nigeria.

ENVIRONMENTAL MANAGEMENT PRACTICE AND NIGERIAN CONSTRUCTION INDUSTRY.

According to Famiyeh (2014), Environmental management can be described as a methodology by which organizations acting in a structured manner assess their operations to ensure that they are functioning in an environmentally legitimate way. There are numerous legislations, laws and regulation on environmental practice in the country. The current policy on environment and applicable laws in the country according to Anago (2002), are as follows:

National Policy
Nigeria’s National Policy on Environment (1989) sets out the following goals:

- Securing the quality of the environment for health and wellbeing;
- Conserving and using the environment and natural resources for the benefit of present and future generations;
- Restoring, maintaining and enhancing the ecosystem and ecological processes essential for the functioning of the biosphere to preserve biological diversity and the principle of optimum sustainable yield in the use of natural resources;
- Promoting public awareness on the link between development and the environment; and
- International co-operation with countries and international organizations in the protection of the environment.

Applicable Laws
The synopsis of applicable laws traverse; international agreements/conventions/protocols and national laws, regulations and bye-laws which apply concurrently. They include the following:
a. International Agreements/Conventions (5)
   i. 1968 African Convention on conservation of Nature and Natural Resources.
   ii. 1972 UN Conference on the Human Environment (Stockholm declaration) which established the nexus between development and environmental integrity.
   iii. 1976 Vancouver Conference on Human Settlements. (Habitat I)
   iv. 1985 Vienna Convention on protection of the Ozone Layer
   v. 1992 UN Conference on Environment and Development (Rio Summit) which produced a suite of five documents:
      - Agenda 21 - an action plan for sustainable development in the 21st century.
      - The Rio declaration - Principles on healthy environment and equitable development.
      - The Convention on Biodiversity.
      - The Convention on climate change
      - A statement of Forest Principles.
   i. 1993 Lugano Convention on Civil Liability for damage resulting from activities dangerous to the Environment.
   ii. 1996 Istanbul Conference on Human Settlements (Habitat II) which links quality living with construction and environment, drinking water etc.
   iii. Kyoto Accord/Kyoto Protocol on global warming CFCs and

b. Nigerian Legislation
   - The 1999 Constitution.

At the apex of applicable local laws is the 1999 constitution of the Federal Republic of Nigeria which provides inter alia:

Section 20: “The State shall protect and improve the environment and safeguard the water, air and land, forest and wildlife of Nigeria.”

Section 16 (2): The State shall direct its policy towards ensuring:
   - The promotion of a planned and balanced economic development;

Section 17 (2) (d) “In furtherance of the social order, exploitation of human or natural resources in any form whatsoever for reasons, other than the goal of the community shall be prevented.”

The only deficiency of the constitutional provisions is their non-justiceability. Performance cannot be enforced by legal action since they
are categorized under foundational objectives and directive principles of state policy (chapter 2 of the constitution)

- African Charter on Human and Peoples Right (Ratification and Enforcement) Act Cap 10

Article 24: “All Peoples shall have the right to a general satisfactory environment favourable to their development.”

- Harmful Wastes (Special Criminal Provisions) Act Cap 165

This law was the immediate reaction to the dumping of toxic waste product in Nigeria in 1988, otherwise known as the Koko incident. Subsequently the Federal Military Government (as it was) promulgated the Federal Environmental Protection Agency (FEPA) Decree No.58 of 1988 (now Cap 131). For the first time, an Agency was set up to oversee the environment with specific powers to:

- Establish such procedures for industrial or agricultural activities in order to minimize damage to the environment from such activities

- Establish such environmental criteria, guidelines, specifications or standards for the protection of the nation’s air and inter-state waters as may be necessary to protect the health and welfare of the population from environmental degradation. FEPA also has responsibility for setting standards for water quality, noise control, effluent limitation, ozone protection, control of hazardous substances, etc.


- This is the core legislation that governs environmental impact assessment in respect of proposed projects in Nigeria and flows directly from the provisions of principle 17 of Rio declaration:

- “Environmental Impact assessment as or national instrument shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent national authority.” The Act therefore makes it mandatory that before the final decision is taken or approval given for any activity likely to significantly affect the environment, the effect of such activity shall first be taken into account.

However, this have not been the case, according to Anago (2002), government at all levels have been the main defaulters, as projects are oftentimes awarded before any kind of impact assessment is made. The basic challenge confronting government is how to translate the laudable provisions of the Act into an effective tool for managing the environment. The challenge is crucial because Nigeria, like most developing countries, has “world class” legislation on various issues, which nevertheless suffers failure at the implementation stage.
ISO 14001 seems to be a relatively new concept in the industry, Environmental management system is a globally recognized Management standard and is published by ISO to serve as a framework to limit such Environmental impact and also ensure regulatory compliance. It provides a framework for the company to define and organize their environmental policy by complying with any accepted standard (Grozalez-Benito and Grozalez-Benito, 2005), the first International Standard Organizations (ISO) ISO14001 EMS standard was published in 1996, the standard provides internationally recognized criteria so the organizations can adopt and improve their environmental performances (Hewitt and Robinson, 1998). Companies that have adopted and implemented the standard are mostly in the oil and gas industry, the standard is however gaining popularity among major business as the preferred EMS in the global arena within different industries. With worldwide popularity and growing numbers, the ISO 14001 EMS has become more globally accepted. While Construction industry no doubt provides countless benefit to the society, it however impacts tremendously on the environment in a number of ways; this includes Emission to air, Land contamination, Noise pollution, Waste disposal, Resource consumption and discharge to water. The construction industry in Nigeria is no exception, the industry is considered to be one of the fastest growing construction industries in the continent and have in one way or the other impacted on the environment by increasing waste generation with poor disposal systems, increase air pollution and water among others.

RESEARCH METHOD

The research design employed for this study was the descriptive survey in which respondents were drawn from higher Institutions, professionals in the construction industry (Land Surveyors Town Planners, Architects, Builders, Quantity Surveyors, Engineers and Estate Surveyors) in Nigeria and the prospective beneficiaries of the policy were randomly selected. The areas covered in this research are: The Federal Capital Territory, FCT, Abuja, Kaduna and Kano States, The main research instrument used was a well-structured questionnaire containing closed ended questions with suggested answered measured on a Likert Scale.

A total of 70 questionnaires were administered, and 65 were retrieved, which equates to a response rate of 92.86% achievement and were used for analysis. The questionnaire solicited substantial information on the reasons, benefit and impediment for adopting ISO 14001 in Nigeria, from the various respondents based on their experience. The opinion sampled include, respondents understanding of Environmental management system, the practice of ISO 14001, problems of adopting ISO 14001, benefits derived from adopting the standard, level of importance attached to the benefits and level of awareness of the concept of EMS ISO 14001in Nigeria.
PRESENTATION AND DISCUSSION OF RESULTS

The data obtained are presented and discussed as follows.

Professionals in the built industry

The sample frame consists of participants in the built environment as the study focuses on the construction industry. Table 1 presented questionnaire response rate.

Table 1: Distribution of questionnaires

<table>
<thead>
<tr>
<th>Number distributed</th>
<th>70</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number properly completed and returned</td>
<td>65</td>
</tr>
<tr>
<td>Percentage response</td>
<td>92.86%</td>
</tr>
</tbody>
</table>

From Table 1 above, it can be observed that the response rate is 92.86%

Table 2: Description of company/organization

<table>
<thead>
<tr>
<th>Description of org./company</th>
<th>No. of response</th>
<th>% of response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consultant</td>
<td>14</td>
<td>21.5</td>
</tr>
<tr>
<td>Contractor</td>
<td>30</td>
<td>46.2</td>
</tr>
<tr>
<td>Academic construction professional</td>
<td>21</td>
<td>32.3</td>
</tr>
<tr>
<td>Total</td>
<td>65</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 2 indicates a breakdown of the questionnaires response rate based on the description of respondent’s company/organization. Responses from regulatory bodies, subcontractors and suppliers were not used for the research. But however the responses of individual professionals were sort for as can be seen the table below.

Table 3: Profession of respondents

<table>
<thead>
<tr>
<th>Profession</th>
<th>No. Distributed</th>
<th>No. of response</th>
<th>% of response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architects</td>
<td>15</td>
<td>15</td>
<td>100</td>
</tr>
<tr>
<td>Builders</td>
<td>15</td>
<td>15</td>
<td>100</td>
</tr>
<tr>
<td>Engineers</td>
<td>15</td>
<td>13</td>
<td>86.6</td>
</tr>
<tr>
<td>Estate surveyors</td>
<td>5</td>
<td>3</td>
<td>60</td>
</tr>
<tr>
<td>Land surveyors</td>
<td>5</td>
<td>4</td>
<td>80</td>
</tr>
<tr>
<td>Quantity surveyors</td>
<td>10</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>Town planners</td>
<td>5</td>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td>70</td>
<td>65</td>
<td></td>
</tr>
</tbody>
</table>

Table 3 indicates a breakdown of the questionnaires response rate based on respondent’s profession. Architects returned 100%, Builders 100%, Engineers 86.6%, Estate surveyors 60%, Land surveyors 80, Quantity Surveyor 100%, and Town Planner 100%
Type of environmental management policy currently been practiced and implemented in organization/company

Companies in the industry adopts range of policies that suits their needs, based on these, the questionnaire respondents were asked to choose from the list of environmental policies list which they currently practice and implement.

<table>
<thead>
<tr>
<th>Environmental management policy</th>
<th>No. of response</th>
<th>% of response</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Environmental Impact Assessment Act of 1992.</td>
<td>30</td>
<td>46.15</td>
</tr>
<tr>
<td>FEPA Decree No.58 of 1988 (now Cap 131).</td>
<td>10</td>
<td>15.38</td>
</tr>
<tr>
<td>1996 Istanbul Conference on Human Settlements (Habitat II).</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1993 Lugano Convention.</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>EMS ISO 14001</td>
<td>2</td>
<td>3.07</td>
</tr>
</tbody>
</table>

Table 4 indicates that 46.15% of the respondents currently are using environmental impact assessment. This represents the largest percentage of the respondents in the study. 35.38% of the respondents currently are using the National policy on environment. 15.38% of the respondents are using the FEPA Decree, while only about 3.07% of the respondents are currently practicing and have implemented ISO 14001 standard in their organization. This indicates that organisations will be able to anticipate and mitigate the environmental impacts of proposed projects at the planning and design stages but will not be able to effectively manage the day-to-day environmental impacts arising from construction, operation and decommissioning of such projects.

Source of information on ISO 14001 standard

Respondents were asked to specify their source of information about ISO 14001 standard. Table 5 shows the number of responses and their percentages.

<table>
<thead>
<tr>
<th>Source of information</th>
<th>No. of responses</th>
<th>% of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPA</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Media</td>
<td>15</td>
<td>27.27</td>
</tr>
<tr>
<td>In-house consultant</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Employees</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Suppliers</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>External consultant</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Seminars</td>
<td>35</td>
<td>63.64</td>
</tr>
<tr>
<td>Institution (Universities/Polytechnic)</td>
<td>5</td>
<td>9.09</td>
</tr>
</tbody>
</table>

As can be observed from Table 5, 63.64% of the respondents get their information by attending seminars. 27.27 % get their information from the
media while 9.09% source their information from their institution of study. Because most of the respondents get their information by attending seminars, this will affect a section of practitioners/professionals.

**Reasons for adopting ISO 14001**

Organization/company now seeks for better ways to enhance their competitive edge in the 21st century by adopting globally recognized standards/systems which impact on their operations in both tangible and intangible ways. Based on these, the questionnaire respondents were asked to indicate on a five point Likert scale, where 1 = ‘strongly disagree’, and 5 = ‘strongly agree’, both quantifiable and non-quantifiable reasons which are perceived to lead organizations/companies to the adoption of an EMS.

**Table 6: Perceived reasons for adopting ISO 14001 in the construction industry**

<table>
<thead>
<tr>
<th>S/no</th>
<th>Reasons</th>
<th>Frequency Responses</th>
<th>Σf</th>
<th>Σfx</th>
<th>Mean x</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>High waste disposal costs</td>
<td>25 18 10 12 -</td>
<td>65</td>
<td>139</td>
<td>2.14</td>
</tr>
<tr>
<td>b</td>
<td>International trade barriers</td>
<td>15 15 15 15 5</td>
<td>65</td>
<td>130</td>
<td>2.69</td>
</tr>
<tr>
<td>c</td>
<td>To comply with existing regulatory requirements</td>
<td>20 25 10 10 -</td>
<td>65</td>
<td>140</td>
<td>2.15</td>
</tr>
<tr>
<td>d</td>
<td>Pressure from the customers</td>
<td>8 20 9 8 7</td>
<td>52</td>
<td>142</td>
<td>2.73</td>
</tr>
<tr>
<td>e</td>
<td>Pressure from the suppliers</td>
<td>30 9 10 8</td>
<td>57</td>
<td>59</td>
<td>1.93</td>
</tr>
<tr>
<td>f</td>
<td>Pressure from the employees</td>
<td>21 10 11 5</td>
<td>47</td>
<td>69</td>
<td>2.00</td>
</tr>
<tr>
<td>g</td>
<td>Pressure from the community</td>
<td>30 15 15 5</td>
<td>57</td>
<td>58</td>
<td>1.92</td>
</tr>
<tr>
<td>h</td>
<td>To identify potential areas for improvement</td>
<td>1 5 15 11 18</td>
<td>50</td>
<td>190</td>
<td>3.80</td>
</tr>
<tr>
<td>i</td>
<td>To monitor set targets</td>
<td>- 18 17 8</td>
<td>43</td>
<td>119</td>
<td>2.77</td>
</tr>
<tr>
<td>j</td>
<td>To benchmark with other organizations</td>
<td>6 1 15 9 17</td>
<td>48</td>
<td>174</td>
<td>3.63</td>
</tr>
<tr>
<td>k</td>
<td>To satisfy insurance, finance and other lending criteria</td>
<td>20 20 10 5 -</td>
<td>55</td>
<td>95</td>
<td>2.00</td>
</tr>
<tr>
<td>l</td>
<td>To explore market for ‘green’ products</td>
<td>17 15 13 5</td>
<td>50</td>
<td>96</td>
<td>2.12</td>
</tr>
<tr>
<td>m</td>
<td>Improved corporate image</td>
<td>7 5 15 11 16</td>
<td>48</td>
<td>186</td>
<td>3.88</td>
</tr>
<tr>
<td>n</td>
<td>To avoid liability costs from spills</td>
<td>2 22 10 -</td>
<td>55</td>
<td>117</td>
<td>2.13</td>
</tr>
<tr>
<td>o</td>
<td>To ensure continual identification and implementation of cleaner production opportunities.</td>
<td>20 20 10 5</td>
<td>55</td>
<td>100</td>
<td>2.09</td>
</tr>
</tbody>
</table>

GRAND MEAN 2.53

As can be observed improved corporate image averaged 3.88 meaning the respondents have strongly agree as a reason for adopting ISO 14001. To identify potential areas for improvement averaged 3.80. To benchmark with other organizations averaged 3.63. To monitor set targets averaged 2.77. Pressure from the customers averaged 2.73. International trade barriers averaged 2.69. To comply with existing regulatory requirements averaged 2.15. High waste disposal costs averaged 2.14. To avoid liability costs from spills averaged 2.13. To explore market for ‘green’ product averaged 2.12. To ensure continual identification and implementation of
cleaner production opportunities averaged 2.09. Pressure form employees and to satisfy insurance, finance and other lending criteria averaged 2.00. Pressure from supplier averaged 1.93. Pressure from community averaged 1.92. The grand mean of the perceived reasons for adopting ISO 14001 averaged 2.53; this indicates that even though the respondents rarely used the standard they are however optimistic that when adopted it will help boost their cooperate image, help them identify potential areas for improvement and help them bridge any international trade barrier.

**Benefit for adopting ISO 14001**

The reason for the adoption of a system or standard by an organization possibly cannot be segregated from any perceived benefit from its implementation and practice. Organizations expect both quantifiable and unquantifiable benefits from EMS implementation and certification. The questionnaire respondents were thus asked to reflect back on the various benefits expected before the adoption of EMS. These benefits could voluntarily drive the organizations or pressure them, depending on the nature of their business and stakeholders, to implement new systems and standards. Respondents were asked to rate each benefit listed in the questionnaire on a five point Likert scale where 1 = ‘strongly disagree’, and 5 = ‘strongly agree’. From the responses obtained, the mean was calculated and the results are presented in Table 7.

<table>
<thead>
<tr>
<th>S/no</th>
<th>Benefit</th>
<th>Frequency Responses</th>
<th>( \Sigma f )</th>
<th>( \Sigma fx )</th>
<th>Mean x1</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Waste reduction</td>
<td>- 20 15 15 5 5</td>
<td>55 170</td>
<td>3.09</td>
<td></td>
</tr>
<tr>
<td>b</td>
<td>Cost savings from waste reduction/ disposal</td>
<td>- 25 15 10 5 5</td>
<td>55 160</td>
<td>2.91</td>
<td></td>
</tr>
<tr>
<td>c</td>
<td>Protection from prosecutions, fines and legal fees</td>
<td>- 35 15 10 - 60 160</td>
<td>2.58</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d</td>
<td>Reduction in cleanup costs</td>
<td>19 11 5 5 10 65 167</td>
<td>2.57</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e</td>
<td>Establish and monitor cleaner production/ eco-efficiency</td>
<td>16 16 18 10 5</td>
<td>65 167</td>
<td>2.57</td>
<td></td>
</tr>
<tr>
<td>f</td>
<td>Leniency in international trade barriers</td>
<td>3 22 13 7 5</td>
<td>50 139</td>
<td>2.78</td>
<td></td>
</tr>
<tr>
<td>g</td>
<td>Reduction in organization risks (health, safety and environment)</td>
<td>3 25 15 9 6</td>
<td>58 164</td>
<td>2.83</td>
<td></td>
</tr>
<tr>
<td>h</td>
<td>Decrease in insurance costs</td>
<td>16 14 22 8 - 60 142</td>
<td>2.37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>i</td>
<td>Compliance to legislation</td>
<td>18 20 10 7 10 65 166</td>
<td>2.55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>j</td>
<td>Market and competitive advantage</td>
<td>- 35 15 5 5</td>
<td>60 160</td>
<td>2.67</td>
<td></td>
</tr>
<tr>
<td>k</td>
<td>Fulfilling customers expectation</td>
<td>10 30 10 10 - 60 140</td>
<td>2.33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>l</td>
<td>Good will from the customer and community</td>
<td>17 13 10 10 5 50 117</td>
<td>2.34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>m</td>
<td>Morale building within the organization</td>
<td>10 30 10 10 5</td>
<td>65 165</td>
<td>2.54</td>
<td></td>
</tr>
<tr>
<td></td>
<td>GRAND MEAN</td>
<td></td>
<td></td>
<td>2.57</td>
<td></td>
</tr>
</tbody>
</table>

As can be observed in Table 7 above, waste reduction averaged 3.09; this suggests that the respondents strongly agree it is a benefit. Cost savings from waste reduction/ disposal averaged 2.91. Reduction in organization risks averaged 2.83. Leniency in international trade barriers averaged 2.78. Protection from prosecutions, fines and legal fees averaged 2.58.
Establish and monitor cleaner production/ eco-efficiency averaged 2.57. Reduction in clean-up costs averaged 1.90. The grand mean averaged 2.83, this indicates that the respondents agree with the perceived benefits and there in prospect in adopting ISO 14001.

**Impediments to adopting ISO 14001**

Some impediments militating against the adoption of ISO 14001 identified from literature were assessed with respect to their severity or importance on a five point Likert scale. Table 6 presents the result. Table 6 indicates responses from questionnaire on the factors impeding the adoption of ISO 14001 standard in the construction industry in Nigeria, on a scale of 1 to 5 ranging from ‘strongly disagree’ to ‘strongly agree’.

Table 8 shows the responses from the questionnaire on the impediments or barriers to adopting ISO 1400. Implementing environmental laws averaged 2.85, indicating that it is an impediment to a successful adoption of the standard. Awareness among practitioners averaged 2.72. Lack of motivation averaged 2.69. Training of contractors averaged 2.59. Resistance from the employees due to changes in operating procedures and external auditors/ consultants costs averaged 2.44. Documentation averaged 2.42. Internal audit costs averaged 2.41. Time lost by employees averaged 2.30. The grand mean averaged 2.54 which indicates the agreement of the factors as impediments to adopting ISO 14001.

### Table 8: Impediments to adopting ISO 14001

<table>
<thead>
<tr>
<th>S/no</th>
<th>Impediments</th>
<th>Frequency</th>
<th>Responses</th>
<th>∑f</th>
<th>∑fx</th>
<th>Mean x[^1]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>a</td>
<td>Documentation (cost, time for preparation)</td>
<td>9</td>
<td>20</td>
<td>20</td>
<td>6</td>
<td>-</td>
</tr>
<tr>
<td>b</td>
<td>External auditors/ consultants costs</td>
<td>8</td>
<td>15</td>
<td>18</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>c</td>
<td>Awareness among practitioners</td>
<td>-</td>
<td>23</td>
<td>18</td>
<td>9</td>
<td>-</td>
</tr>
<tr>
<td>d</td>
<td>Internal audit costs</td>
<td>17</td>
<td>14</td>
<td>10</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>e</td>
<td>Implementing environmental laws</td>
<td>5</td>
<td>20</td>
<td>25</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>f</td>
<td>Training of contractors</td>
<td>4</td>
<td>20</td>
<td>15</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>g</td>
<td>Resistance from the employees due to changes in operating procedures</td>
<td>5</td>
<td>24</td>
<td>23</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>h</td>
<td>Time lost by employees</td>
<td>10</td>
<td>20</td>
<td>15</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>i</td>
<td>Lack of motivation</td>
<td>-</td>
<td>23</td>
<td>17</td>
<td>8</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td><strong>GRAND MEAN</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SUMMARY OF RESULTS**

The study found that:

- EIA is more common among the respondents, about 46.15% of the respondents currently practice and have implemented EIA act of 1992. While 2% currently practice and have implemented ISO 14001.

- Most of the respondents 63.64% get their information by attending seminars.
Respondents agreed with (grand mean 2.53) the reason given for adopting ISO 14001.

Respondents believe there is prospects and agree with (grand mean 2.53) the benefits that is derived by adopting ISO 14001.

Respondents agree that the impediments given could serve as a barrier for the adoption of ISO 14001.

CONCLUSION AND RECOMMENDATIONS

In this study an attempt was made to get the perception of construction professionals as regards their perception on the prospect of ISO 14001 in construction industry in Nigeria. First the impact of activities in the built industry on the environment was analysed, existing literatures on adoption and implementation of ISO 14001 was closely examined. This was followed by preparation of a questionnaire on environmental management practices, reasons, barriers and benefit of adopting ISO 14001. Based on the respondents view on the environment management practices in the construction industry. The following conclusions were made.

ISO 14001 is not practice and implemented by companies in the construction industry, as there are no enabling legislation or policy on the standard. However professionals appreciate the benefits and prospect of ISO 14001 when adopted but the level of awareness tend to be very low among professionals. Source of information for professionals is by attending seminars, there is need to make adequate provision in school syllabus of some courses in the tertiary institutions on environment management systems. Based on the results obtained in this research, the following are recommended.

- Stakeholders in the construction industry should work together to increase the level of awareness among practitioners and other stakeholders as well.
- Government should make it mandatory through the use of appropriate policies and other legislations for contractors and other practitioners in the industry to be ISO 14001 certified.

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DEMOGRAPHIC ATTRIBUTES INFLUENCE ON HEALTH AND SAFETY PRACTICES FOR SMALL AND MEDIUM CONSTRUCTION ENTERPRISES

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There is paucity of research on demographic attributes on health and safety (H&S) practices. Hence, the purpose of this study was to investigate the influence of demographic attributes on the H&S practices within small and medium construction enterprises (SMEs) in South Africa. A mixed method approach was used i.e. Delphi and questionnaire survey. A structured questionnaire consisted of 31 H&S practices/measures. They were categorized in five major H&S practices. The questionnaire was developed from extensive review and the participation of 20 purposively sampled H&S experts, in four iterative rounds of Delphi survey. The questionnaires were distributed to a total of 1,450 conveniently sampled SMEs. 228 questionnaires were returned of which 216 responses were usable. The findings imply that upper management commitment and involvement in H&S, employee involvement and empowerment in H&S, project supervision, project H&S planning and communication in H&S and H&S resources and training were retained as reliable and valid H&S practices. However, multiple linear regression analysis established demographic attributes i.e. experience in the construction industry, education level and the number of employees in the organization was not good predictors of the H&S practices.

Keywords: demographic attributes, health and safety practice, small and medium construction enterprise

INTRODUCTION

The South African small and medium construction enterprises (SME) sector is described as largely underdeveloped and lacking the managerial and technical skills and sophistication enjoyed by larger well established contractors. The SMEs are left on the periphery of the mainstream economy and do not participate fully in the economy (Department of Public Works, 1999). Martin (2010) opined that lack of knowledge including knowledge of pricing procedures, contractual rights and obligations; law,

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management techniques and principles as well as technology were a challenge to SMEs. Despite these general challenges faced by SMEs, the CIDB report 2008 highlighted specific challenges faced by small contractors in managing H&S. Anecdotally the report indicated that medium to large contractors and subcontractors working with large contractors tend to address H&S to greater degrees than small contractors, emerging contractors, as well as the majority of housing contractors (Construction Industry Development Board, (CIDB, 2008).

Construction sites in South Africa continue to be dangerous workplace in the economy (CIDB, 2004). The Department of Labour (DoL, 2012) indicated that in the period 2007 to 2010 the construction industry incurred 171 fatalities and 755 injuries. The industry further paid more than R287 million for occupational injuries in 2010/2011. These statistics are inclusive of SMEs. This poor H&S performance has therefore driven H&S stakeholders especially the South African government to take H&S seriously. Arguably, the poor H&S performance could inevitably be helped by the use of valid and reliable H&S practices.

Health and safety practices
Teo and Ling, (2006) developed a model to measure the effectiveness of H&S management of construction sites. The model was based on 3P + I, namely policy, process, personnel and incentive factors. These core factors were measured by 590 attributes. The large number of attributes might not be practical in the context of SMEs. Fernandez-Muniz et al., (2007) developed a positive H&S culture model that consisted of management commitment, employee involvement and H&S management system (SMS). The SMS included H&S policy, incentives, training, communication, planning and control. The model could be applied to more than one type of industry of different sizes. Chinda and Mohamed, (2008) developed H&S culture model adapted from the European Foundation Quality Model (EFQM). The enablers that were identified were leadership, policy and strategy, partnerships and resources, and processes and H&S outcome or goals. The model was validated using large contractors in Thailand. It might be possible to test this model or a modified model within SMEs. Molenaar et al., (2009) established that for H&S performance to improve that is reduction of accidents. The corporate H&S culture should comprise of: H&S commitment, H&S incentives, subcontractor involvement, H&S accountability and disincentives.

The models of H&S reviewed did not have similar H&S practices. Hence, this suggests a need to determine the H&S practices for construction SMEs in South Africa. Further, the studies did not include demographic variables in their study as predictors of H&S practices. Hinze (1997) opined that demographic attributes can influence safety climate and further influence employee safety behaviour. Therefore, this is a major gap in this study.
Demographic relationship with H&S practices
According to Vinodkumar and Bhasi, (2009) H&S practices perception has been found to vary among different groups in organisations. They established that the perception of H&S practices namely management commitment and actions for safety, workers’ knowledge and compliance to safety, workers participation and commitment to safety, priority for safety over production, emergency preparedness and workers attitude towards safety, differed significantly based on the employees qualification level. They further established that employees perception based on age differed significantly on different H&S practices namely management commitment and actions for safety, workers’ knowledge and compliance to safety, workers participation and commitment to safety and risk justification. Finally, based on the years of experience, the employees’ perception differed significantly on management commitment and actions for safety, workers’ knowledge and compliance to safety, workers participation and commitment to safety and risk justification. Agumba et al., (2014) found that SMEs employees with post-matric qualification strongly agreed that upper management are committed and involved in H&S. According to Cheng, et al., (2012) age significantly relate to safety management practices (SMP) i.e. safety management information, safety management process and safety management committees. The study established that the older the respondents, the higher they rated the importance level of the SMP variables. Furthermore, the study established that years of experience in current position, type of the firm, gender and size of the firm were not significantly related to SMP. In a separate study, Azimah et al., (2009) established no significant difference on workers perception on the H&S practices i.e. safety reporting, safety satisfaction and feedback, training and competence and management commitment between male and female. However, there was significant difference on safety involvement. These studies did not statistically establish the causality or influence of demographic attributes on the H&S practices. Hence, demographic data were collected to determine their influence on the H&S practices implementation at project level of construction SMEs in South Africa.

PROBLEM STATEMENT
It is evident from previous research that no consensus has been reached on the required H&S practices in there models. Moreover, demographic attributes influence or causality on H&S practices has been scantily researched especially within the construction industry SMEs in South Africa, which has a high injury rate among its workers.

The specific objectives of the study are:

- To determine the reliability and validity of the determined H&S practices; and
- To investigate the influence or causality of SMEs demographic attributes on the H&S practices.
RESEARCH METHODS

The research philosophy used for this study was pragmatic i.e. involving mixed method approach. It used a Delphi survey for H&S experts and a questionnaire survey for the contractors. Delphi method straddles between qualitative and quantitative research methods. A questionnaire survey was developed from relevant literature and four rounds of Delphi survey were undertaken. Twenty H&S experts were purposively sampled of which 16 experts finished all the four rounds of Delphi. The Delphi study process is not reported here. The H&S experts indicated that 31 H&S measures/practices were very important and considered to have major impact to improve H&S performance at SMEs project level. These H&S practices comprised the final questionnaire presented to the SMEs in the South African construction industry. The 31 practices addressed five H&S core practice areas. The respondents were required to indicate their level of agreement with the practices. The statements were rated on a five point Likert scale, where 1=strongly disagree, 2=disagree, 3=neutral, 4=agree and 5=strongly agree. Other parts of the questionnaire were designed to profile the participants’ demographic attributes and their organisation.

The questionnaire was piloted with eight SMEs upper management personnel and those knowledgeable of H&S practices at their project level. The final version was presented to 1,450 conveniently sampled SMEs. The data was collected using email and drop and collect method of which 228 questionnaires were returned representing 15.72% response rate. This low response rate concurs with findings of Kongtip et al., (2008). However, 216 questionnaires were deemed eligible for analysis. The statistical package for social science (SPSS) version 20 was used to conduct descriptive statistical analysis of the data computing the frequencies, mean scores and standard deviation. The SPSS was further used to determine the factor analysability of the H&S practices. Similarly, exploratory factor analysis (EFA) was used to determine the unidimensionality and reliability of the H&S practices. Reliability was tested using Cronbach alpha with a cut-off value of 0.70 recommended by Hair et al., (2006).

Confirmatory factor analysis determined the acceptability of the H&S constructs. The acceptability of the H&S constructs were determined using Confirmatory Factor Analysis (CFI), Tucker Lewis Index (TLI) which should be greater than 0.90; Root mean square error of approximation (RMSEA) and Standardized root mean squared residuals (SRMR) less than 0.08; p-value less than 0.05 and normed chi-squared ($\chi^2$/df) less than 5. Finally, multiple linear regression were carried out on a selected number of demographic variables namely; experience in the construction industry, education level and number of employees in the organization on their influence on H&S practices.
RESULTS AND DISCUSSIONS

Descriptive statistics on demographics
The result found that 28% of the respondents had matric and 58% of respondents had post-secondary school qualification. 32% had 6-10 years of experience in the construction industry and only 4% of respondents had over 36 years of construction industry experience. The result also indicates that 19% of the respondents had less than 6 years of construction experience. The results further indicated that 84% of the respondents had less than 50 permanently employed employees in there companies, of which 56% employed less than 20 permanent employees.

EFA for upper management involvement and commitment in H&S
The result in Table 1 indicates Cronbach alpha of upper management and involvement was greater than 0.70 at 0.868, indicating acceptable internal reliability as recommended by Hair et al., (2006). The Kaiser-Meyer-Olkin (KMO) of 0.890 with Bartlett’s Test of Sphericity of $p<0.000$ were also obtained. Indicating consistency with the recommended KMO cut off value of 0.60 and Bartlett’s Test of Sphericity of $p<0.05$ as suggested by Pallant, (2007). These results suggest that factor analysis could be conducted with the data. All the eleven practices expected to measure upper management commitment and involvement in H&S loaded together on this factor. The factor loadings for all practices were greater than 0.452, which were greater than the recommended value of 0.40 as suggested by Field (2005) and Hair et al., (2006). An Eigenvalue greater than 5.107 were established which explained 46.427% of the variance in the data. Therefore, sufficient evidence of convergent validity was provided for this construct. This finding was in line with the study of Fernandez-Muniz et al., (2007) and Findley et al., (2004).

Table 1 Upper management commitment and involvement in H&S

<table>
<thead>
<tr>
<th>Practice</th>
<th>Cronbach alpha</th>
<th>Factor loading</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>I/We communicate regularly with workers about H&amp;S</td>
<td>0.847</td>
<td>0.786</td>
<td>1</td>
</tr>
<tr>
<td>I/We actively monitor the H&amp;S performance of the projects and workers.</td>
<td>0.844</td>
<td>0.778</td>
<td>2</td>
</tr>
<tr>
<td>I/We encourage discussions on H&amp;S with employees</td>
<td>0.849</td>
<td>0.728</td>
<td>3</td>
</tr>
<tr>
<td>I/We regularly visit workplaces to check work conditions or communicate with workers about H&amp;S</td>
<td>0.850</td>
<td>0.717</td>
<td>4</td>
</tr>
<tr>
<td>I/We actively and visibly lead in H&amp;S matters by e.g. walk through the site</td>
<td>0.855</td>
<td>0.672</td>
<td>5</td>
</tr>
<tr>
<td>I/We take responsibility for H&amp;S by e.g. stopping dangerous work on site etc.</td>
<td>0.854</td>
<td>0.667</td>
<td>6</td>
</tr>
<tr>
<td>I/We ensure that the H&amp;S equipment is bought e.g. hardhats, overall etc.</td>
<td>0.857</td>
<td>0.618</td>
<td>7</td>
</tr>
<tr>
<td>I/We conduct toolbox talks with the workers regularly</td>
<td>0.857</td>
<td>0.604</td>
<td>8</td>
</tr>
<tr>
<td>I/We accord workers H&amp;S training when there is less work in the project.</td>
<td>0.865</td>
<td>0.491</td>
<td>9</td>
</tr>
<tr>
<td>I/We reward workers who make extra effort to do work in a safe manner.</td>
<td>0.873</td>
<td>0.465</td>
<td>10</td>
</tr>
<tr>
<td>I/We encourage and support worker participation, commitment and involvement in H&amp;S activities</td>
<td>0.867</td>
<td>0.452</td>
<td>11</td>
</tr>
</tbody>
</table>
EFA for employee involvement and empowerment in H&S

Table 2 indicate that the Cronbach alpha was greater than 0.70 at 0.842 indicating acceptable internal reliability as recommended by Hair et al., (2006). The Kaiser-Meyer-Olkin (KMO) of 0.819 with Bartlett’s Test of Sphericity of $p<0.000$ were also obtained. Indicating consistency with the recommended KMO cut off value of 0.60 and Bartlett’s Test of Sphericity of $p<0.05$ as suggested by Pallant, (2007). These results suggest that factor analysis could be conducted with the data. The factor loadings for all items were greater than 0.458 reported in Table 2, which were greater than the recommended value of 0.40 as suggested by Field (2005) and Hair et al., (2006). An Eigenvalue greater than 3.079 was established in this factor which explained 61.557% of the variance in the data. Therefore, sufficient evidence of convergent validity was provided for this construct. This finding concurs with the study of Fernandez-Muniz et al., (2007) and Agumba et al., (2008).

<table>
<thead>
<tr>
<th>Practice</th>
<th>Cronbach alpha</th>
<th>Factor loading</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Our workers are involved in the production of H&amp;S policy</td>
<td>0.778</td>
<td>0.863</td>
<td>1</td>
</tr>
<tr>
<td>Our workers help in developing of H&amp;S rules and safe work procedures.</td>
<td>0.776</td>
<td>0.839</td>
<td>2</td>
</tr>
<tr>
<td>Our workers are consulted when the H&amp;S plan is compiled</td>
<td>0.791</td>
<td>0.814</td>
<td>3</td>
</tr>
<tr>
<td>Our workers are involved in H&amp;S inspections.</td>
<td>0.832</td>
<td>0.598</td>
<td>4</td>
</tr>
<tr>
<td>Our workers can refuse to work in potentially unsafe, unhealthy conditions</td>
<td>0.857</td>
<td>0.458</td>
<td>5</td>
</tr>
</tbody>
</table>

EFA for project H&S planning and communication

The result in Table 3 indicates that the Cronbach alpha was greater than 0.70 at 0.852 indicating acceptable internal reliability as indicated by Hair et al., (2006). The Kaiser-Meyer-Olkin (KMO) of 0.764 with Bartlett’s Test of Sphericity of $p<0.000$ were obtained. Indicating consistency with the recommended KMO cut off value of 0.60 and Bartlett's Test of Sphericity of $p<0.05$ as suggested by Pallant, (2007). These results suggest that factor analysis could be conducted with the data. The factor loadings for all the four items were greater than 0.665 reported in Table 3, which were greater than the recommended value of 0.40 as suggested by Field (2005) and Hair et al., (2006). An Eigenvalue greater than 2.786 was established in this factor which explained 69.644% of the variance in the data. Therefore, sufficient evidence of convergent validity was provided for this construct.
Table 3 Project health and safety planning and communication

<table>
<thead>
<tr>
<th>Item/practice</th>
<th>Cronbach alpha</th>
<th>Factor loading</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Our firm uses procedures to identify possible H&amp;S dangers on site</td>
<td>0.788</td>
<td>0.833</td>
<td>1</td>
</tr>
<tr>
<td>I/We include H&amp;S in our projects program</td>
<td>0.784</td>
<td>0.822</td>
<td>2</td>
</tr>
<tr>
<td>I/We consider H&amp;S when layout of site is done</td>
<td>0.823</td>
<td>0.789</td>
<td>3</td>
</tr>
<tr>
<td>I/We organize regular meetings to verbally inform workers about the risk and preventive measures of their work.</td>
<td>0.850</td>
<td>0.665</td>
<td>4</td>
</tr>
</tbody>
</table>

EFA for project supervision
The result in Table 4 indicates that the Cronbach alpha was greater than 0.70 at 0.868 indicating acceptable internal reliability (Hair et al., 2006). The Kaiser-Meyer-Olkin (KMO) of 0.868 with Bartlett’s Test of Sphericity of $p<0.000$ were also obtained, indicating consistency with the recommended KMO cut off value of 0.60 and Bartlett’s Test of Sphericity of $p<0.05$ as suggested by Pallant, (2007). These results suggest that factor analysis could be conducted with the data. All six items expected to measure the factor project supervision loaded together on this factor. The factor loadings for all items were greater than 0.666 reported in Table 4, which was greater than the recommended value of 0.40 as suggested by Field (2005) and Hair et al., (2006). An Eigenvalue greater than 3.640 was established in this factor which explained 60.662% of the variance in the data. Therefore, sufficient evidence of convergent validity was provided for this construct. This finding was in line with the study of Fernandez-Muniz et al., (2007).

Table 4 Project supervision

<table>
<thead>
<tr>
<th>Practice</th>
<th>Cronbach alpha</th>
<th>Loading factor</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>I/we allow supervision of work by staff trained in H&amp;S.</td>
<td>0.837</td>
<td>0.786</td>
<td>1</td>
</tr>
<tr>
<td>I/we undertake informal H&amp;S inspection of the work place daily.</td>
<td>0.837</td>
<td>0.781</td>
<td>2</td>
</tr>
<tr>
<td>One of our employees trained in H&amp;S identifies dangerous activities.</td>
<td>0.848</td>
<td>0.718</td>
<td>3</td>
</tr>
<tr>
<td>I/we undertake formal H&amp;S inspection of the work place daily.</td>
<td>0.850</td>
<td>0.714</td>
<td>4</td>
</tr>
<tr>
<td>I/We allow local authorities and H&amp;S enforcement agencies to visit site for inspection.</td>
<td>0.850</td>
<td>0.693</td>
<td>5</td>
</tr>
<tr>
<td>I/we regularly undertake H&amp;S audits of projects</td>
<td>0.854</td>
<td>0.666</td>
<td>6</td>
</tr>
</tbody>
</table>

EFA for H&S resources and training
The result in Table 5 indicates that the Cronbach alpha was greater than 0.70 at 0.864 indicating acceptable internal reliability as suggested by Hair et al., (2006). The Kaiser-Meyer-Olkin (KMO) of 0.801 with Bartlett’s Test of Sphericity of $p<0.000$ were also obtained. Indicating consistency with the recommended KMO cut off value of 0.60 and Bartlett’s Test of
Sphericity of $p<0.05$ recommended by Pallant, (2007). These results suggest that factor analysis could be conducted with the data. All five items expected to measure H&S resources and training loaded together on this factor. The factor loadings for all items were greater than 0.708 reported in Table 5, which were greater than the recommended value of 0.40 as suggested by Field (2005) and Hair et al., (2006). An Eigenvalue greater than 3.281 was established in this factor which explained 65.628% of the variance in the data. Therefore, sufficient evidence of convergent validity was provided for this construct. This finding was supported by Choudhry et al., (2007) and Agumba et al., (2008).

**Table 5 H&S resources and training**

<table>
<thead>
<tr>
<th>Item/practice</th>
<th>Cronbach alpha</th>
<th>Factor loading</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>I/we provide correct tools, equipment to execute construction work.</td>
<td>0.832</td>
<td>0.782</td>
<td>1</td>
</tr>
<tr>
<td>I/we ensure that workers are trained to do the work safely</td>
<td>0.830</td>
<td>0.771</td>
<td>2</td>
</tr>
<tr>
<td>I/We ensure our workers are properly trained to take care and use personal protective equipment</td>
<td>0.834</td>
<td>0.763</td>
<td>3</td>
</tr>
<tr>
<td>I/we conduct induction of all workers on H&amp;S before commencing work on a particular site</td>
<td>0.835</td>
<td>0.751</td>
<td>4</td>
</tr>
<tr>
<td>I/We buy hardhats, gloves, overall etc. for workers</td>
<td>0.847</td>
<td>0.708</td>
<td>5</td>
</tr>
</tbody>
</table>

**Confirmatory factor analysis**

The results in Table 6 indicate that the H&S constructs were acceptable measures of H&S practice at project level of SMEs. However, four of the five constructs tested were not fitting in some of the proposed indices and they were re-specified. The re-specified H&S practices were management commitment & involvement, project supervision, project H&S planning and communication, H&S resources and training. It should be noted that majority of the H&S constructs $p$-value were not acceptable. This was because of the large number of data analysed which tends to produce significant results. It has therefore been argued that $p$-value cannot be used as a solitary measure to determine the acceptability fit of constructs.

The fit indices for management commitment and involvement were fitting after the re-specification of the construct, apart from the $p$-value. The $p$-value indicated significant result greater than 0.05. The normed chi-square was less than 5 that is 1.37 indicating good fitting construct. The CFI and TLI were greater than 0.90 indicating a good fit construct. The RMSEA and SRMR shows values of 0.041 and 0.043 respectively indicating the construct had a good fit. This result concurs with the finding of Fernandez-Muniz et al., (2007).

The fit indices for employee involvement and empowerment were fitting, apart from the $p$-value. The $p$-value indicated significant result greater than 0.05. Furthermore this construct was not re-specified. The normed chi-square was less than 5 that is 1.80 indicating good fitting construct.
The CFI and TLI were greater than 0.90 indicating a good fit construct. The RMSEA and SRMR shows values of 0.061 and 0.033 respectively indicating the construct had a good fit. This result concurs with the finding of Fernandez-Muniz et al., (2007).

The fit indices for project supervision and project H&S planning and communication were fitting after the re-specification of the construct, apart from the p-value. The p-value indicated significant result greater than 0.05. The normed chi-square was less than 5 indicating good fitting construct. The CFI and TLI were greater than 0.90 indicating a good fit construct. The RMSEA and SRMR indicated the construct had a good fit as the values were less than 0.08.

The fit indices for H&S resources and training were fitting after the re-specification of the construct, apart from the TLI. The p-value indicated non-significant result less than 0.05. The normed chi-square was less than 5 indicating good fitting construct. The CFI was greater than 0.90, whereas TLI was less than 0.088 indicating a weak fit. The RMSEA indicated a close fit with a value of 0.088 and SRMR indicated a good fit with a value of less than 0.08.

### Table 6 Confirmatory factor analysis

<table>
<thead>
<tr>
<th>Construct</th>
<th>No. of Items</th>
<th>$x^2$</th>
<th>Df</th>
<th>$x^2$/df</th>
<th>p-value</th>
<th>RMSEA</th>
<th>CFI</th>
<th>TLI</th>
<th>SRMR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management commitment &amp; involvement</td>
<td>11</td>
<td>58.98</td>
<td>42</td>
<td>1.37</td>
<td>0.053</td>
<td>0.96</td>
<td>0.95</td>
<td>0.043</td>
<td></td>
</tr>
<tr>
<td>Employee involvement &amp; empowerment</td>
<td>5</td>
<td>9.00</td>
<td>5</td>
<td>1.80</td>
<td>0.109</td>
<td>0.98</td>
<td>0.96</td>
<td>0.033</td>
<td></td>
</tr>
<tr>
<td>Project supervision</td>
<td>4</td>
<td>12.50</td>
<td>8</td>
<td>1.56</td>
<td>0.130</td>
<td>0.98</td>
<td>0.96</td>
<td>0.033</td>
<td></td>
</tr>
<tr>
<td>Project H&amp;S planning &amp; communication</td>
<td>6</td>
<td>2.227</td>
<td>1</td>
<td>2.22</td>
<td>0.135</td>
<td>0.99</td>
<td>0.96</td>
<td>0.011</td>
<td></td>
</tr>
<tr>
<td>H&amp;S resources &amp; training</td>
<td>5</td>
<td>10.69</td>
<td>4</td>
<td>2.68</td>
<td>0.030</td>
<td>0.94</td>
<td>0.85</td>
<td>0.040</td>
<td></td>
</tr>
</tbody>
</table>

### RESULTS OF MULTIPLE LINEAR REGRESSION (MLR) ANALYSIS

Multiple Linear Regression analysis was carried out to determine if the selected demographic attributes i.e. experience in the construction industry, education level and number of employees in the organization had significant influence on the valid and reliable H&S practices. Different null hypotheses were postulated;

$H^o1$ There is no relationship between the demographic variables and the perceived upper management commitment and involvement in H&S.

The result in Table 7 indicates, the demographic variables explained 3.90% of the variance in the upper management commitment and involvement in H&S at project level of SMEs. This suggests that the demographic variables were not good predictors of upper management commitment and involvement in H&S because of the low $R^2$ value achieved as indicated in Table 7. The results also illustrated significant negative
linear relationship (-2.45; \( p < 0.05 \)) between the education level and upper management commitment and involvement in H&S. However, the result further indicated that the model tested was not significant as the significance level was slightly greater than 0.05 at 0.059. Therefore, the finding that education level predicts upper management commitment and involvement in H&S was therefore not supported.

### Table 7 Demographics influence on management commitment & involvement

<table>
<thead>
<tr>
<th>Dependent variable: Upper management commitment and involvement in H&amp;S</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-square = 0.039</td>
<td></td>
</tr>
<tr>
<td><strong>Independent variables (demographics)</strong></td>
<td>SC. Beta</td>
</tr>
<tr>
<td>Constant</td>
<td>27.67</td>
</tr>
<tr>
<td>Experience in the construction industry</td>
<td>0.018</td>
</tr>
<tr>
<td>Education level</td>
<td>-0.177</td>
</tr>
<tr>
<td>Number of employees</td>
<td>-0.093</td>
</tr>
</tbody>
</table>

**Hº2** There is no relationship between the demographic variables and the perceived worker involvement and empowerment in H&S.

As indicated in Table 8, the demographic variables explained 1.20% of the variance in the workers involvement and empowerment in H&S at project level of SMEs. This suggests that the independent variables were not good predictors of worker involvement and empowerment in H&S, because of the low \( R^2 \) value achieved as indicated in Table 8. The results further indicated no significant linear relationship that emerged between the independent variable and worker involvement and empowerment in H&S. In other words, the respondents, years’ of experience in the construction industry, the education level and number of employees in the organization, have no significant influence on whether workers are involved and empowered in H&S within SMEs. Furthermore, the result indicated that the model was not significant as it was greater than 0.05, significance level at 0.478.

### Table 8 Demographics influence on worker involvement & empowerment

<table>
<thead>
<tr>
<th>Dependent variable: Worker involvement and empowerment in H&amp;S</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-square = 0.012</td>
<td></td>
</tr>
<tr>
<td><strong>Independent variables (demographics)</strong></td>
<td>SC. Beta</td>
</tr>
<tr>
<td>Constant</td>
<td>15.344</td>
</tr>
<tr>
<td>Experience in the construction industry</td>
<td>0.077</td>
</tr>
<tr>
<td>Education level</td>
<td>0.026</td>
</tr>
<tr>
<td>Number of employees</td>
<td>-0.071</td>
</tr>
</tbody>
</table>

**Hº3** There is no relationship between the demographic variables and the perceived project H&S planning and communication.
Table 9 indicates that, the demographic variables explained 2.20% of the variance in the project H&S planning and communication at project level of SMEs. This suggests that the independent variables were not good predictors of project H&S planning and communication because of the low R² value achieved as indicated in Table 9. The results further indicated no significant linear relationships that emerged between the independent variables and project H&S planning and communication. In other words, the respondents, years’ of experience in the construction industry, the education level and number of employees in the organization, have no significant influence on whether project H&S planning and communication is practiced within SMEs. Furthermore, the result indicated that the model was not significant as the model significance level was greater than 0.05 at 0.219.

### Table 9 Demographics influence on project H&S planning and communication

<table>
<thead>
<tr>
<th>Dependent variable: Project H&amp;S planning and communication</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-square = 0.022</td>
<td></td>
</tr>
<tr>
<td>Independent variables (demographics)</td>
<td>SC. Beta</td>
</tr>
<tr>
<td>Constant</td>
<td>20.623</td>
</tr>
<tr>
<td>Experience in the construction industry</td>
<td>0.094</td>
</tr>
<tr>
<td>Education level</td>
<td>-0.098</td>
</tr>
<tr>
<td>Number of employees</td>
<td>-0.081</td>
</tr>
</tbody>
</table>

**Hº4** There is no relationship between the demographic variables and the perceived project supervision.

According to Table 10, the demographic variables explained 0.5% of the variance in the project supervision project level of SMEs. This suggests that the independent variables were not good predictors of project supervision because of the low R² value achieved as indicated in Table 10. The results further indicated no significant linear relationships that emerged between the independent variable and project supervision in other words, the respondents, years’ of experience in the construction industry, the education level and number of employees in the organization, have no significant influence on whether project supervision is practiced within SMEs projects. Furthermore, the result indicated that the model was not significant as the significance level was greater than 0.05 at 0.792.

### Table 10 Demographics influence on project supervision

<table>
<thead>
<tr>
<th>Dependent variable: Project supervision</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-square = 0.005</td>
<td></td>
</tr>
<tr>
<td>Independent variables (demographics)</td>
<td>SC. Beta</td>
</tr>
<tr>
<td>Constant</td>
<td>19.646</td>
</tr>
<tr>
<td>Experience in the construction industry</td>
<td>0.066</td>
</tr>
<tr>
<td>Education level</td>
<td>-0.021</td>
</tr>
<tr>
<td>Number of employees</td>
<td>-0.031</td>
</tr>
</tbody>
</table>
There is no relationship between the demographic variables and the perceived H&S resources and training.

According to Table 11, the demographic variables explained 2.90% of the variance in the H&S resources and training at project level of SMEs. This suggests that the independent variables are not good predictors of H&S resources and training because of the low $R^2$ value achieved as indicated in Table 11. The results also indicated a negative linear relationship (-2.26; $p<0.05$) between the education level and H&S resources and training. However, a further result indicated that the model was not significant as the significance level was greater than 0.05 at 0.106. Therefore, the finding that education level predicts H&S resources and training was therefore not supported.

<table>
<thead>
<tr>
<th>Independent variables (demographics)</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>Sig.(p) 0.106</td>
</tr>
<tr>
<td>Experience in the construction industry</td>
<td>$-0.059$ 0.845 0.399</td>
</tr>
<tr>
<td>Education level</td>
<td>$-0.156$ 2.258 0.025</td>
</tr>
<tr>
<td>Number of employees</td>
<td>$-0.067$ 0.973 0.332</td>
</tr>
</tbody>
</table>

**CONCLUSION**

The H&S practices were valid and reliable and if used will inform South Africa construction SMEs of their H&S performance and reflect their H&S culture at project level. However, the demographic attributes namely; experience in the construction industry, education level and number of employees in the organization were poor predictors of the H&S practices. This study informs the construction SMEs that the suggested demographic variables should not be relied as predictors of H&S practices being implemented. The researchers, further recommends further study on other demographic variables of the respondents apart from those tested in this study.

**CONTRIBUTION OF THE STUDY**

The managerial contributions from this study are that this H&S practices can be used by South African construction SMEs at project level. However, the years of experience, the number of employees in the organization and educational level do not suggest that H&S practices will be used in the construction SMEs organisation.
REFERENCES


DESIGNING EQUATOR-FACING WINDOW FOR DIRECT SOLAR GAINS OPTIMISATION IN BUILDINGS

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4Department of Architecture, School of Environmental Technology, Federal Polytechnic, Bauchi, Nigeria

As solar gains play a vital role in influencing thermal environment in buildings, direct solar gains is the most influential of the three modes of transmission. So, optimising direct solar penetration through equator-facing window would aid in improving thermal performance of buildings during winter. This study seeks to investigate the effects of varying equator-facing window height on horizontal shading device size and the rate of change of radiation beam height (RBH). This study adopted the apparent sun-paths model described in Szokolay (2007) for this analysis. In varying the window height, calculated solar altitude was used to determine the shading device size and corresponding RBH while examining its rate of change. Results show that increase in window height increases the shading device size as well as corresponding RBH. However, the rate of increase of RBH diminishes with increase in window height indicating that optimising direct solar gains does not rely on largest window height. This study focuses on vertical aspect of the equator-facing window which requires only horizontal shading device for optimisation. However, it provides a basis for further research in modelling direct solar gains in buildings, and a useful means for architects to design equator-facing windows.

Keywords: direct solar gain, equator-facing window, façade, radiation beam, shading device.

INTRODUCTION

Since buildings are considered to contributor about 40% of global carbon emission (Edwards, 2015), research has been focused on passive control in buildings in order to maintain thermal comfort with minimal integration of active systems (Arif, Khan, and Alamgir, 2012). In architecture, thermal comfort is considered to be the most important factor in improving
Inusa et al

productivity in a work place – buildings (Arif et al., 2012; Athienitis, 2007; Mallawaarachchi, De Silva, and Rameezdeen, 2013). To achieve thermal comfort in buildings, the environment has to be regulated by controlling heat gain and loss to maintain thermal balance (Kim and Kim, 2009). In design, thermal control is approached in two ways – active and passive means (Olbina, 2005), with the passive approach being the first line of control. As the active control utilises mechanical systems for heating or cooling, designers rely on the passive control means to minimise energy use in buildings so as to reduce heating and cooling loads associated with these mechanical devices (Al-obaidi, Ismail, Malek, and Rahman, 2014; Olbina, 2005). As solar gains play a vital role in influencing thermal environment in buildings, direct solar gains is the most influential of the three modes of transmission; direct, indirect and isolated gains (Aelenei and Rodrigues, 2012; Kim and Kim, 2009; Lim and Gu, 2007; Torcellini and Pless, 2004; Zalewski, Lassue, Duthoit, and Butez, 2002). So, optimising direct solar penetration through equator-facing window would aid in improving thermal performance of buildings during winter (Kim and Kim, 2009; Lim and Gu, 2007; Torcellini and Pless, 2004).

It has been mentioned that in order to optimise direct solar gain, the total area of the equator-facing windows is required to be 30% of equator-facing façade (Athienitis, 2007; Olbina, 2005). However, nothing has been said on whether the window height or the width is the most important in optimising this radiation. How this 30% of the wall area as window opening can be shared between the window height and width has not been suggested. Varying the window width admits solar radiation in constant increment while varying the height admits this radiation in varying proportion, so it would be difficult to share the 30% without considering how varying the height affects horizontal shading device size which allows winter sun while blocking that of equinox and summer and corresponding radiation beam height (RBH) and its rate of change. Therefore, understanding the way the RBH increases with increase in window height with the intervention of shading device would aid in proportioning of the window opening for direct solar gains optimisation in buildings. This study seeks to investigate the effects of varying equator-facing window height on horizontal shading device size and the corresponding radiation beam height (RBH) and its rate of change with the view to determining how the window can be designed for direct solar gains optimisation in buildings.

The remaining sections of this paper indicate review of relevant literature to examine the parameters that can be considered in designing equator-facing window, and how they are interrelated to optimise direct solar gains in buildings. The approach adopted is presented to show how window height, shading device size and RBH are mathematically related. Thereafter, the results of the analysis of the effect of varying equator-facing window height on the shading device size and the corresponding RBH and its rate of change reported. These are then discussed to show the implication of the relationship of these parameters on direct solar gains
optimisation in buildings. The final section then recounted on what has been presented and draws a conclusion on the topic.

**LITERATURE REVIEW**

Since designing equator-facing window is critical for direct solar gains optimisation in buildings, it is necessary to identify the design parameters that when appropriately estimated will improve this window. These parameters are identified and the most critical ones that influence direct solar penetration into building to optimise the gains are considered in the review of articles written by Arens et al. (2014); Arif et al. (2012); Athienitis (2007); Kim and Kim (2009); Szokolay (2007); Torcellini and Pless (2004); and Tsangrassoulis, Geros, and Bourdakis (2006).

The accounts by Arens et al. (2014); Athienitis (2007); Torcellini and Pless (2004); and Tsangrassoulis et al. (2006) altogether offer a full list of the design parameters considered for optimising direct solar radiation through windows. Arens et al. (2014) describe the use of solar calculator (SolCal) to estimate the effects of solar radiation on occupant’s comfort. They estimated level of window shading needed to prevent unacceptable predicted mean thermal sensation vote (PMV) increases for occupants near windows. They state that an occupant’s PMV increase caused by short-wave solar radiation can be used to determine the shading required of the glass and window shades, and suggested that “the transmission of glass plus shades together probably should not exceed 15% if the sun will be shining on an occupant indoors” (p 8). Athienitis (2007) describes a two-storey building considered to be zero-energy building with five major renewable energy features. One of these features is “direct gain passive solar design that emphasizes utilization of distributed thermal mass in the south-facing part of the ground floor”. He described the design of the building and then presented the preliminary results of the first year of the building operation. Having integrated Trombe walls into the envelope of two selected buildings, Torcellini and Pless (2004) analyse the energy performance of the buildings. They analyse “measured electrical end uses, Trombe wall temperature profiles, and thermographic pictures” in order to establish the thermal performance of the walls. Tsangrassoulis et al. (2006) demonstrate how genetic algorithm combined with simplistic calculation can be applied at initial design of south (equator)-facing façade to estimate window size, glazing thermal and optical properties, and shading.

Similarly, Arif et al. (2012); Kim and Kim (2009); Szokolay (2007) present some parameters which were earlier identified. Arif et al. (2012) investigated the potential effects of orientation as a solar passive design strategy on indoor temperatures, and presented a model for predicting indoor temperatures in terms of the surrounding temperatures. They tested a single room module by measuring the indoor temperatures for eight different orientations, rotating the plan at 45° in each case. They establish that indoor temperatures vary with orientation for different
seasons, the strategy can be employed to predict cooling and heating for thermal comfort in buildings, and that optimised orientation could aid in design for energy efficiency at national level. Kim and Kim (2009) developed an experimental external shading device to improve daylighting, thermal performance and view in buildings. The building in which the shading device is tested was simulated and measurements taken “to verify the differentiated advantages in illumination” of back space and building energy consumption while maintaining a clear view. They analysed results of the experiment to show the extent to which the shading device contributes in reducing lighting, heating and cooling loads.

Szokolay (2007) describes sun-earth relationships thereby establishing “conceptual background” leading to the provision of “working tool for the assessment of overshadowing and sun penetration into buildings”. He focuses on the design of shading devices, which so much depends on the solar geometry.

In their paper, Aren et al. (2014) identify two window design parameters that can be determined by occupant’s PMV increase caused direct solar radiation. Although how they are related is not directly contextual to the paper, these parameters are glass transmittance property and window shading device which relate to amount of incident solar radiation, sun's altitude and azimuth.

Citing Carpenter and Mc-Cowan (1998), Arif et al. (2012) mentioned that “the south orientation with a tendency for west was found to be the optimum for cold and temperate climates”. However, they did not explicitly mention in their discussion or conclusion the orientation that could provide optimum results for thermal comfort. It can be deduced that the south (equator-facing) orientation offers the benefit of achieving optimal performance.

In describing the design of a two-storey single family zero-energy building, Athienitis (2007) mentions south (equator-facing) façade, aspect ratio and solar roof as the main feature for optimising form. He further states that “the direct gain system is the major solar energy capture and utilization system of the house”. This system can be optimised, while adequately sizing all windows, in relation to “distributed thermal mass”. This is relevant to this review because it identifies window size as a key parameter for optimising direct solar gains in building.

Kim and Kim, (2009) state that advanced numerical studies were carried out in which optimised shading device design criteria to reduce loads for lighting, heating and cooling were established. Also, they state that size (projection depth) is the most important parameter for the design of shading device in daylighting performance, and that optimisation of this size had been established by considering solar altitude and incidence angles in critical seasons. They lay emphasis on the equator-facing window which shows promising features in terms of direct solar radiation optimisation in buildings.

Szokolay (2007) identifies façade orientation and vertical shadow angle (VSA) as critical parameters for the design of shading device, and the VSA
which is equal to the solar altitude determines the shading performance of the device. He establishes three steps to consider in designing a shading device; identification of overheated period, establishment of shadow angle (horizontal or vertical) and design of the device to satisfy these conditions. The VSA helps to establish equator-facing external shading device size which is also related to window height.

Torcellini and Pless (2004) mentioned that Trombe wall could be integrated along with windows, eaves and other elements to control solar gains. Window position and orientation and eave projection (also shading device size) are parameters that function together to regulate the amount of solar radiation that penetrates directly into the building. The direct solar radiation is allowed during winter and blocked during summer when the window faces the South or North (equator) when in the Northern or Southern hemisphere respectively.

Tsangrassoulis et al. (2006) suggest that passive solar techniques (design) should consider shading device or window size to avoid overheating during summer period so as to increase direct solar gains in winter while maintaining adequate daylight. They identify window length and height, glazing solar transmittance and U-value, and overhang (shading device) width as the design parameters to be estimated to optimise direct solar gains in buildings.

Although different approaches were considered, Arens et al. (2014); Arif, et al. (2012); Athienitis (2007); Kim and Kim (2009); Szokolay (2007); Torcellini and Pless (2004); Tsangrassoulis, et al. (2006) attempt to show the relationships among the window design parameters in order to optimise direct solar gains to reduce heating, cooling and lighting loads thereby improving thermal and daylighting performance.

However, it is imperative to examine the robustness of these literatures in order to buttress their strength to this critical review. Aren et al. (2014) show convincingly the limit transmission of window glass and shading of direct solar radiation should not exceed to avoid occupant’s thermal discomfort. But they do not contextualise to indicate instances when direct solar radiation may be required (for example, in winter). Also, Arif et al. (2012) suggest that orientation as a passive solar design strategy can play prominent role in energy efficient building design thereby achieving sustainable development. Consequently, their results do not suggest which orientation is optimum. In the same way, Athienitis (2007) shows convincingly how the basic principle of sizing equator-facing window area is reflected in a “two-storey single family detached solar home located in Montreal”. It is indicated in the design that the equator-facing window as proportion of the equator-facing façade is 30%. Kim and Kim (2009) show that the experimental external equator-facing shading device has shown promising results by providing 50% illumination performance than the conventional device, and 20% and 12% reduction in cooling and heating loads respectively, although, these are just in the context of South Korea, but the results may look different for other locations. In addition, Szokolay
Inusa et al. (2007) presents how the sun relates to the earth, and how this relationship is used to establish solar altitude and orientation that is useful in optimising sun’s penetration into buildings. Torcellini and Pless (2004) state that a Trombe wall provides passive solar heating in buildings while excluding light and glare, and that shading is required to minimise heat gains in summer. Tsangrassoulis et al. (2006) show convincingly that in complex situations window size, glazing transmittance and U-value, and shading device size can only be adequately estimated using a more general method like genetic algorithm.

In reviewing the question of what design parameters that when appropriately estimated can improve equator-facing window for direct solar gains optimisation to improve thermal performance in buildings, seven literatures were critically reviewed. These literatures help in identifying four window design parameters. Window size, glazing thermal and optical properties, and shading device size are design parameters that can relate to one another in order to optimise direct solar gains in buildings during winter (Arens et al., 2014; Athienitis, 2007; Kim and Kim, 2009; Szokolay, 2007; Torcellini and Pless, 2004; Tsangrassoulis et al., 2006). When these parameters are adequately estimated for the equator-facing façade, they can optimise direct solar gain thereby reducing cooling load in summer and heating load in winter. Orientation is one of the parameters considered in window design with much emphasis on equator-facing window (Arif et al., 2012; Athienitis, 2007; Torcellini and Pless, 2004; Tsangrassoulis et al., 2006).

Although the reviewed literature identify four essential window design parameters and mention their relevance in reducing cooling, heating and lighting loads, they however fail to show how window height and shading device size relate, and subsequently determine the amount of solar radiation that could penetrate through the equator-facing window into the building. Therefore, this research focuses on equator-facing orientation with much consideration to window height and its effects on shading device size, and radiation beam height (RBH) and its rate of change.

**RESEARCH DESIGN AND METHOD**

This study adopted the apparent sun-paths model described in Szokolay (2007) for this analysis. The apparent sun paths are routes the sun follows during sun-rise and sun-set periods. The major sun paths have been identified to be those of equinoxes, mid-summer and mid-winter (Szokolay, 1999, 2007). The earth-sun relationship in terms of heliocentric and lococentric views formed the basis of the description of the apparent sun-paths model. While lococentric view represents the idea in which a location is considered to be the centre of a celestial dome with sun rising from the east and setting at the west, and the sun’s apparent position is given by altitude and azimuth.
Heliocentric view shows the seasonal variations in apparent sun paths presenting different solar altitudes at mid-summer, equinox and mid-winter (see figures 1 and 2). On the equinox days, the sun rises from east at exactly 6:00 hr and sets in the west at 18:00 hr, and it reaches an altitude (ALT) of 90° – |LAT| at 12:00 noon, when zenith angle is the same as latitude (LAT) (Szokolay, 2007). From this position the sun’s altitude increases by 23.5° at mid-summer and decreases by 23.5° at mid-winter (Szokolay, 1999). This altitude was considered for the design of shading device of the equator-facing window to give automatic seasonal adjustment that would allow winter solar radiation beam and block equinox and summer sun (Szokolay, 1999). “...at equinox the noon altitude line coincides with the sectional view of the sun-path, indicating that the vertical shadow angle (VSA, for an equator-facing window) will be constant for the whole day” (Szokolay, 1999:50).

![Figure 1: Apparent Sun's Position](source: Szokolay (1999:39, 2007:6)

![Figure 2: Annual Variation of the Apparent Sun Paths](source: Szokolay (2007:8)
Adopting this model for this study, the window height was varied to see the effects on shading device size (projection) and corresponding radiation beam height. As the solar altitude at equinox (SA_e) coincides with VSA of the shading device, the equator-facing window height (h) together with SA_e alternate angle to θ_e were used to calculate the shading device size (P) (figure 3). Similarly, the shading device size, the window height and the solar altitude at mid-winter (SA_w) alternate angle to θ_w were used in calculating the RBH (figure 4), and subsequently its rate of change.

For a location of given latitude (LAT),
Solar altitude at equinox (SA_e) = 90° − |LAT|  

From figure 3, P = h ÷ tanθ_e

Where h = window height, θ_e = SA_e.
From figure 4,

\[ \text{RBH} = h \cos \theta_w \cos \theta_w \tan \theta_w - (P + W) \cos \theta_w \tan \theta_w \] \hfill -3

Solar altitude at mid-winter (SA_w) = \theta_w - 23.5^\circ \hfill -4

Where \( P \) = shading device size (projection), \( W \) = wall thickness, and \( \theta_w = SA_w \).

Therefore, these formulae were applied to calculate the shading device size and corresponding RBH by varying the equator-facing window height from 0.6 to 3.0 m at 0.3 m intervals. The rate of change of RBH for each change in the window height was then calculated. The results were presented for the different values of window height while considering latitudes 10\(^\circ\), 20\(^\circ\), 30\(^\circ\), 40\(^\circ\) and 50\(^\circ\) N or S.

**RESULTS**

To investigate the effect of varying equator-facing window height on horizontal shading device size, and corresponding RBH and its rate of change, the RBH was calculated for each value of \( P \), and the rate of change of RBH was determined as the ratio of increase in RBH and the RBH as \( h \) increases.

Table 1 shows the calculated values of shading device size and corresponding radiation beam height with its rate of change for varying equator-facing window for latitude 10\(^\circ\). Using calculated solar altitude at equinox (SA_e) which is 80\(^\circ\), the value of optimal shading device size (\( P \)) was determined for each window height (\( h \)). As the sun moves down 23.5\(^\circ\) at mid-winter, solar altitude decreases to 56.5\(^\circ\) forming the basis for the calculation of the RBH at mid-winter for the same location. These results show that as the window height was varied from 600 mm to 3000 mm at 300 mm interval, the shading device size increased along with the corresponding RBH while its rate of change diminished.

**Table 1: Window Height, Shading Device Size and RBH for Latitude 10\(^\circ\)**

<table>
<thead>
<tr>
<th>Window height, h (mm)</th>
<th>Shading size, P (mm)</th>
<th>Radiation beam height, RBH (mm)</th>
<th>Rate of change of RBH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>600</td>
<td>900</td>
<td>1200</td>
</tr>
<tr>
<td>Shading and RBH Elements</td>
<td>105</td>
<td>158</td>
<td>211</td>
</tr>
<tr>
<td>Shading size, P (mm)</td>
<td>56</td>
<td>177</td>
<td>299</td>
</tr>
<tr>
<td>Radiation beam height, RBH (mm)</td>
<td>2.17</td>
<td>0.68</td>
<td>0.41</td>
</tr>
</tbody>
</table>

Table 2 shows the results of the shading device size in millimetres as determined for various latitudes as indicated. The calculations were done in the same way (using formula 2) as applied in table 1, and the solar altitudes at mid-winter for these latitudes were 56.5\(^\circ\), 46.5\(^\circ\), 36.5\(^\circ\), 26.5\(^\circ\) and 16.5\(^\circ\) respectively. As the window height was varied and with
increasing latitude, the horizontal shading device became excessively large.

### Table 2: Shading device size (mm)

<table>
<thead>
<tr>
<th>Latitude</th>
<th>Window height (mm)</th>
<th>600</th>
<th>900</th>
<th>1200</th>
<th>1500</th>
<th>1800</th>
<th>2100</th>
<th>2400</th>
<th>2700</th>
<th>3000</th>
</tr>
</thead>
<tbody>
<tr>
<td>10°</td>
<td>105</td>
<td>158</td>
<td>211</td>
<td>264</td>
<td>317</td>
<td>370</td>
<td>423</td>
<td>476</td>
<td>528</td>
<td></td>
</tr>
<tr>
<td>20°</td>
<td>218</td>
<td>327</td>
<td>436</td>
<td>545</td>
<td>655</td>
<td>764</td>
<td>873</td>
<td>982</td>
<td>1091</td>
<td></td>
</tr>
<tr>
<td>30°</td>
<td>346</td>
<td>519</td>
<td>692</td>
<td>866</td>
<td>1039</td>
<td>1212</td>
<td>1385</td>
<td>1558</td>
<td>1732</td>
<td></td>
</tr>
<tr>
<td>40°</td>
<td>503</td>
<td>755</td>
<td>1096</td>
<td>1258</td>
<td>1510</td>
<td>1762</td>
<td>2013</td>
<td>2265</td>
<td>2517</td>
<td></td>
</tr>
<tr>
<td>50°</td>
<td>715</td>
<td>1072</td>
<td>1430</td>
<td>1787</td>
<td>2145</td>
<td>2502</td>
<td>2860</td>
<td>3217</td>
<td>3575</td>
<td></td>
</tr>
</tbody>
</table>

Also for the same locations, table 3 shows the results of calculated RBH in millimetres corresponding to the shading device size in table 2 for varying window height. Formula 3 was applied in this case. This indicates that the RBH increased as the window height was increased and the latitude as well.

### Table 3: Radiation Beam Height, RBH (mm)

<table>
<thead>
<tr>
<th>Latitude</th>
<th>Window height (mm)</th>
<th>600</th>
<th>900</th>
<th>1200</th>
<th>1500</th>
<th>1800</th>
<th>2100</th>
<th>2400</th>
<th>2700</th>
<th>3000</th>
</tr>
</thead>
<tbody>
<tr>
<td>10°</td>
<td>56</td>
<td>177</td>
<td>299</td>
<td>420</td>
<td>542</td>
<td>663</td>
<td>784</td>
<td>906</td>
<td>1028</td>
<td></td>
</tr>
<tr>
<td>20°</td>
<td>92</td>
<td>219</td>
<td>347</td>
<td>474</td>
<td>601</td>
<td>728</td>
<td>856</td>
<td>983</td>
<td>1110</td>
<td></td>
</tr>
<tr>
<td>30°</td>
<td>143</td>
<td>281</td>
<td>419</td>
<td>557</td>
<td>695</td>
<td>833</td>
<td>972</td>
<td>1110</td>
<td>1248</td>
<td></td>
</tr>
<tr>
<td>40°</td>
<td>212</td>
<td>368</td>
<td>525</td>
<td>681</td>
<td>837</td>
<td>993</td>
<td>1149</td>
<td>1305</td>
<td>1461</td>
<td></td>
</tr>
<tr>
<td>50°</td>
<td>308</td>
<td>495</td>
<td>681</td>
<td>867</td>
<td>1053</td>
<td>1239</td>
<td>1425</td>
<td>1611</td>
<td>1797</td>
<td></td>
</tr>
</tbody>
</table>

### Table 4: Rate of Change of Radiation Beam Height

<table>
<thead>
<tr>
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<th>1200</th>
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<tbody>
<tr>
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<td>-</td>
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<td>-</td>
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<td>0.58</td>
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<tr>
<td>30°</td>
<td>-</td>
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<td>0.25</td>
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<tr>
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<td>0.13</td>
<td>0.12</td>
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</tr>
</tbody>
</table>

In addition, Table 4 presents the values of the rate of change of the RBH for all 0.3 m increase in window height. This rate of change of RBH is expressed as the ratio of the increase in corresponding RBH to the RBH (see table 3). This shows that with varying window height and increasing latitude, the rate of change of the RBH diminished becoming minimal with larger windows.

As a unit, the equator-facing window was designed while considering it height and horizontal shading device size, and the height of radiation beam that penetrates the window at mid-winter determined. Comparing
these results, the implications of the relationship among the window height, shading device size and RBH as well as its rate of change on direct solar gains optimisation in buildings were discussed.

DISCUSSION

Having considered some critical window design parameters in reviewing the literature, no data clearly indicates how the equator-facing window height relates to horizontal shading device size and direct solar radiation beam height. Therefore, this study was designed to investigate the effect of varying equator-facing window height on shading device size and corresponding radiation beam height (RBH) along with its rate of change in order to determine if direct solar gains optimization depends solely on the largest window height.

The shading device size and corresponding RBH increased as window height was varied indicating that the direct solar gains in building can increase. For different latitudes and as the location is further from the equator, the shading device size increased becoming excessively large which indicates its impracticability as a single unit unless split. From $30^\circ$ to $50^\circ$ latitudes, the shading device sizes ranged between 1000 and 3600 mm which as cantilever may be impracticable. However, the rates of change of RBH diminished as window height was varied for different latitudes and as these locations were further from the equator indicating that optimising direct solar gains does not depend on the largest window height. By these results, the optimum window height falls between 2400 mm and 2700 mm as further increase indicates almost constant rate of change of RBH – between 0.12 and 0.13.

This combination of findings provides some support for architects and building designers in the industry to conceptualise design of equator-facing window in which the height plays prominent role in determining the size of horizontal shading device as well as the amount of solar radiation penetrating through the window into the building in winter. Also, the implication for policy is that building regulation authorities could consider the results as bases to draw out guidelines for assessing equator-facing window size for optimum solar gains and daylighting in buildings. In addition, the findings provide researchers in the built environment the grounds to hypothesise in order to undertake further research in determining the exact equator-facing window height and width in relation to the wall area for optimum direct solar gains in winter. In future investigations, it might be possible to also consider climatic factor in this analysis in order to determine the amount of solar radiation gained for each situation.

CONCLUSION

This paper has explained the central importance of varying window height in designing equator-facing window for direct solar gains optimization in
buildings. Optimum window area (width x height) was considered to be 30% of the area of the equator-facing façade, but it was not clear how these could be split between the width and the height. Relevant literatures were reviewed to identify design parameters that were considered to be important in designing windows. Equator-facing orientation, window height and shading device size were considered to be the most influential for direct passive solar design. This research was designed and the method explained while the results were presented and discussed.

The purpose of this study was to investigate the effect of varying equator-facing window height on shading device size, and corresponding radiation beam height and its rate of change in order to determine if direct solar gains optimisation in buildings depends on largest window height. Findings show that in general the shading device size and corresponding RBH increase as equator-facing window height varies. However, the corresponding rate of change of RBH diminishes with such increase in window height. These results suggest that in the design of equator-facing window optimising direct solar gains in buildings does not rely on the largest window height. Therefore, the findings contribute to how the 30% of the equator-facing façade area can be used to apportion the window width and height by considering the optimum height – not the largest height.

This study focuses on vertical aspect of the equator-facing window which gives automatic seasonal adjustment as well as requires only horizontal shading device for optimisation. Moreover, further research is necessary to model the amount of direct solar radiation (while considering climatic condition) that passes through the equator-facing window into the building. However, the study provides a basis for further research in modelling direct solar gains in buildings, and a useful means for architects to design equator-facing windows.

REFERENCES


DETERMINANTS OF OFFICE RENTS IN ACCRA, GHANA

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United Kingdom

This paper examines determinants of office rent in Accra, the capital city of Ghana. Rent determinants are a well-researched topic by a wide range of specialist disciplines. Although existing studies have identified a number of factors that explain determinants of office rents, some factors are unique to certain cases. In Ghana, economic restructuring from the mid-1980s and globalisation have contributed to growing interest in the country as an attractive location for international businesses, firms and organisations. This has led to rising demand for office space and caused rents to increase, especially in Accra. To accommodate growing demand in the short term, property owners often convert residential buildings into other uses. In the medium term, office space development activities increased. Yet, office rents in the city are still high. This paper attempts to ascertain the factors that influence office rent rate in Accra, and what the consequence are in the long term. Following an introduction to the paper, the second section presents a brief discussion of the approach to the paper before a review of studies on determinants of rental rates is undertaken in the third section. In the fourth section the relationship between economic development and demand for office space in Accra is examined. This is then followed by a presentation on demand and supply data on Accra office market, consisting of data collected from office space providers and managers, and interviews with office users, developers and investors. Relevant variables are analysed to establish trends and rent determinants in the office market. The study shows that although there are supply constraints and increasing demand issues, these alone do not sufficiently explain the high office rents in Accra. There might be issues relating to speculation inhibiting factors requiring policy interventions to stabilise the office market in Accra.

Keywords: Accra, office rent, real estate, rent determinants

INTRODUCTION

In Ghana, real estate is one of the largest components of wealth. Housing in particular is a major motivation for household saving and significantly influences household consumption (Karley 2008). The ratio of commercial real estate is also growing gradually within this sector. Many of the office buildings available before the 1980’s economic restructuring were state owned. However, these buildings were not able to meet user’s demand and

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in many cases fell short of users’ requirements. The increased demand for office space led to sharp increases in rents. In the short term, residential buildings were converted into other uses including offices, retailing and even for industrial purposes. Yet, this did not slow down rising rents, and in some cases they posed health and safety hazards for users.

Recognising the long term need for more purpose-built office spaces, both state agencies and the private sector were encouraged by the enabling environment stimulated by the structural reforms to participate in this market. The state entered the market through its agencies such as the Social Security and National Insurance Trust (SSNIT) as investors, mainly in the office sector. The private sector participants were predominantly investors and/or developers in office and other sectors of the property market. Although there has since been a significant level of activities in the market, one would have expected a moderate level of office rents. Yet, rents in Accra are among the highest when compared to other cities in the region and other parts of the world as illustrated in Figure 1.

![Figure 1: Indicative monthly rentals for office in 2013*](image)

* Rentals are gross and reflect prime space of 80 to 100 m²

Source: BROLL (2013)

**STUDY APPROACH AND METHODOLOGY**

To establish trends and determinants of rental values in Accra, a good set of data and information are needed to draw a clearer picture. However, due to paucity of data required, a modest approach is used in this paper. The paper employed two methods as outlined here. First, an update of academic literature is carried out. This consisted of a comprehensive and systematic literature review, focusing on the office rent determinants as well as existing information on historical development and pattern of office development in Accra. A review and analysis of official statistical...
information about the numbers, location, type of investors and users, is undertaken. Secondly, data and information collected through interviews and discussions with stakeholders also formed a key part of the research. The discussions with targeted official representatives in the industry such as BROLL (an office management company), Users, e.g. insurance companies etc. to discuss broader issues of office demand, supply and impact on rents.

Before assessing the determinants of office rents in Accra one needs to know what office rent determinants exist in general, and how they manifest in the market.

**REVIEW OF OFFICE RENT DETERMINANTS**

Determinants of office rent is well researched and documented by several studies with different emphasis (for examples Clapp and Giacotto 1992; Dunse and Jones, 1998; Dunse and Jones, 2002; Long, 2012; Baker, 2012). In more recent studies, Long (2012) emphasised the impact of lease terms on commercial rental values and Baker (2012) highlighted the impact of several different factors. According to Baker (2012), different factors prevail in different situations. It is understandable why these studies have identified variable determinants of office rents. If these factors prevail at the same time, a perfect market scenario will occur. Effectively, this will create a major impact of high performance in the affected office market. This is a hypothetical case, which does not happen anywhere in the office market. Indeed, there is no such a perfect market in micro or macroeconomic context.

The common factors identified from the literature include location, highest and best use, cyclical demand, marketing time, market driven value, site improvements, lease value, financing, vehicle impact, demographics, competition, taxation issues, zoning, creative sales/leasing methods, multipliers and “rules of thumbs”, income (appraisal) approach to value, market (appraisal) approach to value, cost (appraisal) approach to value and net lease value. Jowsey (2011) explains why different attributes must be taken into account in rent determination. That both micro and macroeconomic factors affect values of office rents. Whilst influences on the capital and income structure within a sector, region, city or office grade can be analysed, the individual property’s characteristics such as size, age, quality etc. must be assessed. Thus the questions that need to be answered include: Is there demand for this location? How much supply is currently in the area? What is the age of this building? Does it meet current environmental standards? And so on. In a nutshell, variations in outcome of studies of office rent is caused by attributes of different geographical locations as well as characteristics in relation to the nature of economies; building attributes; varying contractual arrangements; and even government policies. These parameters are now used in reviewing determinants of office rents.
Economic factors

In simple microeconomic terms, the determination of office rent rates is about demand and supply. On one hand demand relates to wants and is only limited by peoples’ ability and willingness, whilst supply is limited by the resources and technology available (Sloman 2006). On the other hand rental values are the market price (per annum) of occupying property. Thus, as market price is determined by interaction of demand and supply, so is rental value. Office space as commercial property is a factor of production. Fraser (1993) observed that demand for office space as a factor of production is derived demand. Office buildings are usually occupied by professional, banking, financing, and other administrative and management users. These users require space to help in the provision of services required by other economic entities. So the demand for additional space depends on the demand for goods and services produced when combined with other factors of production. Also a shift in the stage of market and/or industry development could have impact on associated space requirements and rental values. For instance, an economy moving into or dominated by service activities or an industry potentially moving into the growth phase of its business life cycle, would lead to an increase in demand for office space and possibly an increase in rents.

In assessing the impact of economic fundamentals on office demand, Barras (1994) asserted that real GDP is the most appropriate and widely used demand side measurement at an aggregate level. That real GDP gives a broad indicator of office activity, both for manufacturing and service sectors of the economy. The fact is, demand for goods and services are sensitive to changes in disposable income, which is affected by macroeconomic variables such as real wages, interest rates etc. So the level of occupation demand for office is influenced by general economic conditions.

Henneberry and Gardiner (1991) examined determinants of real office rent within standard geographical regions in the UK for the period 1977-84. They found regional GDP to be the most significant of all the demand-side measures included in the analysis. The other variables identified in the study were service sector employment and average income. Similar results were obtained in a study by Giussani and Tsolacos (1993). These views are supported by recent studies in the UK (UBS 2012), which discovered that demand for space in office, retail and logistics sectors slowed down considerably due to the weakening of the UK economy. Capital Economics (2015) highlighted the impact of economic variables such as real consumer spending, employment rate and GDP on the rental values in office sectors. Thus, office serves all aspects of the economy and so the demand and rent tend to be in line with the economy performance (Fraser, 1993).

Wheaton et al (1997) suggested that the driving factor of office space demand is employment in selected sectors of an economy. This study tracked employment growth in the finance, insurance, business and professional services. With an increase in employment, there is a need for additional office space to accommodate them. This leads to a greater
demand for office space and in turn results in higher rental values. This claim is supported by GVA Grimley’s Economic and Property Review (2012), which asserts that when employment growth increases it is a particularly good news for the property market especially office sector.

Given the level of demand, a suitable level of supply is required to bring the market into equilibrium. Supply in the office market is measured by the level of current stock and new property coming onto the market. Supply depends on the resources available in respect of land, labour and capital. Vacancy being a function of both demand and supply is the amount of empty space that is available for let. Clapp, J. and C. Giacotto (1992) found out that vacancy levels are among the most important drivers of rental rate formation.

In times of high demand (and low availability of supply), vacancy rates should naturally be low leading to a rise in the rental rate. The reverse scenario has the opposite effect in that a high vacancy allows a lessee to exert downward pressure on the rental agreement. Also, understanding of the property cycle and the amount of supply scheduled to come onto the market helps in rent determination. For example, if the economy shifts into a boom phase where demand is strong, then the pressure to provide more supply into the market is strong. However, the inelasticity of supply immediately will put upward pressure rent rate. An area of land should naturally appreciate in value if it is released or regenerated to provide supply onto the market (Clapp, J. and C. Giacotto (1992). This is particularly true where demand is already high with low supply in the market. However, Wheaton et al (1997) has shown that the timing of the release in the property cycle will impact on the scale of the valuation especially if there is low demand with already sufficient supply in the market.

By comparing with industry, the planning and construction period of office is the longest (McCann, 2003). Office have longest supply lag as development pipeline may contain projects that could add significantly to future supply. In the short term, owing to supply lag, office development is unable to react to changing market demand. As supply is ill-equipped to satisfy the immediate demand it can result in rising rent. In the investment market property is an asset amongst competing assets, and the proportion of a portfolio held in property will be influenced by the values and potential of rival assets, inflation, and the need for portfolio ‘balance’. The amount of investment demand and supply activities in the office sector of the property market could impact on the rental rate (Keogh 1994).

Finally, the cost and availability of owner-occupied premises will tend to affect the demand for rented spaces. So firms contemplating buying as an alternative to leasing will take account of the relative cost, particularly the cost and availability of finance (for purchase), expectations for future rental growth, and taxation relief on rent and interest payment.
Location factors
Location for every business is an important decision. A business searches
for a property that best serves their needs. The ability to service employees
and customers in an efficient manner means that businesses will develop
in certain locations to take advantage of certain factors. The classical
economists (Riordanian) explanation of land rent assumed land is
homogeneous, and the market in equilibrium does not change with supply
conditions in the long run (Evans et al. 2004).

Contrary to Riordanian beliefs, decisions of office location are affected by
certain location attributes such as transportation and interactions costs,
quality of the environment and agglomeration economies (Goddard, 1975;
Evans, 1985; Ball et al., 1998). Moreover, as postulated in Von Thunen's
model, rent values fluctuate with distance from a main commercial centre,
which means the office location could be determined by a "trade off"
between transportation cost and distance to the CBD. Alonso in 1964 also
emphasised a negative rent gradient with distance from the urban centre.
But Jones and Dunse and Jones (2002) have shown that rents could
increase away from the CBD on approach to major highways and
motorways. This is a factor of accessibility and relates more to location of
industrial warehouses.

In assessing location specific price determinants, Bollinger et al (1998) find
that nearness to concentrations of office workers exerts a positive impact
on office rent levels in the Atlanta area. Agglomeration could be enhanced
by spatial concentration and composition of population in certain areas. So
industries requiring certain skilled labour may agglomerate their
businesses into an area which forms an enclave. This shows that
agglomeration of industry in a purpose built or business efficient area
could result in high demand and so will rent increase. For example, over
the past three decades there was a major shift of single professional
households and R&D workers towards the South East of England. This
created an increase in demand for, high-tech office units as well as smaller
units of 1/2 bedroom housing in this region. Adjacent effects (externalities
and spill over effects) to the geographic location of office property relative
to public transportation infrastructure and hub have also been observed
(Clapp 2003). Finally, some studies have included the latitude and
longitude coordinates as well as heights of buildings in hedonic modeling
of office rent. This approach was applied for instance by Clapp (2004). The
number of storeys of a building and the availability of panoramic views
and the potential landmark status for very tall buildings tend to impact
positively on rental rates.

Building attributes
There is no substitute for land and property in general. For example, an
office is not a substitute for a shop; offices without air-conditioning are not
regarded as an adequate substitute for air-conditioned premises by most
firms in the financial services. The capacity to substitute property for
another is confined by the need to match individual characteristics,
example, in terms of size, design and layout, age and technology, amenities
in each building to match individual tenant requirements. Besides location, office occupiers are sensitive to certain building attributes that they may be willing to pay higher rent for. So property that meets, among others, these requirements would be in high demand and could lead to higher rental values.

It is expected that tenants pay a high premium for convenience to access amenities in the building, which are perceived as good. Building age could be used as proxy for quality. Slade (2000) and Dunse et al (2002) observed that constructed or renovated building had positive impact on rental rates. Ho et al (2005) also reported that functionality, services, and overall amenities are important in assessing office building quality.

Space size is also critical to some tenants. Assessing determinants of rent in the Atlanta office market, Bollinger et al (1998) have shown that large tenants are often willing to pay a rent premium for sizeable units of contiguous office space that enable their internal operations to run more smoothly than a situation with several scattered locations.

Technological factors play important role in the nature of business activity and demand for space. For example, the introduction of microcomputers into most office-based activities in the UK since the 1980s had an effect on office floor space demand (Fraser, 1993). This led to an increase in demand for offices able to accommodate suspended ceilings and raised flooring, behind which cabling and services are housed. Offices without such facilities have become functionally obsolete.

**Contractual and policy factors**

Lease terms associated with commercial property space are important to the tenant. Hendershott, et al (1999) highlighted a number of key characteristics of the office rental contract in the UK, which include long term, an upwardly only rent escalation clause and other onerous tenant responsibilities. Businesses would always seek tenancy agreements that suits their business needs but during periods of economic uncertainty, costly clauses perceived as onerous are likely to discourage potential tenants and as such this could have negative impact on rent rates.

Government policies may have impact on office rents via a number of routes. Starting with urban land planning and use policies, policies that restrict release of land, such as green belt etc. may affect supply of land development. If the government has no proposal to allow new offices to be constructed through the availability of licences for land development, then this will lead to a decrease in supply. If this remains in place, for example, in an expanding economy, it will lead to a rise in office rents. However, a release of further supply through capital expenditure for refurbishment of current dwellings to compete with new supply could lead to moderation in rents. Red tape associated with planning permission and development permits could also affect the time of delivery of required office space. Consequently, the associated costs are passed on to the end user in the form of high rents/prices, densities, and smaller lot sizes.
The effect of tax relief policy on office rent cannot be overemphasised. When industries are provided incentives, rebates or subsidies for the production of goods or services, it affects profitability of the business. For that reason, firms may consider taxation relief on rent and interest payment when deciding on building space usage – that is, they may consider whether to be owner occupier or a tenant. This affects the desire or not for office space supply to increase. At the same time, the requirement for more or less office space as part of a firm’s portfolio and/or balance sheet affects office space supply. Thus, the way the regulatory and tax aspects of an industry are applied may affect how rents are set.

Growth trend and impact on demand for office space in Ghana
Ghana is a developing country with an estimated population of 25 million in 2013, from population of 6 million in the 1960s. There is an increasing trend in urban population as depicted in Figure 2(a), which presents the Urban Population as percentage of total population.

![Figure 2 (a): Urban Population as Percentage of total population, 1960 to 2011](image)

Global Finance Ghana Country report (February 2013)

The country is well known for its commodities: gold and cocoa production. In addition, is a recent discovery an oil drilling off the shores of the country in the Atlantic Ocean, which begun during 2010. The country is perceived as relatively stable politically and socially compared to others in
the sub-Sahara Africa region (SSA). Ghana’s economy has improved dramatically; well-endowed with natural resources, a competitive business environment and sustained reductions in poverty levels and increasing trend in per capita income of over US$1600 in 2011. Ghana is now recognised as the world’s 16th fastest growing economy on the IMF’s World Economic Outlook (2013). Some are even going as far as to describing Ghana as the ‘Switzerland of Africa’. Figure 2(b) shows the real GDP growth data for the past decade. Macroeconomic developments since 2001 suggests significant gains have been made in the economy, with economic growth currently at 8.8% and inflation coming down to single digits at 9.8%.

Economic growth in Ghana was above 10% in 2014, though this is far from the almost 14% achieved in 2010. This is well above the predicted growth rates of most economies in the region. The peacefully held general elections in December 2012 also highlighted the country’s potential and prompted further economic growth. So much so in fact, that many advanced-nation businesses are currently looking to Ghana for investment opportunities, the Canadian Business Delegation being the most recent.

Global Finance Ghana Country report (February 2013)

It is important to highlight the impact of the modernisation process that accompanied Ghana’s structural adjustment programmes (SAP) three decades ago. These reforms brought about financial assistance from the IMF, World Bank and other international Finance Corporations. The reforms caused an upturn in the industrial output, investment and service sector growth. From a predominantly agricultural based economy after independence in 1957, Ghana’s tertiary sector has now achieved significant growth (World Bank 2013). For example, accounting for only a third of GDP in 2000, the service/tertiary sector now accounts for over 50% of GDP as portrayed in Figure 3. During the early years of 2000 percentage share in GDP largely composed of Agriculture. However, by 2012, the service sector contribution to GDP had exceeded 50% and is set to continue growing. Analysis of the working age population by industry
reveals a generally increasing trend in employment opportunities in the service sector, which tends to require office spaces. Over two third of increases are noted to be in the greater Accra region GSS 2013).

It is interesting to note that Accra’s ranking in terms of number of service firms in sub-Saharan Africa appears to be rather respectable with continuing rise in the number of Foreign Direct Investment (FDI) firms in the service sector. In the midst of volatile political and economic environment in neighbouring countries, Ghana continues to stand out as a stable country and probably the preferred choice for service generating companies.

In view of these factors Ghana (and in particular its major cities Accra, Kumasi, Tema and Takoradi) has become an attractive location in the region for international organisations and businesses. Among the cities, the capital, Accra is highly sought for, because of being centrally placed from other major cities mentioned above, the seat of government, and having relatively better infrastructure. These have among others discussed later, led to further increase in economic activities and the use of purpose built office spaces. Yet, cost of doing business in Accra is very high. According to the Mercer Index, Accra ranks 86th (2011) compared to 214 other cities over the world in the cost of living.

THE NATURE OF DEMAND AND SUPPLY OF OFFICE SPACE IN ACCRA

Factors contributing to office space demand
Demand for office space in Accra appears to be strongly affected by activities of the service sector especially finance, business and services employment. The service sector covers a range of tertiary economic activities which are categorised in Ghana under the following main activities: finance; insurance, real estate and business services; restaurants and hotels; transport storage and communication; wholesale and retail trade; government services; and community, social and personal services and producers of private non-profit services, serving households.

Considering the finance sector for example, there were less than 20 banks (mainly public owned) in Ghana during the 1980s. However, with the development of the banking sector, there was a need for the appropriate office spaces. After the SAP private banks entered the sector and the number of banks increased to the extent that by 2004 there were 115 banking institutions and by 2013 there were nearly 200 private banks in Ghana. All these banks have their head offices located in Accra. In addition, numerous branch offices are located in Accra and other major cities. All of these banks now use sophisticated IT facilities requiring the appropriate state of the art office spaces fitted with suitable equipment.

Furthermore, the number of non-bank financial institutions has increased since the mid-1990s requiring office spaces. Non-bank financial institutions were established in Ghana to provide services to sectors of the
Karley

economy believed to have been denied access to credit by the commercial banks. This sector was given a significant boost in 1995, when the Ghana government received support from IDA credit in the sum of US$25 millions that was used to develop various programmes to enhance the capacity of the non-bank financial sector. In particular, the following sets of institutions were developed:

i. The capital market institutions (Ghana Stock Exchange, Securities Exchange Commission, and the NBFI Department);

ii. Associated Financial Infrastructure (Home Finance Company, Domestic Payment System, and Institute of Chartered Accounts of Ghana); and


Although the financial system in Ghana is dominated by the banking sector (50% of GDP), there has been proliferation of other non-bank financial institutions such as insurance businesses. Compared to other African markets, the insurance industry in Ghana is relatively small. For instance, insurance premium as a percentage of GDP in 2001 was less than 1 per cent. As of December 2004 the sector contribution to the entire financial sector was 1.3 per cent, rising to just under 8 per cent in 2013 (Lamptey 2014). The industry is made up of insurers, insurance brokers, actuarial firms, and agents. But the number of insurance companies has more than quadrupled from only 3 private insurance companies in the 1990s to 17 insurance companies, 30 insurance brokers and 2 re-insurers by 2004. There were over 30 insurance companies as of December 2013. In view of the growing numbers, additional office spaces are required.

Another impact on office demand is the privatisation in the Telecommunication industry. This led to a significant growth in the need and demand for high tech office spaces. For example, before the mid-1990s, parastatals enterprises were the only providers of television and radio broadcasting, and telephone services. However, a significant competition was introduced since the mid-1990s onwards. Compared to a single government owned and controlled TV broadcasting house, the Ghana Broadcasting Corporation (GBC), there are now more than 5 private television broadcasting service providers. In addition, companies providing television service via satellite dish have entered the industry. Over 100 private radio FM radio stations have now spread across the greater Accra region alone, compared to the only government-owned radio stations of the 1990s. Furthermore, post, telephone and mobile phone service providers have entered the industry after the hitherto government owned and controlled P&T Communication was privatised.

Service provider companies are major users of high technology office spaces. Therefore, these developments have introduced competition as well as increased the need and demand for suitable office space in the capital.
They have, no doubt caused a stir in and boosted demand in the Accra office market.

**Supply of office space in Accra**

Accra’s office market can be separated into several grades mainly Premium Grade, Grade A, Grade B, Grade C and Grade D. These office spaces are predominantly located in the Central Business District (CBD). The city is experiencing very low vacancy rates for office space located in the CBD with particular high demand for premium grade and grade A office space. The average vacancy rates of Accra’s office market are 5.8%.

<table>
<thead>
<tr>
<th>Property</th>
<th>Floor Area (sqm)</th>
<th>Rent psm pe month($) / (GHC)</th>
<th>Major Tenant(s)</th>
<th>Property Grade</th>
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<td>MTN, Fidelity</td>
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<td>Heritage Tower</td>
<td>9,340.55</td>
<td>18</td>
<td>UBA, Volta River Authority (VRA), Ghana Revenue Authority (GRA)</td>
<td>B</td>
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<td>Premier Tower</td>
<td>10,262.78</td>
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<td>Zenith Bank, SG SSB GC NET, Affiliated Computer Services</td>
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<td>B</td>
</tr>
<tr>
<td>Okofo House</td>
<td>721.46</td>
<td>13</td>
<td></td>
<td>B</td>
</tr>
<tr>
<td>Total House</td>
<td>12</td>
<td></td>
<td></td>
<td>C</td>
</tr>
<tr>
<td>Movenpick</td>
<td>45</td>
<td></td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>World Trade Centre (WTC)</td>
<td>39</td>
<td></td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Accra Financial Centre (AFC) (under construction – completion 2014)</td>
<td>13,700–Office, 1,800 - Retail (9 storeys plus basement parking)</td>
<td>40</td>
<td>A</td>
<td></td>
</tr>
</tbody>
</table>

Before the 1980s, an area called Ministries and further south of the Ministries is the Accra High Street. This area collectively is perceived as the Central Business District in Accra. This was where the High court was located and the central bank, and major banks had their headquarters and major branches here. It was also a key location for international businesses and organisations. This area being the main CBD of Accra was clogged with traffic congestion. Retail markets located in the vicinity aggravated the concomitant traffic congestion that characterised the area. The Accra Metropolitan Assembly (AMA) realising the impact of traffic congestion in Accra and especially in the CBD, initially focused efforts in redeveloping the main retail sector called *Makola* market in a bid to
easing traffic congestion and to provide appropriate shopping area. In the process few office spaces were added to the office stock.

Office sector expansion became a reality when the Social Security and National Insurance Trust (SSNIT) ventured into real estate investment during the early 1990s. In particular, they entered into office sector and by 2000 they owned several office buildings most of which were skyscrapers located in the Ridge Ambassadorial Enclave of Accra, adjacent to the Ministries area. By 2004, the lettable area of SSNIT office spaces was roughly 30,740 square metres in their property portfolio (Karley 2008). Table 1(a) shows the number of office spaces brought to the Ridge Ambassadorial area and the rents charged are shown on Table 1(b).

Table 1(b): Rental escalation in the Ridge Ambassadorial area

<table>
<thead>
<tr>
<th>Property</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>NIA</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>11.664</td>
<td>11.664</td>
<td>11.664</td>
</tr>
<tr>
<td>Round House</td>
<td>5.38</td>
<td>5.38</td>
<td>5.38</td>
<td>5.38</td>
<td>5.38</td>
<td>5.38</td>
</tr>
<tr>
<td>Okofo</td>
<td>5.38</td>
<td>5.38</td>
<td>5.38</td>
<td>7.64</td>
<td>7.64</td>
<td>7.64</td>
</tr>
</tbody>
</table>

The introduction of these prime office spaces attracted businesses quickly to the area and the rate of take up of office spaces increased. According to BROLL (2007), the property management company responsible for SSNIT commercial properties, most of these offices achieved 100% occupancy rate on inception. The overall occupancy was 88% in 2004 rising above 93% in 2005. Thereafter, the occupancy rate for all SSNIT offices have increased to nearly 100% throughout the years to date.

As the Ridge area became an attractive location so did private companies’ interest in the area. Private companies entered into office development for either their own use and/or for investment purposes. Notably, redevelopment of properties along the Independence Avenue resulted in a complete facelift of both sides of the highway and many international organisations, and businesses relocating to occupy office spaces in the area. Banks, insurance companies and other financial institutions currently have both head offices and branches in this location. The Ridge area has also become a hot spot for the leisure industry, to the extent that some of the best hotels in Accra (e.g. MOVENPICK and NOVOTEL) are located in this area. It is interesting to note that compared to the CBD of the Ministries and Accra High Street areas, Ridge Ambassadorial enclave, experienced lower rate of traffic congestion.

Another addition to the office space came with the reconstruction of the Accra –Airport highway, completion of various overhead bridges on the main highway, completion of the Tettey Quarshie interchange linking the
Tema Motor way to Accra. A new spatial structure of offices emerged. The Ministry of Foreign Affairs commissioned a Chinese construction company to develop a new office building in the vicinity. This was completed in 2012 to allow the permanent seat of the ministry to be moved there. Other developments such as Opeibia House, Gulf House and the Airport City project (shown in Table 2a) completed in stages, brought additional prime office spaces to this area of the city. Hence, there seemed to be a shift or creation of another CBD in the Accra Airport City area, thereby attracting demand to the area and hence a further increase in rents as shown in Figure 4.

Table 2(a): Prime office spaces in the Airport City area

<table>
<thead>
<tr>
<th>Property</th>
<th>Floor Area (sqm)</th>
<th>Rent psm per month($) / (GHC)</th>
<th>Major Tenant(s)</th>
<th>Property Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opeibia House</td>
<td>2,124.00</td>
<td>15</td>
<td>Stanchart/Ghana Life/IFC</td>
<td>C</td>
</tr>
<tr>
<td>Aviation House</td>
<td>2,104.00</td>
<td>18</td>
<td>GCAA</td>
<td>B</td>
</tr>
<tr>
<td>Gulf House</td>
<td>3,233.00</td>
<td>21</td>
<td>GCB/ADB/InterCity Hotels</td>
<td>B</td>
</tr>
<tr>
<td>Millennium Heights</td>
<td>3,500.00</td>
<td>15</td>
<td>JICA</td>
<td>B</td>
</tr>
<tr>
<td>UNA House</td>
<td>2,944.00</td>
<td>25</td>
<td>Barclays/PWC</td>
<td>A</td>
</tr>
<tr>
<td>Silver Star Tower</td>
<td>7,111.00</td>
<td>26</td>
<td>Delta Air/ Ecobank / Stanbic Bank/Lakeside Estates</td>
<td>A</td>
</tr>
<tr>
<td>Manet Towers (Twin Towers)</td>
<td>26</td>
<td>UT Bank and Vodafone Ghana Limited</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Cocoshie Building</td>
<td>3,000</td>
<td>19</td>
<td>Kosmos Energy / Procredit</td>
<td>B</td>
</tr>
<tr>
<td>One Airport Square</td>
<td>16,000</td>
<td>50</td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Icon House</td>
<td>15,000 – offices, 2,500 – retail</td>
<td>40</td>
<td>Stanbic Bank Ghana Limited</td>
<td>A</td>
</tr>
<tr>
<td>Total</td>
<td>- 17,500</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 4: Prime office rents in the Airport City area

DISCUSSION OF ACCRA RENTAL VALES

Whilst many issues affecting rent can be looked at on the micro-economic level of the office market and property industry, the macro-economic
factors of the country, region and global impacts, must be taken into account as they can influence the current and future expectations of rentals across the office sector in Accra.

If the economy is doing well and in a boom, rental values generally are higher than if the economy is in a recession or in a downturn. With Ghana and for that matter Accra’s economy expected to continue to do well as stated earlier, and vacancy rates at low levels, rental values are expected to continue steady ascent.

Ghana’s economic growth figures were assessed earlier. To establish the current impact and the future expectations, we need to establish the following:

Will there be a further period of strong economic growth? Has the economy reached a peak? Are the economies in the region in a decline in output? How will global issues affect office rents? Certainly issues like inflation, interest rates, currency rates, unemployment, demographics, monetary and fiscal policies are also crucial.

Supply and demand are some of the main factors determining rental values. Supply directly relates to the vacant office spaces at any one given time and the demand is determined by the take up rate of new and existing office spaces. We have seen that the supply cycle of office spaces in Accra is currently at or near the bottom of the cycle with very low or negligible vacancy rates and new office buildings only slated to be completed towards 2016 and 2017. New supply coming into the market are situated in the Airport area, a relatively new area in the city. Furthermore, take up rate for new office spaces has experienced high levels of pre-leases and only a low percentage not being taken up yet. As supply continues to be limited, the rental values of office spaces in Accra will remain relatively high and likely continue to go up. The demand for office spaces also remain strong going into 2016/17. New buildings both in Accra’s ‘traditional’ CBD as well as in Airport, a relatively new business district have both seen strong demand for its office spaces with spaces being taken up even before the new office buildings are completed. This strong demand is a determinant of rental values in the city and in this case will likely drive rental prices of office spaces up in the city.

We have seen a growing service sector in Accra dominated by finance and insurance and telecommunication. As there is an increase in employment, there is a need for additional office space to accommodate them. It is interesting to note that during the 1980s, although office employment (white colour jobs) grew considerably, the absorption of office space in Accra did not experience the same level of growth. This is due to the type of jobs being generated currently, requiring high tech and sophisticated office spaces.

The forecast for immediate growth in the Accra Airport areas is high because of their reliance on the banking and oil sector with the news that “investment banks are growing and with oil drilling already in the country. The overall forecast for the Accra office market is on the whole
very positive. For instance, it is anticipated that the current prime rents of US$30 per square foot (psf) in Accra market will increase to USD35 by the end of 2015 and will reach 40 psf in 2017 and a significant increase in rental value is also expected for the Airport city project.

There is an ‘Accra effect’ at work here. Accra attracts businesses from all over the world. The market is of “special interest because of its international character: Over 95% of new office space in prime locations are occupied by non-Ghana firms.” Furthermore, as reported by a number of overseas companies taking up flagship units have driven up rents on prime streets.” Accra is also an attractive destination for businesses seeking office space.

Accra is a prime example of an agglomeration economy, which is embodied by pooling of skilled labour, a greater supply of supply inputs and services, and information flows between firms (Ball et al. 1998). We explained earlier that Accra is attracting other sectors into its commercial property market such as the Technology, Media and Telecommunication (TMT) Sector. Lamptey (2014) supports the theory of agglomeration theory by confirming that businesses from the TMT sector by identifying that “there are clear business advantages for technology and telecommunication companies to choose Accra including talent pool and access to a truly global marketplace in Africa.”

It is the case that “the office space required in Accra specification” because the demand coming from the overseas businesses and the TMT sector will seek a supply of Grade A property. As the level of demand in Accra continued to rise with limited new supply scheduled for 2016/17, this will continue to push up rental values until the supply of quality property increases. The nature of property means that in the short run, supply cannot be easily adjusted in response to increased demand. It is possible to look for alternative property in other areas, but as demonstrated above the types of businesses that operate in the Accra market do so to benefit from the specific advantages of its location. In reality the evidence suggests that rental values in Accra will continue to increase until the market is adjusted to equilibrium with the onset of further supply of quality buildings. Fraser (1993) summarises “if demand increases the rental value will increase due to the inelastic supply curve in the short run. This will induce an increase in supply but only after a time lag.” The cause of this time lag is in the main part down to the time it takes to build office accommodation, particularly the tall and high specified buildings.

CONCLUSIONS

A number of issues determine the price paid per square foot for office. All the three main sub-sectors of the market, namely use, investment and development sector affects the market in various ways. These 3 areas are important when looking at the rental values. As observed earlier, in fact, a premium is paid for central sites in the Accra office market. These
attributes would be carefully considered by each potential occupier and applied to the rent they might want to pay for an office space.

While the main influences of the determinants of the rental values could be explained theoretically by imbalances between market fundamentals – demand and supply for space, there seems to be other unexplained factors contributing to higher office rents. First, premium office is difficult to come by due to the oligopolistic tendencies among suppliers. This is due to the fact that it has a market that has high barriers to entry and as Clapp (2004) suggests ‘No one individual or body has a controlling influence in market as open to all’. However, due to rising values over the past 20 years the market seems to be generally restricted to major funds such as SSNIT, big international property companies or high wealth individuals’. Secondly, there seems to be a significant amount of speculation regarding value of land and anticipated businesses likely to be brought into the city and country in the long run. So landowners are demanding more than current land values and/or reluctant to release land hoping to cash in in the future. It is expected that foreign investor’s interest in the office market in Accra will remain strong going into the future and so office space demand will continue to grow. To ensure that increasing rents does not affect local economy, more needs to be done with regards to curbing speculation and to encourage release of land for office development to ensure that rent escalation is controlled.

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Knight Frank, 2012 Central London Retail


DUE PROCESS PRACTICE ON CONSTRUCTION PROJECTS IN LAGOS STATE, NIGERIA

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Procurement process for construction projects in Nigeria is facing a lot of challenges. These challenges often result in abandonment, cost and time overruns, substandard work, and insolvency. These problems emanate as a result of improper procedures for selecting the appropriate contractor for the project. Hence, this study aims at assessing the implementation of Due Process Practice (DPP) which is a process developed through the Procurement Act (2007). Cross-sectional research surveys were used for this study and the populations are construction professionals such as Architects, Quantity Surveyors, Engineers, Builders, Public clients’ organisation, and contracting organisations involved in government projects. The sampling procedure adopted for this study is stratified sampling technique. Eighty (80) questionnaires were distributed, and sixty-five (65) were retrieved. Statistical packages for social sciences (SPSS) 17th version were used for analysing the data collected using descriptive and inferential statistics. The study shows that the major factor affecting due process implementation on construction projects in Lagos State is political interference by influential political figures and the misuse of power by top level officials. As such, if adequate measures are not taken to curb this amongst the top officials handling public procurement, the purpose of due process is forfeited. Therefore, the need on how to abate to the minimum level all manners of unethical practices and promote the ethos of transparency, objectivity, and accountability for the achievement of projects delivery to time, cost, and quality brought about the emergence of Due process policy.

Keywords: construction project, contractor selection, due process practice, procurement, public client

INTRODUCTION

Executing a successful project is what every member of the design and construction team involved in a construction project should aim to achieve together even right from the pre-contract stage (entry) down to the exit/termination of the contract (discharge). This is because construction projects are generally characterized as one which involves services of various

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professionals, consultants and contractors in the built industry in their various aspects of expertise. Its activities include the procurement of goods and services as well as the execution of a variety of physical structures and infrastructures (Mshelbwala, 2005).

Traditionally, construction projects starts with the client’s brief on which designs are based. The Architect and Engineers prepare designs, in collaboration with Quantity Surveyor who advises on the cost implications of design variables. Tender process examines the contractor on the execution of the work. On the award, the successful contractor executes the work as designed under the supervision of the consultants. Thus, the approach separates the design, tendering process and construction as separate tasks.

Over the years, public projects embarked upon in the recent past, had been struck with the epidemics of failure, collapse, incompletion and abandonment in Nigeria construction industry as a result of the ineffectiveness and inadequacies in contract procurement process for public construction project (Kareem, Asa and Lawal, 2014). The Public Procurement system was described to be characterized by its non-compliance with the principles of tendering process in the selection of contractors that have the financial, technical and managerial know-how to complete projects within time, cost and quality standard (Ayangade, Wahab and Alake, 2009). The increasing reports on the abuse and failure of Public Procurement system in the three tiers of government (Federal, State and Local) in Nigeria have led to huge losses of resources in various public projects. According to Oboirien (2006), the country had lost billions of money over the years as a result of abuse of tendering process, inflation of contract costs, lack of transparency, competence based competition and merit as the fundamental criteria for the award of public contracts.

Before the advent of the Due Process Policy, according to Olatunji (2008), the contract procurement process for public construction projects in Nigeria had been facing lot of challenges. These challenges included the implication of project failures on the image of the Nigeria construction industry in term of project abandonment, delay in project delivery, cost inflation, poor quality of work, and high initial cost of project. Odeyinka and Yusif (1997) opined that, there had been almost universal criticism of failures of the construction industry to deliver projects in a timely manner. Corroborating this view, Ogunsemi (2002) asserts that cost and time overruns have become common occurrences in the Nigerian construction industry and have continued unabated. Apart from the failures of the industry in the areas of cost and time targets, quality of construction works generally have also continued to decline while some projects are being abandoned because of inability of the contractor to perform. These abuses leads to abandonment of government projects, non-value for Public treasury, high cost of procurement and others (Ayangade et al., 2009).

In light of this, the 2001 diagnostic study into the state of the Federal Government Public Procurement in its recommendation gave birth to the
Budget Monitoring and Public Intelligence Unit (BMPIU) under President Olusegun Obasanjo's regime, to sanitize the system and affairs of Public Procurement in Nigeria, popularly adopted as “Due Process.” Due process policy was strengthened with enactment of Public Procurement Act signed into law on June 4, 2007. The purpose of Procurement Act (2007) under the office of Bureau for Public Procurement (BPP) is for harmonizing existing government policies and practices (Ameh and Ogundare, 2013). The Due process procedure mandates certain categories of the procurements which include advertisement, prequalification, short-listing, invitation, tender action and project execution (Olunji, 2008; Ayangade et al., 2009; Olurankinse, 2012). However, the advent of the Nigeria's Due Process policy was able to save the country over $1bn within three years of its application. According to Obiegbu (2005) as cited in Olatuji (2008), many Africa countries and developing countries which had not incorporated objectivity in their approaches of selection of contractors for public works got motivated by the overwhelming success of the strategic application of Due process policy in Nigeria.

It is expected that over a decade of the establishment of Due Process, it should have a significant impact on construction projects delivery. However, construction projects still experienced abandonment, unethical practice, corruption, time and cost overruns. Thus this study intends to assess the implementation of Due Process Practice (DPP) on construction project in Lagos state.

Objectives of the study:

1. To assess the implementation of DPP for award of contract.
2. To identify factors affecting DPP on construction projects in Lagos state.

Hypothesis of the study:

There is no significant relationship between governments comply with due process implementation and the performance of construction project.

THE PUBLIC PROCUREMENT ACT 2007 AND BUREAU OF PUBLIC PROCUREMENT (BPP)

The Public Procurement Act 2007 is concerned with the process of obtaining supplies of goods and services especially for government or an organization through competitive selection (or bidding), clear and open rules and regulations with optimum effectiveness in price and quality of the item or service (Niyi, 2008). The objectives of the public procurement act are for accountability, transparency and fairness. Prudence in governance and a stipulated ten-year jail term without an option of fine for fraudulent contractors and their collaborators (PPA, 2007).

The Act established the Bureau of Public Procurement (BPP) as the regulatory authority responsible for the monitoring and oversight of public procurement, harmonizing the existing government policies and practices
by regulating, setting standards and developing the legal framework and professional capacity for public procurement in Nigeria.

The benefits accrued to due process implementation policy since its advent and enactment cannot be over emphasized as regards to public project procurement in Nigeria and in the construction industry as a whole. Gains derived from the due process are as follows:

**Openness and transparency**
Due process policy ensures that all public projects to be executed or to be put on sale are adequately advertised in major national publications and media such as; newspapers and construction journals so as to promote the ethos of transparency, fairness and openness to all interested contractors and bidders for successful execution of public project.

**Competitive contractor selection process**
The major task of Contractors is to assemble and allocate the resources of labour, equipment and materials to the project in order to achieve completion at maximum efficiency in terms of time, quality and cost. Due process has helped sanitize the public procurement system in Nigeria by ensuring that selection of contractors are determined competitively, objectively and openly through prequalification process (Olatunji, 2008) thus, ensuring that public contract passes through competitive tendering process and hereby awarded to competent contractors. The policy believes that free competition through the bidding process is a fulcrum of value for money, especially when only competent contractors are left in the race (BMPIU, 2005).

**Accountability and value for money**
The BMPIU office declares its implementation has helped the nation to save Billions of Naira in the form of reductions from inflated contract costs (Obasanjo, 2003; Ezekwesili, 2003 as cited in Chika, 2007; Chika, 2007 and Gabriel, 2007). The success story of this savings has contributed to the realization of the recent debt relief granted to Nigeria (Gabriel, 2007). A lot of savings have been made especially in the area of reduction to contract sums in some cases to the tune of $500 million (Obasanjo, 2003). He further stated that DPP has saved Nigeria over N102 billion in two years arising from various Federal Governments’ over-bloated contracts. Ezekwesili (2003) as cited in Chika, (2007) also disclosed that her office “saved N672.4 million (an equivalent of 4.1 million Euros) from a single project by the Ministry of Health meant to procure and supply equipment to tertiary health institutions”. In addition to this, BMPIU was reported to have saved the government about N137,000,000,000 (over US$1b) in 2005 alone (Olatunji, 2008). In fact, the Bureau, according to records, (Mazi, 2011) saved the country a whopping sum of N216.6 billion in 2010.

All avenues of wastages and leakages in the economy as a result of inefficiency in the award of Government contracts and procurements had been minimized through DPP thereby increasing Government revenue base and value for money in projects execution and delivery. (Obasanjo, 2003; Ezekwesili, 2003 as cited in Chika, 2007).
RESEARCH METHOD

The study was conducted in Lagos, because of high percentages of clients’ and consulting organisations in the city. Lagos is a state with population of over twenty-one (21) million (Okpi, 2011), making it 13% of Nigeria population (167 million) by the National population commission. Lagos is on land area of 3,577 sqkm, thus it the sixth populous in the world and the second largest city in Nigeria. It is one of the most populous cities in Africa (Aderemi and Oyeyemi, 2006) and the new biggest city in Africa (Campbell, 2012). Being the industrial as well as commercial centre of the country, the city has a high population density and abundant economic opportunities which in turn has led to over utilization of available utilities with attractive resources. The increasing rate of urbanization has resulted in pressure on land use; hence it involves a lot of construction activities (Adelekan, 2013) to meet the expectation of its populace. The population of the study comprises architects, quantity surveyors, engineers who are the core professionals representing client, contractor and consultant organisations in the procurement process. From the analysis, 38% of the respondents were Engineers, 28% were Builders, 18% were Quantity surveyors and 16% were Architects. Stratified sampling technique was used to obtain the respondents from client/government establishment and from consulting firms. A cross-sectional research design was used which consist of explanatory and exploratory form of research survey. Eighty (80) questionnaires were distributed and sixty-five (65) was retrieved. Statistical packages for social sciences (SPSS) were used for analysing the data collected using descriptive and inferential statistics. Descriptive and inferential statistics are used via mean, frequency, percentages and Pearson moment product correlation coefficient.

RESULTS AND DISCUSSION OF FINDINGS

Implementation of Due process practice (DPP)

Table 1 indicates the assessment of Government’s implementation of DPP on selection of contractors and award of public projects. The significance procurement activities during DPP are comprehensive tender document for project (MIS = 0.70), notification of successful bidder after tender result (MIS = 0.65) and well stated instructions to tender to prospective tenderers /contractors (MIS = 0.64). The least significance DPP procurement activities for award of contract are advertisement of project to interested contractors on national dallies (MIS = 0.56), engagement of more than one procurement specialist/team in the determination of winning bid (MIS = 0.54) and press coverage of tender opening (MIS = 0.51).
Table 1: Implementation of DPP for award of contract

<table>
<thead>
<tr>
<th>DPP implementation factors</th>
<th>MIS</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehensive tender document for project</td>
<td>0.70</td>
<td>1</td>
</tr>
<tr>
<td>Notification of successful bidder after result</td>
<td>0.65</td>
<td>2</td>
</tr>
<tr>
<td>Well stated instructions to tender to prospective tenderers/contractors</td>
<td>0.64</td>
<td>3</td>
</tr>
<tr>
<td>Inviting contractors to tender, the technical and financial bid process</td>
<td>0.62</td>
<td>4</td>
</tr>
<tr>
<td>Confirmation of contractors credibility for the intended project</td>
<td>0.58</td>
<td>5</td>
</tr>
<tr>
<td>Advertisement of project to interested contractors on national dailies</td>
<td>0.56</td>
<td>6</td>
</tr>
<tr>
<td>Engagement of more than one procurement specialist/team in the determination of winning bid</td>
<td>0.54</td>
<td>7</td>
</tr>
<tr>
<td>Press coverage of tender opening</td>
<td>0.51</td>
<td>8</td>
</tr>
</tbody>
</table>

Factors affecting DPP on construction projects

Table 2 indicates the factors affecting DPP on construction projects. From the table, it shows that political interference by political figures (MIS = 0.90), misuse of power by top officials (MIS = 0.81) and high level of corruption in tender exercise (MIS = 0.78) were the most ranked factors affecting DPP implementation on construction projects. Other factors are informal relationship existing between members of the procuring / bid negotiation team and the contractors (MIS = 0.77), unwillingness of public officials to comply with the provision of the BMPIU circular policy (MIS = 0.76), and false claims of urgency need in other to award contract to a particular contractor (MIS = 0.75). The least ranked factors were incompetent procurement officers (MIS = 0.37) and delay (MIS = 0.36).

Correlation between Government compliance with DPP and construction project performance (CPP)

Table 3 shows the relationship between Government compliance with DPP and its performance on construction project. Pearson’s Product Moment Correlation Coefficient (PMCC) was used to shows the relationship between the Government Due Process Implementation and Construction Project Performance. The correlation coefficient ($r = -0.306^*$) indicates that Government Due Process Implementation can account for about 30 - 31\% of Construction Project Performance (CPP). This result indicates a negative relationship between the dependent and independent variable i.e, as Government Due Process Implementation decreases, the performance of public project also decreases at the significance level of less than 0.05. Thus, the alternate hypothesis ($H_1$) is accepted (“there is significant relationship between the extent to which government comply with due process implementation and the performance of construction project)
Table 2: Factors affecting DPP implementation

<table>
<thead>
<tr>
<th>Factors affecting the implementation of DPP</th>
<th>MIS</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Political interference by influential political figures</td>
<td>0.90</td>
<td>1</td>
</tr>
<tr>
<td>Misuse of power by top officials</td>
<td>0.81</td>
<td>2</td>
</tr>
<tr>
<td>High level of corruption in tender exercise</td>
<td>0.78</td>
<td>3</td>
</tr>
<tr>
<td>Informal relationship existing between members of the procuring / bid negotiation team and the contractors</td>
<td>0.77</td>
<td>4</td>
</tr>
<tr>
<td>Unwillingness of public official to comply with the provision of BMPIU circular policy</td>
<td>0.76</td>
<td>5</td>
</tr>
<tr>
<td>False claims of ‘urgency needs’ in other to award contract to a particular contractor</td>
<td>0.75</td>
<td>6</td>
</tr>
<tr>
<td>Ineffective posture of the court in prosecuting related offences</td>
<td>0.74</td>
<td>7</td>
</tr>
<tr>
<td>Insufficient and inadequate documentation</td>
<td>0.73</td>
<td>8</td>
</tr>
<tr>
<td>Failure of anti-corruption agencies to prosecute defaulters</td>
<td>0.72</td>
<td>9</td>
</tr>
<tr>
<td>Enormous information restriction about contracting opportunities</td>
<td>0.71</td>
<td>10</td>
</tr>
<tr>
<td>Deliberate disqualification of certain contractors and colliding with another contractor to fraudulently increase</td>
<td>0.50</td>
<td>11</td>
</tr>
<tr>
<td>Wide acceptance of gift from contractors</td>
<td>0.49</td>
<td>12</td>
</tr>
<tr>
<td>Improper in-house pricing</td>
<td>0.48</td>
<td>13</td>
</tr>
<tr>
<td>Lack of open competitive tendering procedure</td>
<td>0.46</td>
<td>14</td>
</tr>
<tr>
<td>Inadequate preparation of public project, poorly defined scope, specification and object at the project initiation stage</td>
<td>0.44</td>
<td>15</td>
</tr>
<tr>
<td>Bribery of judges and justice to give a favourable judgment</td>
<td>0.42</td>
<td>16</td>
</tr>
<tr>
<td>Ignorance of provision of BMPIU circular policy to public officials</td>
<td>0.42</td>
<td>16</td>
</tr>
<tr>
<td>There is no involvement of competent professional in project packing and supervision of most public projects</td>
<td>0.39</td>
<td>18</td>
</tr>
<tr>
<td>Incompetent procurement officers</td>
<td>0.37</td>
<td>19</td>
</tr>
<tr>
<td>Delay project</td>
<td>0.36</td>
<td>20</td>
</tr>
</tbody>
</table>

Table 3: Person Product Moment Correlation Coefficient (PPMCC)

<table>
<thead>
<tr>
<th>Government</th>
<th>N</th>
<th>r</th>
<th>P</th>
<th>Sig.</th>
<th>Dec.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DPP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CPP</td>
<td>65</td>
<td>-</td>
<td>0.013</td>
<td>S</td>
<td>H₁</td>
</tr>
</tbody>
</table>

Correlation is significant at 0.05 (2 tailed)

CONCLUSIONS AND RECOMMENDATIONS

The significant procurement activities for implementation of DPP are comprehensive tender document for project, notification of successful bidder after tender result and well stated instructions to tender to prospective tenderers /contractors. This finding shows that the implementation of DPP has leads to management of public finance although the vision and goal of the policy had not been totally fulfilled. It implies that the purpose of DPP which was to provide a base to improve
service delivery and foster development of a nation had not be fully achieved.

The factors affecting the implementation of DPP on construction projects were political interference by political figures, misuse of power by top officials and high level of corruption in tender exercise were the most ranked factors affecting DPP implementation on construction projects. Other factors are informal relationship existing between members of the procuring / bid negation team and the contractors, unwillingness of public officials to comply with the provision of the BMPIU circular policy, and false claims of urgency need in other to award contract to a particular contractor. DPP is a reform act to construction projects in Nigeria as such the Government should be proactive in decision relating to the implementation of the policy guiding DPP and ensure strict rules to enforce all parties involve compliance with the principles. DPP will help to improve current procurement system, hence ensure project performance in terms of completion within time, cost and quality standard.

REFERENCES


ECOLOGICAL SELF-COMPACTING CONCRETE USING GUM ARABIC AS A PLASTICIZER

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The general trend towards green construction and sustainability leads to the demand for environmentally friendly construction additives from renewable sources. Gum Arabic is a natural gum made of hardened sap taken from two species of the acacia tree. Gum Arabic has a low reactivity, an excellent emulsifying, and foam stabilizing adhesive properties and does not interfere with blended products. In this study, the suitability of Gum Arabic with respect to its ability to act as a plasticizer in concrete is tested with the aim of producing self-compacting concrete. The self-compacting properties of the fresh concrete were tested as well as the compressive strength of the concrete produced. The research found out that Gum Arabic is a good plasticizer as well as a good viscosity modifying agent for use in cheap self-compacting concrete.

Keywords: ecological, self-compacting concrete, gum arabic, plasticizer, Nigeria

INTRODUCTION
An “ecological concrete” is a concrete which according to ecological criteria has an optimized composition of the individual components (sand/coarse aggregate, cement, water, concrete admixture, additives) as well as high technical specifications (Haner, Galli, Schluep, Madar and Germann, 2004).

Self-compacting concrete (SCC) is an innovative concrete that does not require vibration for placing and compaction. It is able to flow under its own weight, completely filling formwork and achieving full compaction, even in the presence of congested reinforcement. The hardened concrete is dense, homogeneous and has the same engineering properties and durability as traditional vibrated concrete (The European Guidelines for Self Compacting Concrete, 2005).

To make durable concrete structures, sufficient compaction by skilled workers is required. However, the gradual reduction in the number of skilled workers in construction industry has led to a similar reduction in

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the quality of construction work. One solution for the achievement of
durable concrete structures, independent of the quality of construction
work, is the use of the SCC, which can be compacted into every corner of a
formwork, purely by means of its own weight and without the need of
vibrating compaction (Iureş and Bob, 2010).

Also, recognizing the lack of uniformity and complete compaction of
crte by vibration, researchers at the University of Tokyo, Japan,
started out in late 1980’s to develop SCC. By the early 1990’s, Japan has
developed and used SCC that does not require vibration to achieve full

Iureş and Bob (2010) Highlighted that SCC is a concrete which flows to a
virtually uniform level under the influence of gravity without segregation,
during which it de-aerates and completely fills the formwork and the
spaces between the reinforcement. It is a high-performance concrete with
the special property of the fresh concrete of “self-compacting”. As with
other high-performance concretes (e.g. high-strength concrete, acid-
resistant concrete) the special properties of these concretes, which differ
from normal concretes, are achieved only by systematic optimization both
of the individual constituents and of the composition. The flow ability and
mix stability of the SCC are determined primarily by the interactions
between the powder (cement and additions with a particle diameter <
0.125 mm), water and plasticizer. The gradation of the individual size
groups in the overall grading curve also affects the property of the concrete
in the sense of not being blocked by the reinforcement.

The overall quality assessment of concrete is the compressive strength
(Neville and Brooks, 2002). The basic components for the mix composition
of SCC are the same as used in conventional concrete. SCC mixes must
meet three key properties:

1. Ability to flow into and completely fill intricate and complex forms
under its own weight.

2. Ability to pass through and bond to congested reinforcement under its
own weight.

3. High resistance to aggregate segregation.

In order to obtain the requested properties of fresh concrete for SCC a
higher proportion of ultra-fine materials and chemical admixtures (in
particular, an effective superplasticizer and viscosity-modifying agent) are
necessary to be introduced (Iureş and Bob, 2010).

SCC mixes generally have a higher content of fillers, including cement,
and produce excessively high compressive strength concrete, which
restricts its field of application to special concrete only. To use SCC mixes
in general concrete construction practice, low cost materials are required
to make inexpensive concrete (Ahmadi, Alidoust, Sadrinejad, and Nayeri,
2007).
In order to obtain the characteristic properties of self-compacting concrete (SCC) highly effective water reducing agents (superplasticizers) based on polycarboxylate esters (PCE) are necessary. The added superplasticizers are not considered as biologically easily degradable (Herterich, Volland, Wüstholz, Stegmaier, 2004). The composition is in many cases ill-defined and kept secret for proprietary reasons by the manufacturer. The chemical composition from batch to batch may also vary even in the same product of one producer (Ervanne and Hakanen, 2007).

The 20th century became the age of admixtures, the history of which started in the 1920s with the introduction of lignosulfonate, a biopolymer, for concrete plastification. This was the first functional polymer in construction to be used on a large scale, though later on the use of lignite, cellulosics, and microbial biopolymers also became popular (Plank, 2004).

Concrete plasticizers must correspond to the general requirements in EN 934-1 and the additional requirements of EN 934-2. A concrete plasticizer is defined here as: “An admixture that allows the water content of a specific concrete mixture to be reduced without impairing its consistency or to increase its slump without changing the water content or to achieve both effects at the same time.” Superplasticizers must correspond to the general requirements in EN 934-1 and the additional requirements of EN 934-2. A superplasticizer is defined here as: “An admixture that allows the water content of a specific concrete mixture to be considerably reduced without impairing its consistency or to considerably increases its slump without changing the water content or to achieve both effects at the same time” (STATE-OF-THE-ART-REPORT, 2011).

There are several studies on the environmental concentrations of superplasticizers, but there is a lack of detailed study on their budget and estimates of leaching amounts especially from concrete structures. The evaluation of budget is difficult since there are in most cases several sources, which make their contribution to the total flow unclear. In addition, before year 2000 typically the total concentrations of superplasticizers have been measured and not the different components, knowledge of which is important because of their different behaviour. These environmental studies can give an idea about the behaviour and persistency of different compounds of these admixtures, even though the studies do not handle directly leaching aspects from concrete. (Ervanne and Hakanen, 2007).

The realization that properties of concrete, in both the fresh and hardened states, can be modified by adding certain materials to concrete mixtures is responsible for the large growth of the concrete admixtures industry during the last 40 years. Hundreds of products are being marketed today, and in some countries it is not uncommon that 70 to 80 percent of all the concrete produced contains one or more admixtures; together with their typical applications and limitations. Admixtures vary in composition from surfactants and soluble salts and polymers to insoluble minerals. The purposes for which they are generally used in concrete include
improvement of workability, acceleration or retardation of setting time, control of strength development, and enhancement of resistance to frost action, thermal cracking, alkali-aggregate expansion, and acidic and sulfate solutions (Metha, 1999).

The construction industry has become a major field of use for biopolymers. In 2000, an estimated $1-1.5bn in sales was made at the manufacturer's level, and this growth is expected to continue. Applications of biopolymers in construction are widespread and diverse. In some cases, biopolymers offer distinct advantages in performance and/or cost over synthetic polymers, while in other areas biopolymers may be the only product available that can provide certain properties for building materials. Biopolymers also bear the image of being environmentally more acceptable than synthetic polymers produced in a chemical plant, and although this point can be argued it does influence the choice of materials used, especially for interior home building (Plank, 2004).

Gum arabic (GA), a natural composite polysaccharide derived from exudates of Acacia senegal and Acacia seyal trees, is one of the most commonly used food hydrocolloids. Gum Arabic serves as a very efficient emulsifier and a long-term stabilizer in food and cosmetic products containing oil–water interfaces. Ominijei (2003), cited in Nuhu and Abdullahi (2009) found it useful as admixture in concrete mortar. Much research has been conducted over the years to reveal the molecular structure of the gum and to relate it to its exceptional surface-active and rheological properties (Dror, Cohen, Yerushalmi-Rozen, 2006).

Gum Arabic is known by the worldwide food, beverage and pharmaceutical industry as a versatile additive with polyvalent functions: Protective colloid, film-building and coating agent, encapsulating agent, oxidation inhibitor, stabilizer, emulsifier, texturant, clouding and clarifying agent, food adhesive. More recently, western countries discovered that acacia gum is also a dietary fiber with very interesting nutritional properties (El– Kheir, Yagoub and Abu Baker, 2008). Ominijei (2003), cited in Nuhu and Abdullahi (2009) found it useful as admixture in concrete mortar.

The tree grows mainly in the sub-Sahara or Sahel zone of Africa but also in Australia, India and South Africa. The main producing and exporting countries in the Gum belt include Cameroon, Mali, Nigeria, Sudan, Senegal (The defunct Sudanese Government Website, 2005).

Nigeria produces different grades of exudates and is ranked as second largest world producer after Sudan. She recorded an annual average production of 20,000 tons in 2005. The trees are used as potent weapon in the fight against land desertification and soil degradation in sahelian belt of the country without industrial uses (Nuhu and Abdullahi, 2009).

There are 11 gum arabic production states in Nigeria namely, Jigawa, Yobe, Borno, Kebbi, Sokoto, Bauchi, Gombe, Adamawa, Taraba, Katsina and Zamfara States (Umar, Otitolaiye and Opaluwa, 2010).
The composition of gum Arabic is dependent to some extend on the location and age of the tree. The material has many applications and uses i.e. in confectionary, beverages, pharmaceuticals, bakery, cosmetics etc. During growth, harvesting, or transportation it could be environmentally contaminated buy some micro-organisms which consequently affects its properties and functionality and hence it’s various uses. Properties of gum Arabic include emulsification, viscosity, colour, molecular weight, absorption, and chemical structure. Gum Arabic has been known for many years and there are no artificial substitutes that match it on quality or cost of production (Williams and Phillips, 2000). It has considerable variation in physicochemical, functional and toxicological properties according to different locations, type of soil and age of the tree (Anderson, Dea, Karamalla and Smith, 1968).

THEORETICAL AND CONCEPTUAL FRAMEWORK

The general trend towards “green” building and sustainability leads to demand for environmentally friendly construction chemicals. In addition, the environmental behaviour of a newly developed chemical is usually unknown and bears public awareness and legal risks to the producer, distributor and/ or buyer of the product (Haner et al. 2004). Sustainability and ecological demands on concrete, adoption and development of workable construction methods have remained a persistent challenge to researchers and developers of concrete admixtures. Therefore, the development of an “ecological concrete” is the only way to meet these challenges (Haner et al. 2004).

The concept of SCC was introduced into the scientific world in Japan in 1986 by Professor Hajime Okamura from Tokyo University. The first prototype was developed in 1988 by K. Ozawa from Tokyo University as a response to the growing problems associated with concrete durability and the high demand for skilled workers (Iureş and Bob, 2010).

The flowability and the durability of SCC is achieved primarily by using various types of fillers i.e., flyash, limestone powder and chemical admixtures i.e. superplasticizers and viscosity modifying agents. Generally, the self compactability of a mix is sensitive to small variations in the characteristics of the components, such as the type and age of the cement, the type of sand and fillers (shape, surface, and grading) and the moisture content of the sand (Okamura, et al., 2000).

The conceptual framework of this research is built on the desire to produce a self-compacting concrete that meets all ecological criteria’s for concrete by using environmentally friendly admixtures while optimizing the artificial constituents of concrete.
RESEARCH DESIGN AND METHODS

Two concrete mixes with different water/powder ratio were used. The concrete (normal Concrete) that served as control had a water/cement ratio of 0.5 while the Self Compacting concrete which had Gum Arabic as plasticizer at two varying percentages had a water/powder ratio of 0.45.

For the mix proportion, the required quantity of materials were weighed. Fine and coarse aggregate combinations were hand mixed for 90s. Cement and filler combinations were added into the aggregate mixes and remixed for 60s all together in dry state. The water and SP were mixed in a container and poured slowly into the mixer while mixing. The total mixing time was four minutes.

Dangote cement (a commercial OPC brand obtained in Nigeria) was used as well as fine and coarse aggregates that were sourced locally. The Gum Arabic used as plasticizer was obtained from Adamawa State of Nigeria.

The self-compacting properties of the concrete was tested using the L-box, Fill-box, Slump Flow and V-Funnel tests in accordance to the European Standards for Testing Self Compacting concrete.

The casting immediately followed mixing, after carrying out the tests for fresh properties. The top surface of the specimens was scraped to remove excess material and achieve smooth finish.

The compressive strength of the hardened concrete was determined after curing for 7, 14, 28 and 90 days respectively.

Table 1: Proportion in mass of component materials used

<table>
<thead>
<tr>
<th>Component</th>
<th>CM</th>
<th>SCC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement (kg)</td>
<td>12.8</td>
<td>12.8</td>
</tr>
<tr>
<td>Fly Ash (kg)</td>
<td>-</td>
<td>6.0</td>
</tr>
<tr>
<td>Fine Aggregates (kg)</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>Coarse Aggregate (kg)</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>Water (kg)</td>
<td>0.50</td>
<td>0.45</td>
</tr>
<tr>
<td>Gum Arabic (kg)</td>
<td>-</td>
<td>0.19</td>
</tr>
</tbody>
</table>

Table 2. Physical Properties of Fly Ash used as filler

<table>
<thead>
<tr>
<th>Properties</th>
<th>FA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apparent specific gravity</td>
<td>2.25</td>
</tr>
<tr>
<td>Loose bulk density (kg/m³)</td>
<td>1306</td>
</tr>
<tr>
<td>Compacted bulk density (kg/m³)</td>
<td>1414</td>
</tr>
</tbody>
</table>
Figure 1. Equipment for fresh concrete (self-compacting) tests.

Figure 2. Unprocessed Gum Arabic

Figure 3. Processed Gum Arabic.

Figure 4. Fly Ash
RESULTS AND DISCUSSION

The aim of the research was to determine the suitability of Gum Arabic as a plasticizer in the production of self-compacting concrete and the following results were gotten.

Table 3. Result of Setting Time Test

<table>
<thead>
<tr>
<th>Concrete</th>
<th>Initial Setting Time (Hours)</th>
<th>Final Setting Time (Hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>1.8</td>
<td>3.6</td>
</tr>
<tr>
<td>SCC</td>
<td>5.3</td>
<td>8.36</td>
</tr>
</tbody>
</table>

Table 3 shows that GA delays the setting time of SCC as compared with the normal concrete used as control.

Table 4: Results of Self Compacting Properties of Fresh Concrete.

<table>
<thead>
<tr>
<th>Component</th>
<th>Control</th>
<th>SCC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slump</td>
<td>25</td>
<td>-</td>
</tr>
<tr>
<td>Slump T30 (s)</td>
<td>-</td>
<td>4.7</td>
</tr>
<tr>
<td>Flow</td>
<td>Final Average</td>
<td></td>
</tr>
<tr>
<td>L-Box</td>
<td>Diameter(mm)</td>
<td>582</td>
</tr>
<tr>
<td>L-Box T40 (s)</td>
<td>-</td>
<td>7.2</td>
</tr>
<tr>
<td>H/H1</td>
<td>-</td>
<td>0.83</td>
</tr>
<tr>
<td>Fill-Box</td>
<td>Time (s)</td>
<td></td>
</tr>
<tr>
<td>V-Funnel</td>
<td>Time (s)</td>
<td>5.48</td>
</tr>
</tbody>
</table>

Table 4 shows the self-compacting properties of concrete made with gum Arabic as a plasticizer. The slump flow test measures the degree of flowability of the concrete which has a conformity criteria of slump flow class 1 ($\geq 520, \leq 700$ mm).

The L-box test assesses the passing ability of the concrete through obstacles and also the filling ability of the concrete. It has a conformity value of $\geq 0.75$ for a class 1 passing ability and a time based conformity of 7.2 seconds.

The fill-box test measures the filling ability of the concrete through heavily reinforced formwork. The nearer the value of the height measured after the concrete has stopped flowing at the end of the box to the top of the concrete at the tip of the funnel, the greater the ability to compact on its own.

The V-funnel test measures the viscosity of the concrete and has a conformity criteria of $\leq 8$s.

Table 5. Compressive Strength of Concrete Produced

<table>
<thead>
<tr>
<th>Concrete</th>
<th>7 days (N/mm$^2$)</th>
<th>14 days (N/mm$^2$)</th>
<th>28 days (N/mm$^2$)</th>
<th>90 days (N/mm$^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>14.5</td>
<td>18.79</td>
<td>21.13</td>
<td>25.6</td>
</tr>
<tr>
<td>SCC</td>
<td>11.5</td>
<td>12.4</td>
<td>18.2</td>
<td>32.34</td>
</tr>
</tbody>
</table>

Table 5 shows the compressive strength of normal concrete and SCC produced with GA as a plasticizer. Table 5 shows the slow strength gain of
the SCC over 28 days and a considerable strength gain over 90 days because of the presence of FA used as the filler in SCC.

![Figure 5. Variation of Compressive Strength with Age (N/mm²).](image)

**CONCLUSION**

From the results above, Gum Arabic has proven to be a viable ecological plasticizer as well as a very good viscosity modifying agent. The trend towards green construction and the move towards the use of more bio-polymers will enhance and promote the adoption of Gum Arabic as a plasticizer in cheap self-compacting concrete. GA delays the setting time of SCC which will make it an ideal plasticizer for concrete in situations where delayed setting time is required. SCC made with GA as a plasticizer develops considerable more strength than normal concrete over a long period of time.

**REFERENCES**


EDUCATION AT THE CONFLUENCE OF EFFECTIVE BUILDING INFORMATION MODELLING INTEGRATION TO BUILDING INDUSTRY IN MALAYSIA

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It is an open fact that building information modelling (BIM) have been and is still expanding its usefulness across professional specialization in the built environment. Building Information Modelling (BIM) as a new way of doing things in the building industry and it is a system that is rapidly revolutionizing entire process therein. It is also apparent that most professionals in the building industry are aware and willing to embed the BIM culture but with absolute little to no knowledge about it workability. Thus, the craving to be BIM compliance both in academics and practices it is very imperative that a serious study of the education system needs should immediately be ensured. It is on this note that this paper is an attempt to confirm the important role of education in the BIM adoption in the building industry globally, then establish the gap that exist in BIM adoption in Malaysia building industry as a result of inadequacy of BIM education among the industry. The objective to this aim is to determine the current state of BIM and the trends of BIM education and training so as to come with a statement that BIM-education is a factor that needs consideration in the adoption of BIM in the building industry.

Keywords: building information modelling, built environment, construction industry, education

INTRODUCTION

Building Information Modelling (BIM) has become the measure of yardstick and an international benchmark for efficiency in Architectural, Engineering, and Construction (AEC) and host of other building services. It is the platform that brings about collaboration and integration of environmental professionals and all other stakeholders. Ibrahim, affirm that every professional practice have particular task needed to achieving a successful BIM platform (Ibrahim and Krawczyk, 2003). Thus, BIM can now be said to encompasses all phases of project development from

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conceptual stage through to architectural, civil/structural, Mechanical/electrical, cost evolution and analysis, tendering and award, construction to completion and occupation, facility maintenance and operation, and finally the demolition of the building with a positive resultant returns on investment at the end of its lifespan. This is a very enormous and cumbersome task that can be rolled into a series of integrated tasks for easy project delivery with the use of BIM. Of course, it can be argued that these various tasks mentioned above have been initiated and executed successfully before the coming of BIM, but BIM is a better coordinated and integrated method whereby, time, money, decision making and precise predictions of project characters are of advantages, and besides, more potentials of BIM are still awaiting yet to be exploited (Abubakar, 2012).

The aim of this paper is to confirm the important role of education in the BIM adoption in the building industry globally, then establish the gap that exist in BIM adoption in Malaysia building industry. The objective to this aim is to determine the current state of BIM and the trends of BIM education and training. In an attempt to adopt BIM into various specialization of building industry practices, several efforts have been put in place by individuals, cooperate organizations, professional bodies and even government related agencies. These efforts includes seminar, workshop, and conferences but with little consideration to the education of the upcoming professionals in the industry. This is very apparent in the study carried out by the author where building industry professionals both in practices and academic acknowledged to the fact that education of the new technology is the main obstacle.

BACKGROUND OF THE STUDY

Building information modelling is a technology that revolves around three base components, without any one it BIM is not complete, these components are: - people, process and digital technology. The interrelationship of these elements make up a system called building information modelling. From the figure 1 below the BIM cycle cannot be completed without any of these items. This is a very important reason that doing BIM cannot in solos for any professional discipline of the building industry (Kiviniemi, 2013).

In many countries of the world, it is largely believed that construction industry is one of the most challenging industries in this age. But construction industry still remains with a low reliable rate of profitability, little investment in research, education and development. Also part of the problem is a crisis in training of beginners for replacement of aging people and lack of inject or non-availability of computer native hands, worst still the investor’s tendency of selecting the lowest price are among the issues raised by the Construction Task Force Report (1998) as cited in (Ahmad, 2013). Conversely, building information modelling can be said to be a methodology to manage the building design and project data in digital
format throughout a building lifecycle (Succar, 2009) and it is considered as a paradigm shift within the industry. Series of study have also reveal that BIM is having the potential to significantly change and improve performance and documentation in the AEC industry, and this will invariably reduce inefficiencies, enhancing productivity, and increasing collaboration and communication (Go´edert & Meadati, 2008), with the intention that BIM will achieve decreased project costs, increased productivity and quality, and reduced project delivery time (Azhar et al., 2008b). Despite the success factor perceived of the BIM and the envisage potential, the embracement and the adoption of these opportunities has remain low (Becerik-Gerber et al., 2011).

In Australia, it was identified that various problems facing AEC industry can be put out by the implementation of BIM as industry operational language, this give raise to the development of ‘National BIM Initiative Blueprint’ which was developed by BuildingSmart, part of it aim was meant to promote the education and adoption of BIM at higher education level. Also the blueprint is to facilitate Australia government’s adoption of full collaborative BIM for all government building projects procurement coming year 2016. This is touring same line of BIM development in UK, US and other governments world over (Kriengsak et al., 2013). Besides, Gu and London (2010a) revealed that limited understanding of industry needs and technical requirements pose a major factor hindering the advancement and adoption of BIM related technologies within the Australian AEC industry. Aksamija and Ali (2008) recent study identified “inadequate training and education” as major hindrance to the adoption BIM in the Australian AEC industry which is consistent with that being faced globally. These are challenges that BIM as an emerging technological process is facing in Australia and this largely due to inadequate education foundation BIM.

**BIM awareness in Malaysia**

In any capital development, human resources is believed to be important if not the most important factor and the quality of this variable depends on the level of awareness of the society. This can only be ascertained by the quality of education and training. (Jajri and Ismail, 2007). Furtherance to that, Foray and Freeman, (1992) believed that an overall level of education and in particular technical education is essential for the design and productive use of new technologies (Castells, 1999). The ability to adopt and practice new ICT technology largely depends on the capacity of the whole society to be educated and to be able to assimilate and process complex information. The only avenue for this to be achieved is by starting with the education system, from the bottom up, that is, from the primary education through to the university (Castells, 1999). From the works of Enegbuma and Ali (2011), Malaysia government is aware of the importance of BIM as an emerging technology that is revolutionizing the entire building industry, it is at this instance that the government established Jabatan Kerja Raya (JKR) and the Construction Industry Development Board (CIDB) came up with Construction Industry Master
Plan (CIMP) 2006-2015, in its Seven Strategic Thrusts, the number fourth and fifth of these thrusts will strive to develop human resources and also to encourage innovative research and development and also to encourage the use of modern technology for building project delivery. Besides these, CIDB have been organizing awareness talk among building industry team players. As a step further, JKR is now have a BIM unit that is responsible for the implementation building projects using BIM. Bernstein, P.G. (2010), suggested that BIM should be made more important in the training of architects and other professionals, and he warn that failure to embrace this trend at our education institution may connotes a fundamental setback.

Both the academia and the professional community attested to fact that education is critical for quickening the learning and recruitment of BIM professional for the industry. This is because they both acknowledge that there exist gap between the industry expectations and university turned out graduates. This explain why most often companies recruit fresh graduate for jobs opening dedicated to BIM (Wu and Issa, 2013). At international arena the Malaysia Deputy Prime Minister (DPM) Tan Sri Muhyiddein Yassin retraced the unrelenting effort on producing skilled and qualified work force, he explained that there is need for education system that not only served the community at large but will also projected what is to be expected in the future (Abdul Waheed, S. 2012). Further to this, the outcome of the interview survey that conducted by researcher includes; two architects, two quantity surveyors, and one engineer all in private practice, another set of responders are; one architect, and two quantity surveyors from academics sector of AEC and finally one senior management staff each from CIDB and JKR; indicated that all agreed to the fact that, there is need for BIM to be integrated to education and they also collectively argued in favor of man-power development needs for the upcoming BIM market in Malaysia in a very near future.

Study Significant and Values

Building Information Modelling (BIM) has become the international benchmark for efficiency in Architectural, Engineering, and Construction (AEC) and host of other building services. Also recent studies have revealed that construction industry is vital to the economic growth of most developed countries (Macdonald, 2012). Malaysia is a rapidly growing economy in Asia which cannot afford to folder it arms to the modern technology that is positively aids building project delivery. Studies also shown that the maximum utilization of BIM benefits cannot be fully earnest because of lack of adequate manpower in the sector. The education sector especially the higher education is still lacking behind in balancing the imbalance of the industrial needs in terms of manpower to the current turn-out (Macdonald, 2011b). Taking clue from happiness in UK, US, Australia, and host of others, where BIM education is growing, integration of BIM into university education under collaborative setting among all the building industry disciplines will enable maximum BIM benefits to be achieved at all levels. Considering experience from other
countries believed to have integrated BIM to education and a study of local situation in Malaysia universities, a suitable approach to BIM integration to education would be developed. Discussed below are some of the characteristics of BIM that have made the most preferred building delivery process for this age.

**METHODOLOGY**

From array of available literatures, the research made use of review of literatures and empirical pilot survey conducted by the researcher among practicing and academia in the building industry. Thus, the paper is primarily descriptive and provide an empirical assessment of the benefits that building information modelling (BIM) adoption offers and the challenges that limits its wider adoption among both the practicing and academic professionals in the industry. The research design is such that the data mining is from the primary data and secondary data. The author carried out interview survey of nine professionals of which three are architects, three quantity surveyors and three engineers. Of them all six are practicing while the remaining three are in academics as shown the figure 1.

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Paradigm shifts in society and the relationship between society and education are considered; and features of an information-age educational system based on changes in the workplace and family are presented (Reigeluth, 1992; Reigeluth and Garfinkle, 1994). It has also been revealed that construction industry is vital to the economic growth of most developed countries (Macdonald, 2012). It is also noted that the maximum utilization of BIM benefits cannot be fully earnest because of lack of adequate manpower in the sector. The education sector especially the higher education is still lacking behind in balancing the imbalance of the
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INFLUENCE OF BIM ON THE BUILDING INDUSTRY

Building information modelling adoption and understanding varies from country to country, discipline to discipline and from client to client, this in turn affect the level of adoption and usage among various building project teams. This have pose challenges to building information modelling adoption in AEC industry (Gu and London, 2010b). Although, building information modelling is a collaboration work process, but Ford et al. (1995) noted that, despite the abundance and complexity of information in the construction industry, the non-corresponding management of the information is increasingly resulting to fragmentation among the industry practitioners, it is also note that the construction industry has always been very slow in adopting strategies, methodologies and techniques. In another study, Macdonald (2011a) noted that the construction industry is vital to the economies of most developed countries, but studies shows that despite this importance the productivity has declined over the past 30 years and that the industry is extremely inefficient compared with others. The construction industry has also been described as extremely fragmented and lacking integration. To this ends, in order to improve this situation it is necessary to enhance the communication among the different disciplines through BIM technology that is contributing to greater construction industry efficiencies and boost collaboration among project delivery teams, reduce collisions and remove rework (Darius et al., 2013; Ford et al., 1995).

Various studies have indicated that construction industry and its activities have and are still significant effecting the environment and that sustainability performance of any construction project through its life cycle phases are indispensable in attaining the goal of sustainable development (Shen et al., 2007). In the same vein globally, the cost of energy and environmental impact of construction active has pose serious concerns to the building industry, this have demanded for sustainable building facilities with minimal environmental impact and energy cost. To carry out the most effective decisions regarding sustainability in a building facility, decisions are better made in the early design and preconstruction stages (Azhar and Brown, 2009). This is only practicable with BIM technology which allows for multi-disciplinary information to be superimposed within one model, and this creates an opportunity for sustainability measures and performance analysis to be performed throughout the design process (Schlueter and Thesseling, 2009). Taking clue from definition given by Häkkinen and Kiviniemi (2008); Wong and Fan (2013) that the Sustainable construction brings about the required performance with the
least unfavourable environmental impact, while encouraging economic, social and cultural improvement at a local, regional and global level. In another definition by the World Commission on Environment and Development, that sustainable development is meeting the basic needs of the public and satisfying their aspirations for a better life without compromising the ability of future generations, here the emphasis of this definition is placed on the balance among social development, economic development, and environmental sustainability which is tailing same line as above (Shen et al., 2007). To this ends, an efficient information-technological solutions are needed and this can only be supported by complete design information of a building consists of several domain specific design BIMs, such as architectural, structural, HVAC and electrical, with building construction process and overall building environmental management operations. Therefore, in this context, Building Information Modelling (BIM) is a platform for performing complex building performance analyses to ensure an optimized sustainable building design (Azhar et al., 2009; Gray et al., 2013) and to carry out some of the basic sustainable building task such as; Service life design; Environmental assessment; Energy consumption estimate; Maintenance manual; Optimization on building refurbishment and sustainable building rating. The benefits that the building industry stands to benefits from the use of building information modelling for environmental sustainability are still unfolding as shown in Table 1.

**BIM Project management**

BIM in its characteristics, creates building models that is consistently been used for coordination, computation of information about a building project during design, construction and building operation and management. it is a repository of building information that covers not only geometry, spatial relationships and geographic information and quantities, but also properties of building components quantities and shared properties of materials can be extracted; it also can be used as source of information for analysis of the building solutions as well as to store the results of analysis; in addition, it can be used to represent the entire lifecycle (LC) of buildings including the processes of construction and facility operation (Häkkinen and Kiviniemi, 2008)

**Sustainable BIM**

Various studies have indicated that construction industry and its activities have and are still significant effecting the environment and that sustainability performance of any construction project through its life cycle phases are indispensable in attaining the goal of sustainable development (Shen et al., 2007). In the same vein globally, the cost of energy and environmental impact of construction actives have pose serious concerns to the building industry, this have demanded for sustainable building facilities with minimal environmental impact and energy cost. To carry out the most effective decisions regarding sustainability in a building facility, decisions are better made in the early design and preconstruction stages (Azhar and Brown, 2009). This is only practicable with BIM technology
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situation it is necessary to enhance the communication among the different disciplines through BIM technology that is contributing to greater construction industry efficiencies and boost collaboration among project delivery teams, reduce collisions and remove rework (Darius et al., 2013; Ford et al., 1995).

**Effects of BIM on project delivery time**

Of importance is the effects of BIM implementation on project delivery time (Gray et al., 2013). Based on the survey conducted by Reddy (2008) and Azhar et al. (2008) both examined a number of case studies that employed BIM, they both found that that BIM can influence time management with a 7% reduction in time for project completion. Issa and Suermann (2009) also share the same opinion that BIM helps to delivery projects on time.

**Effects of BIM on project delivery cost**

Azhar et al. (2008a) reports that a 2007 study by the Stanford University Centre for Integrated Facilities Engineering (CIFE), based on 32 major projects that employed BIM, found cost benefits including a reduction of unbudgeted change by 40%, accuracy of cost estimation brought to within 3%, time taken to produce a cost estimate reduced by 80%, and clash detections resulting in savings of as much as 10% of the contract value. Another cost effective evidence was a study from a 2009 US study, with two thirds of over 1,000 BIM users attested to positive return on investment (ROI) (Young et al., 2009). Issa and Suermann (2009) carried out similar survey, where qualitative data was collected to assess practitioners' perceptions about BIM impacts on building project delivery through some Key Performance Indicators (KPI) of: quality control (rework), on-time completion, cost, safety (lost man-hours) and others. The resulting from this survey, it was gathered that in the KPI ranking as: Quality, with 87.7%, Cost, with 83.7%, Schedule, with 82.8%, Productivity, with 74.9% and Safety, with only 53.7% of despondences attested that BIM improves these KPI elements.

**BIM as a learning tool**

Meadati and Irizarry (2011) retreated that due to the characteristic inherent in the BIM, it is a better option as a learning tool. Some of the BIM characteristics that qualifies it are: reduce accessibility time to data information, easy visual correlation with real world elements through a 3D model, cost estimation methods which facilities approximate-accurate quantification at the early design stage and many more. With the tradition delivery process of using 2D critical path method (CPM), visualization skills limits the students' ability to comprehend the construction sequence (Messner and Horman, 2003). But with the 3D model, this is addressed by using four dimensional (4D) modelling (Koo and Fischer, 2000; Kang et al., 2004), which give a better understanding of construction sequence.

**BIM through the Phases of Project Delivery**

All above discussion on the evident benefits of BIM into the building industry can be sum-up into three basic phases of project delivery and
these are identified are; design phase which comprise comprehensive drawings and document from all the disciplines as relates to the project; the construction phase which sum-up all that entails the physical construction of the project till hand-over of the facility and the operation phase comprise of all activities that kept the facility in use from the point of take over for use throughout till demolition.

<table>
<thead>
<tr>
<th>Project Delivery Phases</th>
<th>BIM Qualities</th>
<th>Use of BIM</th>
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<tbody>
<tr>
<td><strong>Design Phase</strong></td>
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<tr>
<td>Virtualization</td>
<td>- Earlier and more accurate visualizations of a design. - The 3D model generated which can be used to visualize the design at any stage of the process with the expectation that it will be dimensionally consistent in every view. - It also facilitate the generation of accurate and consistent 2D Drawings at any stage of the design, this enables easy production of design drawings (Eastman et al., 2011), (Rwamamara et al., 2010)</td>
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<tr>
<td>Earlier Collaboration Of Multiple Design Disciplines</td>
<td>- Earlier collaboration of multiple design disciplines. This allows simultaneous work by multiple design disciplines, shorten design time, reduces errors and omission and it also unveiled design problems and possible improvement opportunities (Eastman et al., 2011), (Poerschke et al., 2010)</td>
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<tr>
<td>Cost Extraction At The Design Stage</td>
<td>BIM enables accurate extraction of bill of quantities and spaces that can be used for cost estimation at early design stage. (Eastman et al., 2011), (Gray et al., 2013)</td>
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<tr>
<td>Clash Detector</td>
<td>It is very useful in the design stage, single model with conglomerator of the interwoven components e.g. Pipes, electrical, beam structure can be united to detect any clashes. (Sacks and Barak, 2008; Sacks et al., 2004).</td>
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<tr>
<td>Clash Resolution</td>
<td>Practical, as with this case study BIM software will notify you of these clashes and adjustments can be made so that the error that have arisen will not become a problem during actual construction. (Sacks and Barak, 2008; Sacks et al., 2004).</td>
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<tr>
<td><strong>Construction Phase</strong></td>
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<tr>
<td>Work Schedules</td>
<td>It also enables automated material takeoffs, cost estimation and construction schedules. (Azhar et al., 2009)</td>
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<td>Construction Management</td>
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<td></td>
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<tr>
<td>Cost</td>
<td></td>
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<tr>
<td>Project Management</td>
<td>Easy evaluation of design, construction and management of project before the actual project implementation. Ellis (2006).</td>
<td></td>
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<tr>
<td>Positive Return On Investment</td>
<td>BIM enable the investors to monitor the profitability of their investments before actually embarking on such projects. (Young et al. 2009)</td>
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<tr>
<td>Sustainable Design</td>
<td>BIM facilitates complex processes of sustainable design such as daylighting and solar access, it also enables automated material takeoffs, cost estimation and construction schedules, all these from a single integrated building model. (Azhar et al., 2009)</td>
<td></td>
</tr>
<tr>
<td>Data Management</td>
<td>BIM is an excellent tool for data management, that facilities easy and fast access to the information in a single centralized database through the 3D model (Meadati and Irizarry, 2010).</td>
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NEED FOR BIM EDUCATION IN THE HIGHER INSTITUTION

Succar, (2013) noted that with rapid BIM proliferation within Design, Construction and Operation (DCO) industry there is need to equip current and future professionals with the necessary knowledge and skills to engage in collaborative workflows and integrated project deliverables and for this, there is need for a Competency Knowledge-Base (CKB) for BIM learning to be taught at higher education institutions. This is a process that leads to identification, classification, and aggregation of instruction materials for BIM competency delivery in education. In other words, BIM as a tools is mainly a repository of shared digital building information models and the management of the corporate knowledge information will increase the productivity and efficiency which will further provides organizations with competitive advantage (Wu, 2013). In the management of this corporate knowledge information education must be fully involved in the identification, classification and sorting of items for adequate BIM education delivery in higher institutions. Various studies have shown that both the academia and the professional community attested to fact that education is critical for quickening the learning and recruitment of BIM professional for the industry. This is because they both acknowledge that there exist gap between the industry expectations and university turned out graduates. This explain why most often companies recruit fresh graduate for jobs opening dedicated to BIM (Wu and Issa, 2013)

CONCLUSION

BIM is very likely to be the building industry standard and it teaching and training of this technology it at university education is inevitable (Kelly, 2010). However the growth of BIM globally is without limits and more breakthrough of it usage are still unfolding. Therefore for maximum benefit to be achieved, an unrelenting effort on producing skilled and qualified work force to the AEC industry in Malaysia remain the immediate need of the education system that will serve the present industrial needs and also projected what is to be expected in the future. Inclusion of BIM education, integration and implementation into AEC industry considerable efforts must be put via some of the following approaches:

- Awareness campaign among the educators and institution of higher learning.
- Retraining of the trainers.
- Collaborative education amount AEC industry and academic disciplines.
- Introduction of model making and model appreciation.
- Integration of works of each team and necessary point of integration
• Knowledge of conflict detection and resolution across disciplines.
• Integration of professional practices, academic educator and student across AEC academic disciplines on sample project delivery.

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EFFECT OF AFRICAN LOCUST BEAN WASTE WATER ON SOIL BRICKS FOR MASONRY WALLING

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2,4 College of Technology Education, University of Education, Winneba, Ghana.  
3Department of Building Technology Takoradi Polytechnic, Takoradi, Ghana.

A newly proposed concept of soil bricks as masonry units for low-cost environmentally friendly construction is proposed using agro-based waste water obtained from the processing of the African locust bean into local food condiments. Laboratory test system was designed to perform strength and durability test on four types of soil brick mixed with African locust bean waste water (ALBWW) as replacement of portable water and also as soil stabiliser for bricks production. Tests were conducted on strength and durability properties of the specimens. There was an increase of 66% over unstabilised specimens when the soil was fully mixed with ALBWW. The density of the bricks increased from 2120kg/m³ for the soil bricks without ALBWW to 2167kg/m³ when the soil was mixed with ALBWW. The resistance to wear for bricks increased steadily from 6.45cm²/g for bricks without ALBWW as stabilisation to 9.45cm²/g for bricks with ALBWW. The presence of ALBWW reduced the amount of water absorbed by the bricks. The study concluded that ALBWW which is an environmental nuisance can be used to replace portable water and also as stabiliser for masonry units in construction. This then implies that effective utilization of ALBWW as soil stabiliser would reduce the cost of relative durable houses for the rural and peri-urban areas in Northern part of Ghana where locust beans are prevalent.

Keywords: abrasion resistance, compressive strength, locust bean, water absorption

INTRODUCTION

Building with soil materials is one of the ancient technology which still remains as the cheapest means of providing accommodation needs to a large number of people. Despite popular misconception that soil is a walling material for low income earners, soil-built houses, according to Stulz and Mukerji (1988) portray cultural diversity and will continue to be

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a major integral part of modern housing needs. The most tangible proof of this is the continued use and existence of many thousands of new and historic traditional houses such as rammed, cob, wattle and daub, etc., soil-built houses dotted across both developed and developing countries. Using soil for housing projects offers a number of advantages to human life. Firstly, it is eco-friendly due to its low embodied energy content and low environmental impact. This is because soil is locally obtained with minimal transportation costs and used in its natural state; hence no fossil fuel is needed for processing. Secondly, soil-built houses can boast of excellent sustainability credentials and this is combined with good thermal and acoustic properties. It has also been indicated that earth buildings are cost effective, when compared with other materials. (Dobson, 2000; as cited in Hall, Damms and Djerbib, 2004).

Historically, primitive man in his attempt to use soil to provide comfortable shelter, did little more than sticking lumps of wet soil on poles woven closely together. Though in modern times, the traditional methods of erecting soil houses in the past have improved. Stulz and Mukerji (1988) indicated that soil-built houses are vulnerable to the hazards of the weather elements causing early development of erosion, cracks and collapse. To address these and many other problems associated with the use of soil, several experimental investigators have studied the stabilising effect of conventional additives such as cement, lime, bitumen and the like on soil to improve strength and durability properties (Amsterdam, 2012).

Even though research findings have shown that small addition of cement, lime, bitumen, etc, in the soil enhances its performance properties, the Ghana Business News (2009) reported that the over dependence on these materials for housing is responsible for the continuous increase in housing cost in developing countries, often beyond the means of the poor. The report added that the importation of clinker and gypsum alone for the production of Portland cement, use extensively in Ghana cost the nation not less than 180 million dollars annually. It is in the light of this that the United Nations Habitat (2009) advised that, for developing countries to be able to provide affordable housing, they should take cost of imported materials into consideration and develop new technologies that would employ the use of local materials through research. In response to this, some local additives derived from industrial and agricultural sources have been studied as potential substitutes (Stulz and Mukerji, 1988; Browne, 2005; UN-Habitat, 2009; Yalley and Zievie, 2013). However, most published works have focused on pulverized and ash wastes because of their pozzolanic activity towards lime (Alhassan, 2008; Yalley and Bentle, 2009). The main drawbacks of using soil block as a building material is the need for continuous maintenance due to its low durability and poor resistance to water (Adam and Agip 2001; Yalley and Asiedu, 2013). Soil blocks have also been found to suffer from shrinkage cracking and most importantly low strength making them unsuitable for homes of more than two-storeys high.
Stabilization of soil is the process of modifying the soil properties in relation to its strength, texture, voids and water resisting properties, so as to obtain permanent properties compatible with a particular application. Yalley and Aseidu (2013) reiterated that, stabilizing soil leads to irreversible change in the physical properties of soil depending on the quality of building design, materials employed, economic aspects of the project, or on issues of durability. The use and adoption of the right stabilisation method can improve the compressive strength of a soil by as much as 400% to 500% with other supplementary characteristics such as increased cohesion, reduced permeability, improved water repellent, increased durability and minimal shrinkage and expansion of soil during dry and wet conditions (Adam and Agip 2001). The stabilisation mechanism may vary widely from the formation of new compounds binding the finer soil particles to coating particle surfaces by the additive to limit the moisture sensitivity. Therefore, a basic understanding of the stabilization mechanisms involved with each additive is required before selecting an effective stabilizer suited for a specific application. Chemical stabilization involves mixing or injecting the soil with chemically active compounds such as Portland cement, lime, fly ash, calcium or sodium chloride or with viscoelastic materials such as bitumen the process of chemical modification or stabilization with calcium-based chemicals, like African locust bean waste water requires a basic understanding of the mechanisms of reaction. Each calcium-based stabilizer contains some amount of free lime (CaO or Ca(OH)₂) that reacts pozzolanically with the fine particles (Little, and Nair, 2008).

The savanna belt across west and central Africa leads in the production of the African locust bean (Parkia biglobosa), commonly known in Hausa as ‘dawadawa’, which is traditionally used in a fermented state (Akinoso and El-alawa, 2013). The fermentation process involves the bean seeds being sorted and soaked in hot water for seven days or boiled for eight hours to de-hull and the water poured away as waste. This waste water has been found to contain chemicals such as calcium, iron, potassium, sodium and magnesium (Bot, 2007) which are equally present in cement, lime and bitumen. Such binders and certain locally specific plant-based materials such as gum arabic, other specific resins and the sap, latexes and juices from specific trees and other (Corum, 2005) are aimed to improving water proofing or wear resistance properties of vulnerable earth based construction. These materials can make a particular contribution in conserving energy in the manufacture of cementitious materials and of lightweight aggregates. A study on the reuse of paper de-inking sludge, undertaken in Spain, showed that, it has the potential as raw material for producing a binding material with pozzolanic properties (Asavasapisit and Chotklang, 2004; García, Vigil de la Villa, Vegas, Frías and Sánchez de Rojas, 2008). A research conducted by García, et. al.,( 2008) showed that calcination paper sludge has higher pozzalnic characteristics as compared to other industrial pozzolanic by-products, such as fly ashes normally used in cements.
Therefore the purpose of this study is to evaluate the strength characteristics of soil bricks stabilised with African locust bean waste water. To realize this objective, soil stabilisation techniques already in use were studied and references made to other relevant studies.

MATERIALS AND TESTING METHODS

Materials

Soil
The soil material used for the study was taken from a depth of 300mm below ground level after removing the top soil from a local construction site closed to Wa Polytechnic in the Upper west region of Ghana.

African Locust Bean Waste Water (ALBWW)
African locust bean water was used in the study as the stabiliser. It is an agro-based waste water obtained from the processing of the African locust bean into local food condiments popularly called ‘dawadawa’ in the Hausa language. It was sourced from a local ‘dawadawa’ processing set-up in Kpaguri in the Wa Municipality in the Upper west region of Ghana. This Local construction site is where the indigenes fetch soil for construction of mud houses; hence the research deemed it fit to use samples from this site for soil test and brick moulding.

Testing Methods and Procedures

Classification of Soil
Laboratory quality identification tests were performed on the soil used for the study. To ensure that stones and other foreign matter were removed, the soil was firstly passed through a 5mm network of sieves before it was characterized to assess its index properties. Sieve analysis was performed in accordance with Clause 7.4.5 of BS 1377 – 1: 1990 to determine the grade of soil used through the proportion by mass of various sizes of particles present in the sample. This was followed by sedimentation test, using the jar method, to assess the silt, clay and sand/gravel fractions for the determination of the soil type.

The Casagrande Apparatus method was used in Atterberg Limits test and was conducted in accordance with Clause 7.4.3 of BS 1377 – 1: 1990 to determine the plasticity range of the soil sample. To assess the amount of organic compounds present in the soil that may have an effect on the strength characteristics, the organic matter content test by ignition was performed. For the assessment of the soil’s linear shrinkage, Clause 6.5 of BS 1377 – 2: 1990 procedures were followed whiles the specific gravity was determined in accordance with BS 1377: 1990. Soil compaction test was conducted to determine the optimum water content for moulding of the soil bricks. This was done in accordance with BS 1377 – 1: 1990.
Soil Bricks Production using African Locust Bean Waste Water (ALBWW)
A BREPAK earth block press (see Figure 1) that could deliver pressures of up to 35 MPa for brick production was available at the Wa Polytechnic, Civil Engineering laboratory. The soil and water with or without locust bean waste water were thoroughly mixed manually. With four different batches (0%, 25%, 50%, 100 %). Fifteen (15) soil bricks with dimensions 200mm × 150mm × 100mm were produced from each batch (five bricks for compression test, five for abrasion resistance test and five for water absorption test).

![BREPAK brick mould](image)

The soil bricks were initially covered with damp plastic sheets and sacks for the first 7 days, according to the shrinkage test results. This was to prevent surface shrinkage cracking due to rapid evaporation which tends to promotes undesirable loss and uneven distribution of moisture in the bricks. The plastic sheets were then removed after which the soil bricks were air dried at room temperature of 25°C for the remaining twenty-one (21) curing days.

**Testing Methods and Procedures**
Experimental tests such as dry density, compressive strength, water absorption and abrasion resistance were conducted on the bricks specimens. Three soil bricks which had no surface cracks visible to the naked eye were selected from each batch for these tests. The bricks were wiped of any dust or loose dirt stuck to them before being tested and the means and standard deviations reported.

**Compressive Strength**
The compressive strength test was performed in accordance with BS 3921: 1990. The test was done at the Wa Polytechnic, Civil Engineering Departments laboratory using the compression test machine.

**Water Absorption by Capillary**
The water absorption by capillary test was conducted according to BS 3921. The water absorption was measured by the increase in weight for
bricks immersed in 5mm depth of water for ten minutes and subsequently
the absorption coefficients ($C_b$) using the equation

$$C_b = \frac{100 \times (M_1 - M_2)}{S \sqrt{t}} = \text{g/cm}^2\text{/min.}$$

Source: Centre for Development of Enterprise Guides (2000)

Where, $M_1 - M_2$ is the mass of absorbed water in grams, $S$ is the
submerged surface area in centimetre square, and $t$ duration of immersion
in minutes.

**Abrasion Resistance**

For the abrasion strength test, BS 3921: 1921 procedures were followed.
The test was used to determine the surface hardness of the soil bricks and
thus their resistance to wear. The abrasion coefficient ($C_u$) given by CDEG
(2000) expresses the ratio of the brushed surface, $S$ (in cm$^2$) to the mass of
the material detach by brushing ($M_1 - M_2$). The bricks were subjected to
mechanical erosion applied by brushing with a metal brush in turns at
forward and backward motions per about a second for 60 cycles. The mass
of the detached (loose) matter was collected and weighed from which the
abrasion coefficients ($C_u$) were calculated

$$C_u = \frac{S}{M_1 - M_2} = \text{cm}^2/\text{g}$$

**RESULT AND DISCUSSION**

**Soil Characteristics**

Various laboratory and field tests were conducted on the soil sample used
in accordance with BS 1377-1990 so as to determine it characteristics. The
tests conducted were sieve analysis, sedimentation test, Atterberg limits,
organic matter test, linear shrinkage test and specific gravity test. Table 1
presents the summary of characteristics of the soil used.

**Sieve analysis**

The results indicated that the soil is well graded with small amount of fine
particles. The soil’s coefficient of uniformity ($C_u$) and coefficient of
gradation ($C_g$) were 6.4 and 1.2 respectively. According to Aysen (2005) soil
having $C_u$ greater than 6 and $C_g$ between 1 and 3 has its grain size
distribution being at the optimum. Thus, in terms of particle size grading,
the soil used was well graded (Table 1).
Table 1: Characteristics of the Soil used

<table>
<thead>
<tr>
<th>SN</th>
<th>Soil Properties</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sieve analysis</td>
<td>C_u = 6.4 and C_g = 1.2</td>
</tr>
<tr>
<td>2</td>
<td>Soil grade</td>
<td>Well graded</td>
</tr>
<tr>
<td>3</td>
<td>Silt fraction (%)</td>
<td>9</td>
</tr>
<tr>
<td>4</td>
<td>Clay fraction (%)</td>
<td>22</td>
</tr>
<tr>
<td>5</td>
<td>Sand/gravel fraction (%)</td>
<td>69</td>
</tr>
<tr>
<td>6</td>
<td>Soil type</td>
<td>Sandy clay loam</td>
</tr>
<tr>
<td>7</td>
<td>Liquid limit (%)</td>
<td>26</td>
</tr>
<tr>
<td>8</td>
<td>Plastic limit (%)</td>
<td>15</td>
</tr>
<tr>
<td>9</td>
<td>Plasticity index (%)</td>
<td>11</td>
</tr>
<tr>
<td>10</td>
<td>Plasticity range</td>
<td>Low plastic clay</td>
</tr>
<tr>
<td>11</td>
<td>Organic matter content (%)</td>
<td>1.7</td>
</tr>
<tr>
<td>12</td>
<td>Linear shrinkage (%)</td>
<td>3.8</td>
</tr>
<tr>
<td>13</td>
<td>Specific gravity</td>
<td>2.8</td>
</tr>
</tbody>
</table>

**Sedimentation test**
From the sedimentation test results, the soil was found to have a silt content of 9%, clay content of 22% and sand/gravel content of 69% (Table 1). This satisfies the recommendations made by Aysen (2005) which stated that soil suitable for brick, the optimum fine content should be about 25% of which more than 10% should be clay.

**Organic content**
The amount of organic compounds present in the soil tested by ignition was 1.7% (Table 1). Past studies have shown that up to 2% organic compound in the soil does not have any significant influence on strength and durability (Houben and Guillaud, 1984).

**Linear shrinkage**
The linear shrinkage test was to establish the extent to which the soil can shrink and to help the curing regime. The soil recorded a maximum of 3.8% linear shrinkage after 5 days (Table 1). Previous studies showed that soil mixture with a maximum shrinkage of 6% is satisfactory for building purposes (CEBS, 1970).

**Specific gravity**
The specific gravity of the soil tested was 2.8 (Table 1). Amsterdam (2012) had established that soils with specific gravities between 2.5 and 3.2 are suitable for building purposes. In general, the soil sample used for the experimental studies was suitable for building purposes.
Atterberg limit
The result from the Atterberg limit test indicates that the soil has a liquid limit of 26%, plastic limit of 15% and plasticity index of 11% (Table 1). According to the Commonwealth Experimental Building Station (1970) the preferred plasticity index for a soil for bricks, the mixture of gravel, sandy clays and clay loams should be between 10% and 20%. Thus the soil used could be classified as intermediate sandy clay loam as indicated in Figure 2.

Soil Bricks Properties

Density
The mean densities of the bricks presented in Table 2, range from 2120kg/m³ for soil bricks without ALBW content to 2167kg/m³ for soil bricks with hundred percent ALBW content stabilisation. Ebony (2011) found that juicy liquid stabilisers enhance compressed soil density more than ash and pulverized stabilisers, hence the results was expected. These values obtained fall within the ranges of 1200kg/m³ and 2400kg/m³ recommended by Morton (2008) as being suitable for masonry units.

Compressive Strength
From the results presented in Table 2, it is noticed that compressive strength steadily increased as the African locust bean waste water content increases. A compressive strength of 2.38N/mm², 3.29N/mm², 3.53N/mm², and 3.95N/mm², were obtained for the specimens A, B25, B50, and B100 respectively. The compressive strength of stabilised specimens increased

![Plasticity Chart for Soil Classification](image)
by 66% over the unstabilised specimens, when the soil was fully mixed with African locust bean waste water for bricks production.

This steady increased in compressive strength was expected as previous studies have found that soils stabilised with juicy liquid stabilisers improve the compressive strength more than with ash, pulverized and greasy stabilisers (Houben and Guillaud, 1984; Obonyo, 2011). According to Browne (2005) the compressive strength of soil materials adequate for walls in low-rise and low-cost buildings is between 2N/mm² and 4N/mm². Hence, these bricks compressive strength is within the recommended range and therefore is adequate in terms of strength for low rise buildings.

The compressive strength values and the African locust bean waste water percentage additions were highly correlated with a correlation coefficient, $R^2 = 0.851$ and this implies that the compressive strength of the soil bricks was highly influenced by the juicy liquid of the ALBWW by 85%.

Again, from the regression equation, $Y = 0.014 (X) + 2.12$; where $Y =$ compressive strength (dependent variable) and $X =$ ALBWW content, (independent variable) it is clear that the compressive strength of the soil bricks has positive but weak relationship with the ALBW content. A percentage increase in the ALBWW content would increase the compressive strength of the soil bricks by 1.4 N/mm².

<table>
<thead>
<tr>
<th>ALBWW Content (%)</th>
<th>n</th>
<th>Dry Density (kg)</th>
<th>Compressive Strength (N/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>Std. Deviation</td>
</tr>
<tr>
<td>$A_0$</td>
<td>5</td>
<td>2120</td>
<td>9.165</td>
</tr>
<tr>
<td>$B_{25}$</td>
<td>5</td>
<td>2135</td>
<td>6.083</td>
</tr>
<tr>
<td>$B_{50}$</td>
<td>5</td>
<td>2161</td>
<td>11.080</td>
</tr>
<tr>
<td>$B_{100}$</td>
<td>5</td>
<td>2167</td>
<td>14.502</td>
</tr>
</tbody>
</table>

Figure 3.0: Relationship Between Compressive Strength and ALBWW
Water Absorption by Capillary

The results given in Table 3, indicates that increasing levels of ALBWW has a steady declining effect on the amount of water absorbed by the bricks, that is, the higher the ALBWW content the less the absorption.

The R-square value of 0.643 shows that the low ingress in water into the soil bricks is about 64% influenced by the addition of the ALBWW content. From the regression equation obtained, \( Y = -0.086 \times (X) + 10.22 \), it is observed that a fairly negative relationship exists between the ALBWW percentage additions and the water absorption coefficients. Hence, a percentage increase in ALBWW content would reduce the water permeating into the soil bricks by 8.6%.

The results confirms previous works that reported that soil with optimum clay content stabilised with agro-based juicy liquids has an increasing effect on density and compressive strength and decreasing effect on water absorption (McHenry, 1984; Walker, 1997; Obonyo, 2011).

Table 3: Water Absorption Coefficients of Soil Bricks

<table>
<thead>
<tr>
<th>ALBWW Content (%)</th>
<th>Sample 1 (g/cm²min)</th>
<th>Sample 2 (g/cm²min)</th>
<th>Sample 3 (g/cm²min)</th>
<th>Mean (g/cm²min)</th>
<th>Std Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A_0</td>
<td>7.906</td>
<td>15.969</td>
<td>15.811</td>
<td>13.229</td>
<td>4.610</td>
</tr>
<tr>
<td>B_25</td>
<td>6.541</td>
<td>5.060</td>
<td>3.004</td>
<td>4.902</td>
<td>1.824</td>
</tr>
<tr>
<td>B_50</td>
<td>6.166</td>
<td>4.427</td>
<td>3.320</td>
<td>4.638</td>
<td>1.435</td>
</tr>
<tr>
<td>B_100</td>
<td>3.472</td>
<td>2.842</td>
<td>2.688</td>
<td>3.004</td>
<td>0.418</td>
</tr>
</tbody>
</table>

Abrasion Resistance

The abrasion coefficient for bricks without ALBWW content was 6.45cm²/g. This increased steadily to 9.45cm²/g for bricks stabilised with 100% ALBWW (Table 4). A high abrasion coefficient shows that a large brushing area is required to yield a certain amount of discarded material. This then implies that the increase in the ALBWW contents increased the bricks resistance to wear and tear by cutting and erosive agents such as wind.
rain, snow, etc. These findings are similar to those of Minke (2006) and Obonyo (2011) who observed that agro-based juicy liquid wastes stabilizers increase compacted/compressed soil weight thereby improving its abrasion resistance.

Table 4: Weights and Abrasion Resistance Coefficients of Soil Bricks

<table>
<thead>
<tr>
<th>ALBWW Contents (%)</th>
<th>Weight Before Brushing</th>
<th>Abrasion Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (g)</td>
<td>Std Dev.</td>
</tr>
<tr>
<td>AO</td>
<td>2108</td>
<td>0.009</td>
</tr>
<tr>
<td>B25</td>
<td>2123</td>
<td>0.006</td>
</tr>
<tr>
<td>B50</td>
<td>2148</td>
<td>0.010</td>
</tr>
<tr>
<td>B100</td>
<td>2154</td>
<td>0.014</td>
</tr>
</tbody>
</table>

CONCLUSION AND RECOMMENDATION

The results of the study support the conclusion that, the addition of the African locust bean waste water in the soil bricks has steadily improved its strength and durability. Even though the maximum values were achieved at the 100% ALBWW content, the results obtained at the 25% and 50% ALBWW content met the required recommendations for earth housing. The ALBWW which is environmentally nuisance can be used to replace portable water and also as a stabiliser for masonry units in construction.

The study recommended that, to produce cheap and environmentally-friendly stabilised soil specifically for rammed, cob, and wattle and daub walling, the soil type and its suitability must be established before using ALWW as mixing water.

LIMITATION

Hand mixed was used for mixing of the bricks ingredients. It would have been better if concrete mixer was used for the mixing to reduce possible evaporation of both mixing water and the juice stabiliser.

Soil sample was taken from one site near the Wa Polytechnic, it would have been appropriate if samples were taken from different site within the Wa Municipality to ascertain the suitability of the soil in the municipality.

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Yalley, P. P. and Aseidu E. (2013), enhancing the properties of soil bricks by stabilizing with corn husk ash, *Civil and Environmental Research, ISSN 2224-5790 (Paper) ISSN 22250514 (Online) Vol.3, No.11, pp 43-52.*
EFFECT OF COMPACTING RATE ON THE STRENGTH PROPERTIES OF SOIL BLOCKS

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Compaction of soil blocks contributes significantly to the strength properties of the blocks. This paper investigates the strength properties of soil blocks produced with different compaction rates. Experiments were conducted to determine the density, compressive strength, splitting tensile strength and erosion properties of soil blocks produced with different rates of compaction speed. The study concludes that although the low rate of compaction achieved better performance characteristics, there is no statistically significant difference between the soil blocks produced with low compaction rate and high compaction rate. However, the study suggests the use of low compaction rate due to its better performance characteristics. The paper contributes to the general body of knowledge in the area of built environment particularly in construction and building materials.

Keywords: compaction rate, compressive strength, density, erosion, soil blocks, tensile strength

INTRODUCTION

One of the factors that affect the strength of earth blocks is compaction. Compaction is the process of mechanically densifying a soil by pressing the soil particles together into a close state of contact so that the entrapped air can be expelled from the soil mass (FM 5-410, 1992). Compaction is an old phenomenon which is called tamping. The tamping used wooden tamper to manually press the earth in a wooden mould to form the blocks. Currently, earth blocks are compacted with compressed earth block machines such as advance earth construction technologies (AECT) compressed earth block machines (AECT, 2009), CINVA-RAM press (Taylor, 2011), BREPAK block making machine (Webb, 1988), among others. These presses are not expensive as they do not require high energy to operate and their maintenance is not complex (Al-Sakkaf, 2009).

The idea of compacting earth is to improve the quality and performance of moulded earth blocks (Guillaud et al., 1995). Soils blocks are often compacted to improve their engineering characteristics, and this can be done in three ways: (a) dynamic compaction, (b) static compaction and (c)

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vibratory compaction for soil blocks improvement (Reddy and Jagadish, 1993). Compressed soil blocks are generally produced by compaction of soil in a hydraulic or electrical block making machine, in which static and control pressure is applied. The strength of compressed earth blocks greatly depends on the compaction energy/pressure (Millogo and Morel, 2012) and the properties of the soil constituent. In recent study by Millogo et al. (2014), the pressure applied in producing the pressed adobe blocks was approximately 2 MPa. In an earlier study on compaction of soil blocks, Lunt (1980) advocated increased forming pressure for more economical block production of 8–16 MPa compared to the usual 1–2 MPa. Another study by Gooding and Thomas (1997) investigated the numerical relation between compaction pressure and cement content, which the range of compaction pressures were from 1 to 10 MPa. In all these studies, the focus was on the compaction pressure.

Since compaction pressure application in producing soil blocks is important to the engineering properties of the blocks, it is imperative to find out if the rate (speed) of applying the compaction pressure could as well affect the strength properties of the blocks. This study therefore, investigates the effect of compaction rate for producing soil blocks on the strength properties of the blocks. Therefore, it is hypothesize that there is significant difference between the soil blocks produced with low compaction rate and high compaction rate.

EXPERIMENTAL METHOD

The experiments were conducted at the civil engineering laboratory of University of Portsmouth. Table 1 reports the characteristics of the soil used for the experimental work. This soil was obtained from Horsea Island, Portsmouth, England. It is defined as low plasticity soil (CL) according to the Unified Soil Classification System (Akbulut, 1999; Kalkan, 2003).

The soil was mixed with water (Figure 1a), weighed and used to fill a steel cylindrical mould. The cylindrical mould was 40 mm in diameter and 125 mm length with a top piston presser of which the mixed soil was compressed to a length of 80 mm with Tinius Olsen (Figure 1b) obtaining as cylindrical specimen of 40 mm by 80 mm (Figure 1c). A number of specimens were produced with compaction rates of 1 mm/min, 5 mm/min, 10 mm/min and 15 mm/min. These compaction rates were selected because they provide a range between a very low speed and a very high speed for compacting soil blocks. The specimens were then dried in an electronic oven at a temperature of 30 °C (Figure 2). Four different types of tests were conducted which includes density, compressive strength, splitting tensile strength and drip. These test were selected because they provide a wide coverage of testing for engineering properties of soil blocks.
Table 1: Soil characteristics

<table>
<thead>
<tr>
<th>Properties</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atterberg limits</td>
<td></td>
</tr>
<tr>
<td>Liquid limit (%)</td>
<td>33</td>
</tr>
<tr>
<td>Plastic limit (%)</td>
<td>25</td>
</tr>
<tr>
<td>Plasticity index</td>
<td>8</td>
</tr>
<tr>
<td>Soil classification</td>
<td></td>
</tr>
<tr>
<td>USCS</td>
<td>CL</td>
</tr>
<tr>
<td>Compaction</td>
<td></td>
</tr>
<tr>
<td>Maximum dry density (Mg/m³)</td>
<td>1.83</td>
</tr>
<tr>
<td>Optimum moisture content (%)</td>
<td>11.8</td>
</tr>
<tr>
<td>Particle size (%)</td>
<td></td>
</tr>
<tr>
<td>Gravel (&gt;2000 μm)</td>
<td>8</td>
</tr>
<tr>
<td>Sand (75–2000 μm)</td>
<td>64</td>
</tr>
<tr>
<td>Silt (2–75 μm)</td>
<td>16</td>
</tr>
<tr>
<td>Clay (&lt;2 μm)</td>
<td>12</td>
</tr>
<tr>
<td>Chemical composition (%)</td>
<td></td>
</tr>
<tr>
<td>SiO₂</td>
<td>76.6</td>
</tr>
<tr>
<td>TiO₂</td>
<td>0.97</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>10.53</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>3.24</td>
</tr>
<tr>
<td>MnO</td>
<td>0.05</td>
</tr>
<tr>
<td>MgO</td>
<td>1.58</td>
</tr>
<tr>
<td>CaO</td>
<td>0.37</td>
</tr>
<tr>
<td>Na₂O</td>
<td>0.73</td>
</tr>
<tr>
<td>K₂O</td>
<td>2.26</td>
</tr>
<tr>
<td>P₂O₅</td>
<td>0.16</td>
</tr>
</tbody>
</table>

Figure 1: Cylindrical Specimen preparation process
Dry density of the specimens were determined in accordance with BS EN 771-1 (2011). The specimens were further dried at constant temperature of approximately 110 °C in an oven for 48 hours. After, the dimensions of each specimen were taken and the overall volume computed. The specimens were then weighed and the density of each specimen calculated from Equation 1.

\[ p = \frac{m}{V} \]  

(1)

Where: \( p \) is the density; \( m \) is the mass (kg); and \( V \) is the volume (m³).

Compressive strength test was conducted in accordance with ASTM C39-96 (1996). The test was made with testing machine (Tinius Olsen) with maximum capacity 50 KN for which three specimens were tested for each compaction rate. Each specimen was placed uprightly on the base plate of the testing machine and carefully centred (Figure 3a). The testing machine applied load at a rate of 0.05 N/mm²/s until the block failed (Figure 3b). The maximum load at which the specimen failed was recorded and the compressive strength determined from Equation 2.

\[ f_c = \frac{P_{max}}{\pi r^2} \]  

(2)

Where \( f_c \) is the compressive strength; \( P_{max} \) is the maximum load sustained by the specimen; and \( r \) is the radius of the specimen.
Tensile strength test was conducted in accordance with BS EN 12390-6 (2009). Each specimen was placed longitudinally in the test jig of the Tinius Olsen, for which load was applied till the specimen failed (Figure 4). The maximum load at which the specimen failed was recorded and the slitting tensile strength determined from Equation 3.

\[ f_t = \frac{2P}{\pi Ld} \]  

(3)

Where \( f_t \) is the splitting tensile strength; \( P \) is the maximum load sustained by the specimen; \( d \) is the diameter of the specimen and \( L \) is the length of the specimen.

Figure 4: Tensile strength test process

Erosion test was performed using Drip (Geelong) method to determine the rate of erodability of the specimen. The test was conducted in accordance with New Zealand Standard (NZS 4298, 1998). The equipment (Figure 5a) was setup with container containing water for which 100 ml mark from the top was noted (Figure 5b). Wettex (J-Cloth) of 16 mm wide (Figure 5b) was placed on the container to soak and transmit the water onto the specimen. The specimens were placed at an angle of 27° at the base and 400 mm vertically away from the J-Cloth, from which water (100ml) was dropped for between 20 minutes and 1 hour. The depth of the pit created on the specimen (Figure 5c) was then measured and the Erodability Index determined.

Figure 5: Drip (Geelong method) test process
Table 2: Compaction rate result

<table>
<thead>
<tr>
<th>Compaction rate (mm/min)</th>
<th>Sample</th>
<th>Dry Density (kg/m³)</th>
<th>Compressive strength (MPa)</th>
<th>Tensile strength (MPa)</th>
<th>Erosion (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1931</td>
<td>3.10</td>
<td>0.43</td>
<td>6.00</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1895</td>
<td>3.50</td>
<td>0.48</td>
<td>7.50</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1857</td>
<td>3.20</td>
<td>0.57</td>
<td>5.00</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>1894</td>
<td>3.30</td>
<td>0.49</td>
<td>6.20</td>
</tr>
<tr>
<td></td>
<td>Std Dev</td>
<td>38</td>
<td>0.23</td>
<td>0.07</td>
<td>1.26</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>1925</td>
<td>3.70</td>
<td>0.29</td>
<td>8.00</td>
</tr>
<tr>
<td></td>
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<td>1899</td>
<td>2.70</td>
<td>0.47</td>
<td>6.00</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1845</td>
<td>2.60</td>
<td>0.48</td>
<td>7.00</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>1890</td>
<td>3.00</td>
<td>0.41</td>
<td>7.00</td>
</tr>
<tr>
<td></td>
<td>Std Dev</td>
<td>41</td>
<td>0.62</td>
<td>0.11</td>
<td>1.00</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td>1904</td>
<td>2.40</td>
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</tr>
<tr>
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<td>3</td>
<td>1821</td>
<td>2.70</td>
<td>0.49</td>
<td>6.00</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>1866</td>
<td>2.80</td>
<td>0.46</td>
<td>7.30</td>
</tr>
<tr>
<td></td>
<td>Std Dev</td>
<td>42</td>
<td>0.37</td>
<td>0.11</td>
<td>1.53</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>1916</td>
<td>2.50</td>
<td>0.36</td>
<td>8.00</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1873</td>
<td>3.10</td>
<td>0.44</td>
<td>7.00</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1825</td>
<td>2.70</td>
<td>0.42</td>
<td>9.50</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>1871</td>
<td>2.70</td>
<td>0.41</td>
<td>8.20</td>
</tr>
<tr>
<td></td>
<td>Std Dev</td>
<td>46</td>
<td>0.28</td>
<td>0.14</td>
<td>1.26</td>
</tr>
</tbody>
</table>

RESULTS AND DISCUSSION

Dry Density
Details of the result obtained from the dry density test are presented in Table 2. The results show a closely related average density among the different compaction rates, between 1894 kg/m³ and 1866 kg/m³. This was expected due to the equal mass of the mix used for producing each specimen. Similar result was obtained in the study by Chan (2011), which the non-baked specimens did not undergo obvious density change. The density is the relationship between the volume and the mass of the blocks, and therefore shows how compact the blocks are. The dry density is largely a function of the constituent material’s characteristics such as moisture content at pressing and the degree of compaction effort applied (Walker, 1995). This implies that the compaction rates may have some influence on the density of the blocks. Although there was slight difference in the density among the compaction rates, the result indicates that the lower
rate of compaction achieved the highest density. This implies that the slower the application of compaction load the better the arrangement of the material constituents, making the block denser.

**Compressive strength**
Figure 6 presents summary of the compressive strength test results. The details of the results can be found in Table 2. The results indicate that the average compressive strength decreased with increase in compaction rates. Implying that the higher the compaction rate the lower the compressive strength of the blocks. The reduction could be attributed to the reduced density of the blocks as the compaction rate increases. This shows a clear relationship between the compressive strength and the density of the soil blocks, which recorded decrease in their values with increased compaction rate. This aligns with Gooding and Thomas (1997) assertion that a given increase in density will result in a greater increase in strength.

![Figure 6: Compressive strength test result](image)

There was about 19% increase in the average compressive strength of the lower (1 mm/min) over the higher (15 mm/min) compaction rate. However, One Way Repeated Measures Analysis of Variance (ANOVA) test result at 95% confidence interval (Table 3) indicates that the differences in the mean values among the different compaction rates are not great enough to exclude the possibility that the difference is due to random sampling variability. There is therefore not a statistically significant difference (p =...
Danso

0.491) in compressive strength among the different compaction rates of the soil blocks.
Table 3: Summary of test of significant difference (One Way RM ANOVA)

<table>
<thead>
<tr>
<th></th>
<th>Compressive strength (MPa)</th>
<th>Tensile strength (MPa)</th>
<th>Erosion (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Missing</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F</td>
<td>0.907</td>
<td>2.211</td>
<td>0.990</td>
</tr>
<tr>
<td>p (Sig.)</td>
<td>0.491</td>
<td>0.188</td>
<td>0.458</td>
</tr>
</tbody>
</table>

Significant at 0.05 (p-value)

Splitting tensile strength
The summary of the splitting tensile strength test result is presented in Figure 7. Details of the results can be found in Table 2. The trend of the result is similar to the compressive strength, however, the 10 mm/min speed recorded an increase in tensile strength over both 5 and 15 mm/min compaction rates. The lower compaction rate recorded the highest strength while the highest compaction recorded the lowest as in the case of compressive strength. This trend can also be linked to the result of the dry density, meaning there is a relationship between the tensile strength and density as well as the compressive strength. This means the lower compaction rate application makes the soil particles arrange very well by eliminating bigger pores in the soil matrix, which contributes to the increase resistance of the material against splitting failure.

![Tensile strength test result](image.png)

Figure 7: Tensile strength test result
There was about 20% average tensile strength increase of the lower compaction rate over the higher compaction rate. There was similar trend in the compressive strength results. The One Way ANOVA test result (Table 3) indicates that there is not a statistical significant difference ($p = 0.188$) between the compaction rates of the soil blocks.

**Erosion test**

Summary of the erosion test results are provided in Table 4, while the details can be found in Table 2. It can clearly be seen from the results that the average depth of pit increased with the increase in compaction rates. This shows a relationship with the results of the density test, where density of the blocks reduced with increased compaction rates. This suggests that densification of the blocks affects the rate of the erosion of the soil blocks. The low rate of compaction increased the density of the soil blocks with reduction in the erodability rate. This means that the lower the compaction rate of producing soil blocks the lower the effect of erosion by rain or water on the blocks.

<table>
<thead>
<tr>
<th>Compaction rate (mm/min)</th>
<th>Average depth of pit (mm)</th>
<th>Erodability index ($E_I$)</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6.2</td>
<td>3</td>
<td>Erosive</td>
</tr>
<tr>
<td>5</td>
<td>7.0</td>
<td>3</td>
<td>Erosive</td>
</tr>
<tr>
<td>10</td>
<td>7.3</td>
<td>3</td>
<td>Erosive</td>
</tr>
<tr>
<td>15</td>
<td>8.2</td>
<td>3</td>
<td>Erosive</td>
</tr>
</tbody>
</table>

**Keys:** $E_I 1=0$ (None-erosive), $E_I 2=0<5$ (Slightly erosive), $E_I 3=>5<=10$ (Erosive), $E_I 4=>10$ (Very erosive)

There is also a relationship between the strength test results and the erosion results. The trend of the test results for compressive strength and drip are similar, as in both cases there were reduction in strength and erosion resistance with increase compaction rate. The results show that the average depth of pit for all the compaction rates were within erodability index of 3, which means they were all erosive and therefore failed erosion test (NZS 4298, 1998). However, the low compaction rate performance was better than the higher rates. Conversely, the test of significant difference (Table 3) indicates that there is not a statistically significant difference ($p = 0.458$) among the compaction rates of producing the blocks.

**CONCLUSION**

The aim of this study was to investigate the effect of compaction rate for producing soil blocks on the engineering properties of the blocks. Based the above findings, the following concluding remarks can be made:
The lower compaction rate for producing soil blocks obtained a better performance characteristics in terms of physical, mechanical and durability. Thus, 1 min/mm compaction rate recorded the highest density, compressive strength, splitting tensile strength and the erosion resistance of the blocks.

There was good relationship between the test types. Thus, the compressive strength test result could be associated with the density test result of the blocks. There was also a similar trend in the test results of compressive strength and the tensile strength. Similarly, there was a common trend in the test results of the density and the erosion.

Test of significance by One Way RM ANOVA at 95% confidence interval for all the test types suggested that there was no a statistically significant difference among the different compaction rates of producing the soil blocks.

The study therefore concludes that although the low rate of compaction achieved better performance characteristics, the hypothesis is rejected, indicating that there is no statistically significant difference between the soil blocks produced with low compaction rate and high compaction rate. This study has demonstrated that there is not much effect on the strength properties of soil blocks produced from low and high compaction rates, but suggests to researchers and practitioners to choose low compaction rate due to its better performance characteristics. Manufacturers of compressed earth block machines may also consider producing machines that do not use high rate of compaction, since it will not improve the strength properties but only consume high energy. Another important factor of making soil blocks is the type of pressure applied, further studies on the use of static and dynamic forces in production of soil blocks are therefore recommended.

REFERENCES


EFFECT OF CRUSHED CERAMICS WASTE PARTIALLY REPLACED WITH FINE AGGREGATE IN HOT MIX ASPHALT

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This research studies the effect of Crushed Ceramic Waste (CCW) partially replaced with fine aggregate in Hot Mix Asphalt (HMA). The ceramics used was obtained from laundry sink which was cleaned and crushed. Marshall Method was used to determine the Optimum Binder Content (OBC) and to evaluate the properties of the asphalt mix. In total, twenty-seven (27) samples were prepared, of which all have been used to determine the OBC, and the effects of adding different percentages of CCW to the asphalt mixture. Marshall Samples showed that the OBC was 5.5% of the total weight of the HMA. Also, the Marshall Samples containing different percentages of ceramic showed that the optimal replacement ratio of CCW was 12.5% of the weight of the aggregate which was against the optimal replacement ratio of 10% by Wu, et al., (2003).

Keywords: bitumen, ceramic, fine aggregate, hot mix asphalt, Marshall Method

INTRODUCTION

With the rapid economic growth and continuously increased consumption of resources, a large amount of waste materials is generated. Among them, waste glass material is an important part. Glass material is nonmetallic and inorganic, it can neither be incinerated nor decomposed, so it may be difficult to reclaim (Wu, et al., 2003). Dealing with the growing problem of disposal of materials is an issue that requires coordination and commitment by all parties involved. One solution to a portion of the waste disposal problem is to recycle and use these materials in the construction of highways (Arnold et al., 2008).

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Crushed ceramic is a readily available, environmentally clean, relatively low cost material whose engineering performance properties generally equal or exceed those of most natural aggregates (Wartman et al., 2004). Although the ceramics is a nonmetallic inorganic material that cannot be decomposed or burned, till now there is no use of recycled ceramic in Nigeria. There are many applications that could make use of the recycled ceramics such as using ceramics as aggregate in road base and sub-base, aggregate in asphalt, aggregate in tiles, aggregate in decorative concrete for architectural facades, filtration material, alternative to fill and bedding material, aggregate in concrete and asphalt. The use of ceramics in these applications will contribute in minimizing the area of landfills and saving the natural resources by reducing the demand of raw materials. This study was conducted to investigate the effect of using crushed ceramic waste partially replaced with fine sand in Hot Mix Asphalt (HMA) as an idea to find out the best percentage of Crushed Ceramic Waste (CCW) that could be used to produce the asphalt under the local conditions in Nigeria.

**Waste Ceramic**

Ceramic is a transparent material produced by melting a mixture of materials such as silica, soda ash, and CaCO₃ at high temperature followed by cooling where solidification occurs without crystallization (Gautam, et al., 2012).

**Ceramic with asphalt**

In recent years, the discovery of several economic and environmental benefits could increase the use of recycled ceramic in highway construction, making the evaluation of the engineering properties of ceramic and aggregate mixes necessary. The uses of recycled ceramic have varied widely, depending on the specific application. Crushed recycled ceramic, has been used independently, and has also been blended with natural construction aggregate at different replacement rates (Finkle and Ksaibati, 2007). Viswanathan (1996) in his work titled “Characterization of Waste Recycled Ceramic as a Highway Material”, found that crushed ceramic has properties similar to natural aggregates and could be used as a highway material.

**RESEARCH METHOD**

**Materials**

The constituent materials used were natural aggregates, bitumen, filler and waste ceramic. The bitumen used was obtained from Mothercat construction company yard at Kafur Local Government, Kastina State. The cement used was Ordinary Portland Cement manufactured in Nigeria. The fine aggregate used was a natural sharp sand having a maximum nominal size of 2.36mm, while the coarse aggregate were machine crushed rock locally obtain from a quarry in Zaria and all the aggregate used for the work are from the same source. The ceramic used was obtained from a demolished house in Science School Quarters, Kufena Wusasa Zaria, Kaduna State-Nigeria.
Methodology
For investigating the properties of asphalt with ceramic and to find out the suitability of using crushed ceramic waste in asphalt mixtures, an extensive experimental work was conducted.

- Evaluating the properties of constituent materials (i.e. bitumen, aggregates, and crushed ceramic waste) to be used for asphalt mixture. The various tests carried out on the bitumen includes penetration test, viscosity test, flash and fire point, solubility test, ductility test and softening point (Ring and Ball) test in accordance to ASTM Standard Specification. These tests were conducted in Transportation Laboratory of the Ahmadu Bello University Zaria. Also, the various tests carried out on the cement includes consistency of standard paste of cement (initial and final setting time) and soundness test.
- Carrying out sieve analysis for CCW and each aggregate type.
- Blending of aggregate to obtain gradation curve which would be used in the preparation of the asphalt mix.
- Determination of OBC using Marshall Test.
- Preparation of asphalt mixes with various percentages of CCW using OBC obtained.
- Evaluating the properties of the asphalt-ceramic mixes using Marshall Stability Test analysing the laboratory tests results obtained.

RESULTS

Table 1: Result of Preliminary Tests on Bitumen

<table>
<thead>
<tr>
<th>Test</th>
<th>Test Method (ASTM)</th>
<th>Specification by codes for penetration Grade*</th>
<th>Results obtained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penetration at 25°C</td>
<td>D5</td>
<td>40/50 60/70 80/100</td>
<td>98</td>
</tr>
<tr>
<td>Flash point and fire point</td>
<td>D92</td>
<td>232 232 219</td>
<td>240</td>
</tr>
<tr>
<td>(°C) Min.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solubility in carbon tetrachlorid (CCl4) (%) Min.</td>
<td>D2042</td>
<td>99 99 99</td>
<td>99</td>
</tr>
<tr>
<td>Specific gravity at 25°C Min.</td>
<td>D70</td>
<td>0.97-1.02 0.97-1.02 0.97-1.02</td>
<td>1.00</td>
</tr>
<tr>
<td>Ductility at 25°C Min.</td>
<td>D113</td>
<td>- 50 75</td>
<td>100</td>
</tr>
<tr>
<td>Viscosity (mm³/s)</td>
<td>D4402</td>
<td>220-400 120-250 75-150</td>
<td>138</td>
</tr>
</tbody>
</table>

Tests on pure bitumen
The results obtained for consistency tests conducted on the pure bitumen and its comparison with the standard specification by ASTM Standard are as presented in Table 1.


Discussion
From the result obtained (98°C), the penetration falls within penetration grade 80-100 which is suitable for HMA design. For the viscosity, the result obtained (138mm³/sec) conforms to the viscosity requirement (75-150mm³/sec) for penetration grade of 80-100; it is therefore suitable for HMA design. The flash and fire point result obtained (240°C) conforms to the ASTM D92 requirement (219°C) for penetration grade of 80-100; it is therefore suitable for HMA design. Solubility test result of 99% conforms to the ASTM D2042 requirement (99%) for penetration grade of 80-100. Also, ductility test result obtained (100mm) conforms to the ASTM D113 requirement (75mm) for penetration grade of 80-100; it is therefore suitable for HMA design.

Tests on CCW
Test result obtained was compared with those specified by ASTM test methods for use as admixture in asphalt concrete. Table 2 presents the physical properties of CCW obtained for this research. The Ceramics had a specific gravity of 1.89 which falls within specified range according to ASTM C127 and ASTM D854.

The particle size distribution curve for coarse aggregate, CCW and fine aggregate were presented in Figure 1 and 2 respectively.

![Figure 1: Particle Size Distribution Curve for Coarse Aggregate](image-url)
Figure 2: Particle Size Distribution Curve for Crushed Ceramic Waste

Table 2: Selected Physical Properties of Waste Ceramics

<table>
<thead>
<tr>
<th>Test</th>
<th>Crushed ceramic Samples</th>
<th>ASTM Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particle Shape Angularity Flat (%)</td>
<td>Angular 20-30 1.2</td>
<td>Angular 1.1</td>
</tr>
<tr>
<td>Flat/Elongated (%)</td>
<td>Angular 1.1</td>
<td></td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>1.96 - 2.41</td>
<td>2.49 - 2.52</td>
</tr>
<tr>
<td>Permeability (cm/sec)</td>
<td>2 x 10^{-1}</td>
<td>6 x 10^{-2}</td>
</tr>
</tbody>
</table>

Tests on OPC
The test results obtained for the preliminary test on OPC and its comparison with the Standard of Specification are presented in Table 3.
Table 3: Comparison of Test Result on the OPC with Standard

<table>
<thead>
<tr>
<th>Property</th>
<th>Unit</th>
<th>Test results</th>
<th>Code used</th>
<th>Code specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial setting time</td>
<td>Min</td>
<td>44</td>
<td>BS EN 196 PART 3 (1995)</td>
<td>&gt;45mins</td>
</tr>
<tr>
<td>Final setting time</td>
<td>Hr-min</td>
<td>5hrs</td>
<td>BS EN 196 PART 3 (1995)</td>
<td>&lt;10hrs</td>
</tr>
<tr>
<td>Soundness</td>
<td>mm</td>
<td>2</td>
<td>BS EN 196 PART 3 (1995)</td>
<td>&lt;10mm</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>-</td>
<td>2.43</td>
<td>ASTM C188</td>
<td>3.15</td>
</tr>
</tbody>
</table>

Discussion

From Table 3, the initial setting time obtained was 44 minutes while the final setting time obtained was 5 hours. Comparing with the code specification, it conforms with the stipulated setting times values of 45 minutes and 10 hours for initial setting and final setting times respectively. Also, the difference between the lengths was 2.00mm which was less than 10mm specified by the code. Therefore the cement is suitable for engineering purposes.

Table 4: Summary of Marshall Analysis at 0%CCW/100% Sand (Control)

<table>
<thead>
<tr>
<th>Bitumen Content (%)</th>
<th>Stability (kN)</th>
<th>Flow (mm)</th>
<th>CDM (g/cm³)</th>
<th>VIM (%)</th>
<th>VMA (%)</th>
<th>VFB (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.5</td>
<td>3.97</td>
<td>2.43</td>
<td>1.78</td>
<td>28.51</td>
<td>36.22</td>
<td>21.31</td>
</tr>
<tr>
<td>5.5</td>
<td>6.70</td>
<td>3.00</td>
<td>1.49</td>
<td>39.40</td>
<td>47.27</td>
<td>16.63</td>
</tr>
<tr>
<td>6.5</td>
<td>2.73</td>
<td>5.64</td>
<td>1.53</td>
<td>36.78</td>
<td>46.33</td>
<td>20.61</td>
</tr>
<tr>
<td>7.5</td>
<td>3.81</td>
<td>3.56</td>
<td>1.55</td>
<td>35.15</td>
<td>46.75</td>
<td>24.81</td>
</tr>
<tr>
<td>8.5</td>
<td>2.96</td>
<td>4.10</td>
<td>1.65</td>
<td>30.08</td>
<td>43.88</td>
<td>31.43</td>
</tr>
</tbody>
</table>

Table 5: Summary of the result

<table>
<thead>
<tr>
<th>Percentage of CCW (%)</th>
<th>Stability (kN)</th>
<th>Flow (mm)</th>
<th>CDM (g/cm³)</th>
<th>VIM (%)</th>
<th>VMA (%)</th>
<th>VFB (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>6.70</td>
<td>3.00</td>
<td>1.49</td>
<td>39.40</td>
<td>47.27</td>
<td>16.63</td>
</tr>
<tr>
<td>5.00</td>
<td>6.00</td>
<td>2.20</td>
<td>1.95</td>
<td>20.63</td>
<td>29.89</td>
<td>33.32</td>
</tr>
<tr>
<td>7.50</td>
<td>6.30</td>
<td>2.40</td>
<td>1.89</td>
<td>20.77</td>
<td>30.44</td>
<td>24.65</td>
</tr>
<tr>
<td>10.00</td>
<td>6.50</td>
<td>6.20</td>
<td>1.82</td>
<td>25.64</td>
<td>40.00</td>
<td>25.43</td>
</tr>
<tr>
<td>12.50</td>
<td>6.80</td>
<td>2.10</td>
<td>1.82</td>
<td>25.42</td>
<td>34.09</td>
<td>25.43</td>
</tr>
<tr>
<td>15.00</td>
<td>6.72</td>
<td>2.50</td>
<td>1.84</td>
<td>25.87</td>
<td>33.12</td>
<td>26.25</td>
</tr>
<tr>
<td>17.50</td>
<td>6.67</td>
<td>2.20</td>
<td>2.03</td>
<td>18.27</td>
<td>27.69</td>
<td>63.98</td>
</tr>
<tr>
<td>20.00</td>
<td>6.70</td>
<td>2.60</td>
<td>1.75</td>
<td>27.76</td>
<td>36.76</td>
<td>25.80</td>
</tr>
<tr>
<td>22.50</td>
<td>6.10</td>
<td>2.50</td>
<td>1.74</td>
<td>27.76</td>
<td>36.00</td>
<td>23.52</td>
</tr>
<tr>
<td>25.00</td>
<td>5.90</td>
<td>2.60</td>
<td>2.04</td>
<td>15.10</td>
<td>24.80</td>
<td>54.20</td>
</tr>
</tbody>
</table>
Marshall Test Results
A number of twenty-seven (27) samples each of weight 1200 gram, were prepared using five different bitumen contents (4.5, 5.5, 6.50, 7.5 and 8.5 % by total weight) in order to determine the OBC. The result of Marshall Analysis for the control and with different percentages mixes of CCW were presented in Table 4 – 5. The relationships between binder content and the properties of mixtures {stability, Flow, Void Filled with Bitumen (VFB), Void in Mineral Aggregate (VMA), Void in the Mix (VIM) and Compacted Density of Mix (CDM)} were presented in Figures 4 – 9.

Discussion
From Figure 4, it was observed that the maximum stability of HMA was 6.7 kN at 5.5% bitumen content, which is greater than the minimum value 6.6 kN specified by the standard shown in Table 6 for heavy traffic.

### Table 6: Typical Marshall Mixture Design Criteria

<table>
<thead>
<tr>
<th>Description</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Base course</td>
<td>Binder or levelling course</td>
<td>Wearing course</td>
</tr>
<tr>
<td>Marshall Specimen (ASTM D 1559)</td>
<td>Min. 75</td>
<td>Min. 75</td>
<td>Min. 75</td>
</tr>
<tr>
<td>No of comp. Blows, each end of specimen</td>
<td>Max. 75</td>
<td>Max. 75</td>
<td>Max. 75</td>
</tr>
<tr>
<td>Stability (N)</td>
<td>2224</td>
<td>3336</td>
<td>6672</td>
</tr>
<tr>
<td>Flow (0.25mm or 0.01inch)</td>
<td>8 16</td>
<td>8 16</td>
<td>8 16</td>
</tr>
<tr>
<td></td>
<td>(2) (14)</td>
<td>(2) (14)</td>
<td>(2) (14)</td>
</tr>
<tr>
<td>VMA</td>
<td>13</td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td>Air voids, (%)</td>
<td>3 8</td>
<td>3 8</td>
<td>4 6</td>
</tr>
<tr>
<td>Aggregate VFB (%)</td>
<td>60 80</td>
<td>65 85</td>
<td>70 85</td>
</tr>
</tbody>
</table>
Discussion
Figure 5 presents the flow of the mix results for different bitumen contents. From Figure 5, it was observed that the maximum flow of HMA is at 6.5% bitumen content.

Discussion
Figure 6 presents the CDM results for different bitumen contents. From figure 6, it was observed that the maximum CDM was 1.78 g/cm³ at 4.5% bitumen content and then began to fall with increase in bitumen content.

Discussion
Figure 7 presents the VIM results for different bitumen contents. From figure 7, it was observed that the maximum VIM was 50 at 5.5% bitumen content and then began to fall with increase in bitumen content.
Discussion
From Figure 7, it was observed that the VIM content increases at 4.5% then gradually decreases with increasing bitumen content.

![Figure 8: VMA vs. bitumen content](image)

Discussion
From Figure 8, it was noticed that the VMA is highest at 5.5% bitumen content with a value of 47.27%. This value is greater than the minimum value of 16% for a maximum aggregate size of 9.5mm (used for the HMA) as stated Table 6.

![Figure 9: VFB vs. bitumen content](image)

Discussion
From Figure 9, it was observed that the VFB% increase at 5.5% and gradually as bitumen content increase and that due to the increase of VFB in the HMA.
Optimum bitumen content (OBC)
The OBC was found to be 5.5% by weight of the total mix which was calculated as the average of bitumen content values that corresponds to the maximum stability, maximum density and median of the air voids.

Discussion
Figure 10 shows that the stability increases as the CCW content increases but to decrease from 12.5 % CCW content corresponding to 6.8 kN.

Discussion
Figure 11 shows that the maximum flow of 6.2 was obtained at 10% CCW while the minimum flow of 2.21 was obtained at 12.5% CCW. Although there were variations in the flow of samples, they all fall within 2-14mm specifications for heavy traffic according to Table 6.
Discussion

From figure 12, the CDM was 1.49 at 0% CCW. It was observed that the variation for the CDM was maximum at 25% CCW with a value of 2.04 for the CCW mix.

Discussion

From figure 13, the percentage void in mix (VIM) was determined to be 39.4% at 0% CCW content and then oscillate between 12.5 – 25% CCW.

Discussion

From figure 14, the percentage void in mix (VIM) was determined to be 39.4% at 0% CCW content and then oscillate between 12.5 – 25% CCW.
**Discussion**

From figure 14, the VMA was found to decrease with increase in CCW. The value obtained still full within the specification given in Table 6.

![Figure 15: Asphalt Voids Filled with Bitumen – CCW content relationship](image)

Discussion

The voids fill with bitumen (VFB) at 0% CCW was obtained to be 16.63%. It has a highest value of 63.98% at 17.5% CCW and then oscillates down to 25% CCW.

**Optimum Crushed Ceramic Waste Content**

From Figure 10, it was observed that all values of Marshall Stability for different CCW content satisfy the specifications and the maximum stability corresponds 12.5% CCW content. Figure 13 represents the VIM percentage at different CCW content. Also, it was observed from figure 13 that at 12.5% CCW content the corresponding VIM value was close to that in the specifications. Figure 12 shows that all the values of CDM at different CCW content are very close to each other and all achieved the specifications requirements.

**CONCLUSION**

The objective of this study was to investigate the effect of CCW as fine aggregate in the HMA, where the results can be concluded as the following:

a) CCW can be used in HMA with an optimum replacement of 12.5% aggregate.

b) Marshall Stability and the CDM achieve the specifications requirements with 12.5% CCW content.
RECOMMENDATION

The results of this study apply only to the specific gradation and the type of ceramic that was used. It is therefore recommended that further studies are required for various ceramic gradation and different percentages of CCW content.

REFERENCES


A period during which a country’s economy is performing baldly or a business cycle contraction or general slowdown in economic activity in a country over a sustainable period of time is known as financial crisis. The financial crisis that started in August, 2007 in the United States due to difficulties in making higher payment on adjustable mortgages and which resulted into sub-prime mortgage crisis was experienced all over the world. This research examined the financial performance of indigenous construction firms in Katsina state before and during the period of financial crisis with an aim to establish how the crisis affected their performance. Questionnaire survey was adopted for the study. Financial records of the firms were evaluated using three Profitability and Efficiency Financial Ratios as the financial indicators of the firms’ performance. Results obtained indicated that Global Financial crisis has impacted negatively on the performance of the indigenous construction firms in the state. In 2007 there was a sharp drop in firms’ averages in ‘Return on Capital Employed’ to -15.38%. In 2008 average ‘Return on Equity’ and Net Profit Margin’ dropped to -10.61% and -0.038%, respectively. Other impacts disclosed by the study included; projects cancellation, default on repayment of loans and loss of bonds, high rate of job loss and wages cut. It was recommended, among other things that construction firms should diversify their operations and should also exploit the benefits of joint venture and/or partnership in order to cushion effects such as that of the global financial crisis.

Keywords: financial crisis, financial ratio, indigenous firm, performance, period.

INTRODUCTION

Soludo (2009) opined that the financial crisis that hit the global economy in 2007 started in the United States when in August, 2007 households faced difficulties in making higher payment on adjustable mortgages resulting into sub-prime mortgage crisis. By the first quarter of 2008,
there was widespread ‘credit contraction’, as financial institutions in the
country tightened their credit standards in the light of deteriorating
balance sheets. As a result of this, the general economy of the world was
affected including job losses as a result of decreased economic activity.

Generally, the effects of this situation spread all over the economic and
financial sectors of many countries including construction and
manufacturing sectors. Laryea et al (2012) identified such effects on the
local construction firms in the West African countries to include
plummeting growth rates and falling private and public spending.
Consequently, these limit the scope for domestic expansion and
innovation. In the past, several financial crises were experienced across
the world with far reaching effects.

Financial crisis is defined as a period during which a country’s economy is
performing baldly (Collin Co-build Dictionary 1996). It is also defined by
Merriam Webster Online Dictionary (2009) as a business cycle contraction
or general slowdown in economic activity in a country over a sustainable
period of time. Empirically, when a country realises at least two
consecutive quarters of negative growth, then it is said to experience
financial crisis (McConnel and Bruce 2005; and Modimoeng, 2009).
Moreover, Achuthan and Banerji (2008) view financial crisis as a decline of
economic activity that manifests itself through widespread contraction in
all economic sectors which last for at least six month. According to Rogoff,
(2002), global financial crisis is said to occur when global economic growth
drops to below 3%. Financial crisis is not similar to depression. Depression
is an adverse economic downturn that last for several years, while
financial crisis is just a temporary collapse of a business cycle (Nagpal
1982; Amadeo 2009).

Economic growth of a nation, region and the world as a whole can be
evaluated at macroeconomic level using indicators such as Growth
Domestic Product (GDP), Unemployment Rate and Price Indices, among
others. However, at microeconomic level financial analysis provides a base
upon which financial strength and weakness of individual firm can be
Ratios are tools for measuring the relationship between various elements
of performance to see whether we a getting better or worse. Thus, financial
ratio analysis is establishes the relationship between financial data in the
financial statements to aid the financial condition and performance of a
firm. Such analysis may be ‘Trend’ in nature (for comparing present with
past and expected future ratios for the same company), ‘Cross Sectional,’
(compares rations of similar companies) and rations that used to compare
with industry average at the same point in time. Financial ratios are
broadly categorised into Liquidity Ratios, Activity and Asset Management
Ratios, Debt/Leverage/Gearing Ratios, Coverage Ratios and Profitability
Ratios.

This paper is aimed at evaluating the effect of the global financial crisis on
financial performance of indigenous construction firms in Katsina State
with focus on profitability and efficiency of the firms during the period of the global financial crisis. Thus the study would be conducted in only in the context of Firms' Profitability Ratios within the period of study.

HISTORICAL BACKGROUND, CAUSES AND EFFECTS OF FINANCIAL CRISIS

According to NBER (2008), since 1854, the United States has encountered 32 financial crises. In 1980s the US experienced a severe financial crisis which began in July 1981 and ended in November 1982 (Urquhart and Hewson, 1983). Another crisis hit much of the world in the 1990s. Early in 2000 financial crisis was mostly experienced in the Western countries and the US. Moreover, Adam et al (2009) has the view that the recent crisis can be attributed to a number of factors in both housing and credit markets, which developed over an extended period of time. In the first place, ‘Liberalization of Global Financial Regulations’ is one reason for the crises. The regulatory model adopted by banks in US and elsewhere emerged as a result of liberalization of banking business in the early 1990s and international consensus reached within the ‘Balse Committee of banking Supervision’ as regards the acceptance model of prudential supervision of banking institution. This liberalization facilitates the global abolition of restrictions on capital flows in the 1990s and caused the operation of international investment funds to be largely unregulated. Other identified causes were ‘Boom and Bust’ in the housing market (a combination of low interest rates and large inflows of foreign funds), Speculation and poor credit rating due to securitization practices of high-risk loans.

Anan (2009) noted that in Africa, many countries faced difficult times. The effects of the global economic recession and climate change had reversed the progress the continent has made over the last decade with many countries experiencing reduced trade and economic activity, withdrawal of investors and an acute scarcity of credit; projects were postponed or cancelled altogether. Financial inflows dropped, including levels of international assistance and remittances.

The last few years have been a trying period for most corporate institutions the world over, with many companies either going bankrupt or completely folding up. Spa girl (2009) noted that corporate organizations in general and particularly financial institutions and construction firms have been the worst affected. Even the small holder businesses and non-governmental organizations (NGOs) are not left out of the crises. Many of the NGOs were either seen to be closing shops or laying staff to manageable sizes (Mu’azu, 2009). Specific examples include cancellation of Murray and Roberts’ 3.2 billion Riyals Donald Trump Tower in Dubai, in addition to cutting down at least 1400 of its workers, drop in value of houses and pension savings decimated on stock market and the drop in the economic growth of the South African manufacturing industry from 46.2% to 6.7% in 2008 (Classen 2009; Buczynski and Bright 2009; Hart 2009).
RESEARCH METHOD

Data Collection
In order to achieve the aim of this research, the work was pursued through literature review and field surveys. Questionnaire survey was adopted for the study. The questionnaire was divided into three sections (A, B and C). Section A was designed to obtain information regarding registration category of firms, age of the firms, specialty and number of projects handled within the period of study. Section B was designed to appraise the effect of the financial crisis on firms’ such as project cancellation, job loss among workers, loss of bond from banks and the possible action taken by the firms in response to the prevailing difficulties imposed by the crisis (salary cut, retrenchment and diversification). Section C was devoted to acquiring financial data from the firms (Balance sheet and profit and loss account).

Due to lack of records and in other instances, confidential reasons, Company Audited Accounts were used in place of the Balance Sheets (the ideal data). The principal data consisted among others; the value of turnover from each firms as well as each firms equity capital and profit for each year during the period considered (2005 – 2010).

Types of construction firms and sample of study
Basically, two types of construction firms exist in the study area; Multinationals and Indigenous Construction firms. According to Katsina State Tenders Board (2012), there are 200 registered Indigenous Construction firms with the Board. Out of these, a sample size of 75 was calculated using approach outlined by Barlett et al (2001). Thus 75 questionnaires were administered to the management of the firms. A total of 57 questionnaires were returned. However, only 12 firms provided their financial data. Therefore, analysis conducted was based on 16% of the administered questionnaires and 21.1% of returned questionnaires.

Data analysis techniques
The data collected was analysed and presented based on the various sections of the questionnaire. Generally, data obtained using sections A and B of the questionnaire was analysed using simple percentages. On the other hand, section C was analysed based on the principles of the tools of financial ratios.

This paper focuses on the Efficiency and Profitability group of ratios which include; Return on Capital Employed (ROCE), Return on Equity (ROE), Net Profit Margin (NPM) and Gross Profit Margin (GPM). The group of ratios is concerned with relative profitability and efficiency of utilisation of resources of a business. Due to insufficient data, only first three were covered by the paper. The computation of these ratios is described according to Suraj (2009) and Jonathan (2009) as follows:
Return on Capital Employed (ROCE)
Return on capital employed (ROCE) is a ratio that is used to measure how much a company gets for the cost of its capital (overall profitability of a company). It shows whether the company is obtaining adequate profit for the amount of capital it owns. The higher the ratio, the better the company is. To calculate the return on capital employed, the total assets, current liabilities, revenue and operating expenses need to be established. The ratio is calculated using equation 1 below.

\[
ROCE = \frac{Profit \ before \ interest \ and \ tax}{Total \ Assets - Current \ Liabilities} \times 100\% \tag{1}
\]

Return on Equity (ROE)
Return on Equity (ROE) shows the firm’s earning power on shareholder’s book value investment. The ratio is obtained using equation 2.

\[
ROE = \frac{Profit \ after \ Tax}{Share \ Capital + Reserves} \times 100\% \tag{2}
\]

Net Profit Margin (NPM)
This shows the relation of profit after considering all revenues and expenses to sales. It measures the profit made on sales after all the running expenses have been deducted from the gross profit. The higher the net profit ratio, the better it is. Equation 3 is used to calculate the value of NPM.

\[
NPM = \frac{Profit \ before \ interest \ and \ tax}{Sales \ results} \times 100\% \tag{3}
\]

The analysis of the financial data obtained was based on the response of 12 indigenous construction firms in the state. This resulted from the high rate of lack of incomplete or poor financial information and data confidentiality.

Profiles of Responding Firms
The response of Section A of the questionnaire indicated that the indigenous firms have various registration statutes with the Federal Government, State Government and Local Governments. This indicated their recognition by government to practice as construction firms.
Regarding firms’ years of existence, response indicated that 14.55% of the companies exist between 0 – 8 years, while 85.45% exist for 9 and above years in operation. This suggests that most of these companies have been in operation for a long period in the state, particularly before the period of the financial crisis.

Companies with Building Construction as their specialization fall in the category – ‘Building’ only, while those undertaking construction works in civil engineering works are in the category of ‘Civil Engineering Company’, while all other companies outside these two classes are grouped as ‘Others’. Hitherto, the response indicated that 76.36% of the firms are Building firms, with 18.18% Civil Contractors only, and 5.45% undertake other specialty works. This showed that majority of the companies do undertake Building works.

Appraisal on the number of projects handled within 9 years by the firms revealed that about 61.90% of the firms handled 4-6 projects. On other hand, 19.05% handled only 1-2 projects within the years, 11.90% handled 2- 4 projects, and 7.15% handled above 6 projects within the period.

Impact of Global Financial Crisis

Impact not based on financial analysis

Generally, 83.33% of the firms expressed that they have experienced the impact of the financial crisis in the performance of projects awarded to them in several ways, while 16.67% of the firms claimed that they did not experience the impact of Financial crisis in the execution of the their projects. This suggests that the impact is significant. Such impacts included projects cancellation, loss of bonds from bankers, loss of jobs among personnel, wages cut and diversification into some other businesses.

Response indicated that 37.14% of the companies experienced projects cancellation during the period under study. The remaining 62.86% attested otherwise. Even though the percentage of those firms that did not experienced projects cancellation during the period is comparably lower, however this can lead to other problems such loss of jobs.

The study discovered that 85.71% of the firms used to source loan from banks, while only 14.29% of the firms finance themselves in some other ways. However, according to the respondents, during that period, banks ceased provide long – term loans. The loans disbursed were limited to less than 10 years with high interest rate (22 – 27%). Thus, borrowers were unable to cope with prevailing interest charges. The short period and high interest rates on loans may not be unconnected to the liquidity problem being faced by banks as a consequence of the financial crisis. This became a major challenge to the firms as bonds were difficult to get from the banks to secure contacts.

The research revealed that 85.71% of the companies experienced loss of jobs among workers. This illustrated that loss of jobs cut across firms
irrespective of whether a contract was cancelled or not. Generally, the research established that 48.57% of the firms had to cut down salaries of staff. This became necessary in order to remain in business and to avoid staff retrenchment. 34.29% of the firms revealed that in order to avoid staff retrenchment or salary cut and also to survive they had to diversify into other businesses.

**Impacts based on financial analysis**

Trend analysis was generally employed to study the impact of the financial crisis between the years 2005 and 2009 based on the identified key financial ratios.

**Return on Capital Employed (ROCE)**

Table 1 presents the calculated values of Return on Capital Employed using equation 1.

<table>
<thead>
<tr>
<th>Firms</th>
<th>Years%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2005</td>
</tr>
<tr>
<td>Construction Marshals Ltd.</td>
<td>-10.39</td>
</tr>
<tr>
<td>Afdin Construction Ltd.</td>
<td>-23.95</td>
</tr>
<tr>
<td>Dreams Homes Ltd.</td>
<td>-2.52</td>
</tr>
<tr>
<td>Abug Investment Ltd.</td>
<td>-5.59</td>
</tr>
<tr>
<td>Makabs Engineering Ltd.</td>
<td>+7.06</td>
</tr>
<tr>
<td>AMH Universal Investment Ltd.</td>
<td>+8.09</td>
</tr>
<tr>
<td>Hamlaurat Nig. Ltd.</td>
<td>+4.20</td>
</tr>
<tr>
<td>IWT and K Ventures Ltd.</td>
<td>+8.88</td>
</tr>
<tr>
<td>A.A Hamzat Nig. Ltd.</td>
<td>+10.30</td>
</tr>
<tr>
<td>Jamil Ventures Ltd.</td>
<td>+2.20</td>
</tr>
<tr>
<td>Nda Technical Services Ltd.</td>
<td>+13.57</td>
</tr>
<tr>
<td>Akumau Ventures Nig. Ltd.</td>
<td>+42.80</td>
</tr>
<tr>
<td>Average</td>
<td>+4.55</td>
</tr>
</tbody>
</table>

A close look at the table 1 indicated that there is a sharp drop in ROCE figures among all the firms in the year 2007 and the year 2008 which coincides with the financial crisis period. This was followed by a general rise in subsequent years, possibly due to recapitalization by the proprietors of the firms. The companies worst hit by these changes are Akumau Ventures Ltd with a drop of 33.15% in 2007, Construction Marshals Ltd with a drop of 25.61% in 2008, IWT and K Venture Ltd with a drop 17.12% in 2009 and Abug Investment Ltd with a drop of 44.85% in 2010. The positive value indicated possible profit while negative values indicated possible loss to the respective firms. The highest profitability rise of 24.86% was observed by Afdin Construction Ltd in 2010.

**Return on Equity (ROE)**

Table 2 presents the calculated values of ROE for the firms between 2005 and 2010. The figures in table 2 indicated that all the firms studied...
experienced drop in either 2009 or 2008. However the drop is most pronounced for Afdin construction Ltd in 2010 with a figure of -28.16% followed by Construction Marshals Ltd in 2008 with a figure of -27.33%, the Abug Investment Ltd in 2010 with a figure of 26.48%. A.A Hamzat Nigeria Ltd appeared to be the worst hit because the decline was persistent for the company from 2006 up to 2010. Some rise in this ratio was experienced by some of the companies which included Construction Marshall Ltd (2.93) Afdin Construction Ltd (11.78%), Dream Homes Ltd (2.35%) and Abug Investment (31.47%). This ratio was negative for all the other companies. The average values depicted the general effect during the period of financial crisis (2007-2008). A slight improvement was recorded in 2009, but with a further decline in 2010 which suggested the difficulty the firms were experiencing in recovering from the effect of the financial crisis.

Table 2: Return on Equity

<table>
<thead>
<tr>
<th>Firms</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction Mashals Ltd.</td>
<td>-7.74</td>
<td>-1.63</td>
<td>6.23</td>
<td>-27.23</td>
<td>+2.93</td>
<td>+0.43</td>
</tr>
<tr>
<td>Afdin Construction Ltd.</td>
<td>-11.36</td>
<td>-5.01</td>
<td>-6.65</td>
<td>+7.52</td>
<td>+11.78</td>
<td>-28.16</td>
</tr>
<tr>
<td>Dreams Homes Ltd.</td>
<td>-2.61</td>
<td>-3.79</td>
<td>-3.68</td>
<td>-9.64</td>
<td>+2.35</td>
<td>-2.06</td>
</tr>
<tr>
<td>Makabs Engineering Ltd.</td>
<td>-12.10</td>
<td>-4.30</td>
<td>-7.74</td>
<td>-5.57</td>
<td>-5.49</td>
<td>-3.01</td>
</tr>
<tr>
<td>AMH Universal Investment Ltd.</td>
<td>-5.69</td>
<td>+18.85</td>
<td>-14.10</td>
<td>-6.35</td>
<td>-13.61</td>
<td>-8.95</td>
</tr>
<tr>
<td>Hamlaurat Nig. Ltd.</td>
<td>-6.20</td>
<td>-8.50</td>
<td>-4.80</td>
<td>-5.18</td>
<td>-5.92</td>
<td>-6.15</td>
</tr>
<tr>
<td>IWT and K Ventures Ltd.</td>
<td>-12.36</td>
<td>+9.77</td>
<td>-4.74</td>
<td>-10.97</td>
<td>-9.92</td>
<td>-1.00</td>
</tr>
<tr>
<td>A.A Hamzat Nig. Ltd.</td>
<td>+10.60</td>
<td>+9.70</td>
<td>-16.11</td>
<td>-26.05</td>
<td>-0.84</td>
<td>-14.17</td>
</tr>
<tr>
<td>Jamil Ventures Ltd.</td>
<td>+5.69</td>
<td>+13.16</td>
<td>-14.10</td>
<td>-6.39</td>
<td>-13.61</td>
<td>-8.95</td>
</tr>
<tr>
<td>Nda Technical Services Ltd.</td>
<td>+7.74</td>
<td>+2.51</td>
<td>-18.11</td>
<td>-23.87</td>
<td>-0.43</td>
<td>-2.93</td>
</tr>
<tr>
<td>Akumau Ventures Nig. Ltd.</td>
<td>+2.34</td>
<td>+4.01</td>
<td>-4.09</td>
<td>-17.29</td>
<td>-2.06</td>
<td>-0.29</td>
</tr>
<tr>
<td>Average</td>
<td>-4.01</td>
<td>+1.01</td>
<td>-9.68</td>
<td>-10.61</td>
<td>-0.28</td>
<td>-8.47</td>
</tr>
</tbody>
</table>

Net Profit Margin (NPM)
The calculated values for the NPM of the firms under study are presented in table 3.

From Table 3, the average figure revealed that the firms’ Net Profit Margin for the period covered was largely negative. This pointed out that as a result of financial crisis among other factors, the firms operated mainly at loss and/or at most at breakeven point in 2006 and 2007.

Closer look at the table indicated that negative trend was experienced by all the firms in the year 2008, with a first rise in 2009, except for Abug Construction Ltd whose downward trend was experienced in 2007 and IWT and K Ventures Ltd which experienced the worst downward trend in the year 2009. However, some upward (positive) trend was experienced by most of the firms in 2010 except for Makabs Engineering Ltd, Afdin Construction Ltd, AMH Universal Investment Ltd and Abug Investment...
This suggested gradual recovery in the performance of most of the firms after the period of the global financial crisis.

### Table 3: Net Profit Margin

<table>
<thead>
<tr>
<th>Firms</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction Mashals Ltd.</td>
<td>+0.01</td>
<td>+0.02</td>
<td>+0.01</td>
<td>-0.11</td>
<td>0.00</td>
<td>+0.01</td>
</tr>
<tr>
<td>Afdin Construction Ltd.</td>
<td>+0.02</td>
<td>-0.01</td>
<td>0.00</td>
<td>-0.17</td>
<td>-0.05</td>
<td>-0.06</td>
</tr>
<tr>
<td>Dreams Homes Ltd.</td>
<td>-0.04</td>
<td>-0.01</td>
<td>-0.01</td>
<td>-0.02</td>
<td>-0.01</td>
<td>0.00</td>
</tr>
<tr>
<td>Abug Investment Ltd.</td>
<td>-0.17</td>
<td>-0.04</td>
<td>-0.06</td>
<td>+0.05</td>
<td>+0.21</td>
<td>-0.17</td>
</tr>
<tr>
<td>Dreams Homes Ltd.</td>
<td>-0.04</td>
<td>-0.02</td>
<td>-0.02</td>
<td>-0.02</td>
<td>-0.02</td>
<td>+0.02</td>
</tr>
<tr>
<td>AMH Universal Investment Ltd.</td>
<td>-0.02</td>
<td>-0.01</td>
<td>0.00</td>
<td>-0.01</td>
<td>0.00</td>
<td>-0.02</td>
</tr>
<tr>
<td>Hamlaurat Nig. Ltd.</td>
<td>-0.02</td>
<td>-0.01</td>
<td>-0.01</td>
<td>-0.02</td>
<td>0.00</td>
<td>-0.02</td>
</tr>
<tr>
<td>JIWt and K Ventures Ltd.</td>
<td>+0.02</td>
<td>+0.04</td>
<td>+0.02</td>
<td>+0.03</td>
<td>-0.03</td>
<td>+0.02</td>
</tr>
<tr>
<td>A.A Hamzat Nig. Ltd.</td>
<td>-0.04</td>
<td>+0.06</td>
<td>-0.07</td>
<td>-0.06</td>
<td>+0.15</td>
<td>+0.01</td>
</tr>
<tr>
<td>Jamil Ventures Ltd.</td>
<td>-0.10</td>
<td>-0.01</td>
<td>-0.01</td>
<td>-0.02</td>
<td>+0.08</td>
<td>-0.09</td>
</tr>
<tr>
<td>Nda Technical Services Ltd.</td>
<td>-0.08</td>
<td>-0.01</td>
<td>+0.06</td>
<td>-0.07</td>
<td>+0.03</td>
<td>-0.05</td>
</tr>
<tr>
<td>Akumau Ventures Nig. Ltd.</td>
<td>-0.06</td>
<td>-0.02</td>
<td>-0.01</td>
<td>+0.05</td>
<td>-0.09</td>
<td>+0.02</td>
</tr>
<tr>
<td>Average</td>
<td>-0.04</td>
<td>0.00</td>
<td>0.00</td>
<td>-0.04</td>
<td>-0.02</td>
<td>-0.03</td>
</tr>
</tbody>
</table>

**CONCLUSION**

From the result obtained in this study, it could be concluded that Global Financial crisis has impacted negatively on the performance of indigenous construction firms in Katsina State, this is as portrayed by the pattern and behaviour of financial performance indices of the firms during the period. Moreover, many of the constructions firms suffered from projects cancellation, loss of bonds from banks. Some of the firms had to lay off part of their workforce resulting into loss of jobs among personnel. Other had to cut down wages which impacted negatively on the personnel. In order to survive many firms had to diversify into some other businesses.

Due to observed negative effects on indigenous construction firms in Katsina State as a result of the Global Financial crisis and in order for the sector to control and prevent further re occurrence, some of the following measure become desirable.

Firms should diversify their operations instead of specializing in single services to ensure flexibility during adverse economic periods. Firms should consult with the relevant professionals for proper contracts assessment in order to avoid being forced to cancel or abandon projects after they have been started. Firms should also engage in joint ventures/partnership/cooperation in order to ensure that the shortfall in skills is spared; and to ensure that the partnering firms also get work through each other.
The spirit of in-house professional training and retraining should be encouraged in order for construction workers to improve their skills and not settle for just being general labourers to avoid being vulnerable to such situations. Government should make favourable policies in order to ensure that small local firms are given certain level of preference in public jobs to encourage their growth. Small scale firms should also strive towards perfecting their trades in order to improve their status of ‘emerging’ contractors.

It is also recommended that further studies in the area should be undertaken. Of particular importance is a comparative study on the subject matter on indigenous and multi-national companies at national and regional levels. This will hitherto give a wider understand of the effect of Global Financial crisis in the construction industry.

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http://www.merriam-webster.com/dictionary/Recession
ENHANCING ARCHITECTURE IN NIGERIA THROUGH RESEARCH: BRIDGING THE GAP BETWEEN ACADEMIC AND PRACTICE-LED RESEARCH

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The architecture reflected within a society cannot go beyond the knowledge base it develops, which relates directly to the quality of research activity being conducted within it. Architectural research is commonly accepted as having two components - the academic and the practice-led component. It is not new, however there have been recent attempts to re-establish it as a research discipline. The current state of architectural research in Nigeria indicates that most research conducted is academic-led; although practice-led research occurs this is often in an ad hoc manner. By discussing two predominant orientations to architectural research as a thematic background to the discussions that follow this paper addresses two questions: where is architectural research as practiced in Nigeria situated in relation to contemporary thinking and current global practices? How may architecture in Nigeria be enhanced through research? The first question is addressed through the analysis of recent research work in Nigeria where issues of the researchers' involvement in research is explored and paradigmatic frameworks most commonly adopted are examined. The second question leads to the suggestion that from a perspective of global happenings, architectural research by bridging the gap between academic and practice-led research can potentially enhance architectural quality in Nigeria.

Keywords: academic research, architecture, architectural research, PhD dissertation, practice-led research

INTRODUCTION

Research is generally understood to be a systematic inquiry that leads to the creation of communicable new knowledge (Snyder, 1984; Archer, 1995). Architectural research in Nigeria has however lagged behind global practice and can be seen to suffer from three major deficits. First, the absence of a national discourse by architects on what constitutes architectural knowledge has hindered a clear research agenda from being established. Secondly, knowledge is always produced within a cultural...
framework through discourse and so it is essential for people outside the professional domain to also engage and contribute to architectural issues (Duffy & Hutton, 1998). There have however been limited linkages between research efforts in architecture in Nigeria and the wider society. This is important, particularly as some have argued that architectural research is needed not only to deepen architectural knowledge among architects but also to spread architectural knowledge within society (Wikforss, 2011). Thirdly, architectural research in Nigeria has suffered from poor government funding as well as very little strategic research initiatives from the professional body.

Architecture is a practice-based design discipline from which research is carried out either from universities or from architectural practice. The degree to which architectural research in any country thrives and develops depends on the level of collaboration and knowledge sharing between architects in the academia and those in practice. In recent times there have been calls in the United States, Australia, Sweden, Denmark and the United Kingdom for a reflection on what constitutes architectural research and how it can develop in line with trends in practice (AAASA, 2003; Jenkins et al. 2005; ScotMARK, 2006; ARCC, 2012). Difficulties in conducting architectural research which is at the same time locally and globally relevant have been highlighted in previous works (Jaiyeoba, 2004). Other challenges include the need for such research to be viable in the academic as well as the professional world. Criteria for viability in the former directly relate to meeting the demands of academic scholarship, while in the latter the criterion relates to its relevance for practice (Dunin-Woyseth & Nilsson, 2014). Academic research as defined in this paper is that which is initiated from within an institution of higher learning, where the research problem and context have been clearly defined, the research process well documented, and the research output has been subjected to some form of peer-review prior to its dissemination. Practice-led research as defined in this paper is ‘research which is initiated in practice, where questions, problems and challenges are identified and formed by the needs of practice and practitioners’ (Gray, 1996).

Architectural research in Nigeria has traditionally been academically-initiated. This has been further driven by a national agenda to develop a research-oriented profile among teaching staff of Nigerian universities where obtaining a doctoral degree is mandatory (NUC, 2000). Fundamentally, such research is meant to generate new knowledge that will be useful to practice. In spite of the volume of research output, however, very little of this is actually used in practice (Akande et al, 2006). This situation is not peculiar to Nigeria. With specific reference to the Australian construction industry, Manley, et al. (2001) observes that most academic papers in architecture are often not read or used by architects in practice who tend to rely more on the transfer of new knowledge in the industry through representations in drawings and photographs. It is still unclear why this is so; although it has been suggested that research in architecture is often seen by the profession as being unrelated to the
business of architecture (Finch, 2005). Evidence further reveals that although knowledge is generated in architectural practice when projects are done, little of this is actually transferred from one project to another and even less is shared with other practicing architects (Gann cited in Maher & Mewburn, 2007; Stevens et al, 2009). The preceding discussion reveals two knowledge structures within architecture – a theoretical disciplinary knowledge base and a professional knowledge base.

This paper aims at investigating how the gap between academic and practice-led architectural research in Nigeria may be bridged. Why does it matter that the gap between academic and practice-led research be bridged? Till (2012) infers that when academic and practice-led research are not coordinated ‘the development of architectural knowledge happens but fitfully, and so the long-term sustainability of the profession is threatened’. The objectives of academics and architectural practitioners in relation to research differ although the knowledge developed by each is valuable and important for the viability and sustainability of the profession (Forsyth, 2005). The mutual benefits to be derived from collaborative research activities in the intersection of practice and academic work have been highlighted elsewhere (ScotMARK, 2006), unless barriers are broken down, architectural knowledge as a whole cannot really develop; this is in our opinion the most compelling case for closing the gap between academic and practice-led research.

The paper considers how architecture in Nigeria may be enhanced through research. Other sub-issues investigated include where architectural research as practiced in Nigeria is situated in relation to current global practices and the relationship between research initiated from the academia and practice-led research. The paper first reviews the nature, scope and methodological issues surrounding architectural research. It then reviews contemporary architectural discourse in order to identify the key issues with regards to research. Finally, the paper suggests a need for platforms that will foster discourse and collaborative research between academia and architectural practice.

LITERATURE REVIEW

The Nature and Scope of Architectural Research

Defining what constitutes architectural research is difficult because its scope is broad, its strategies are diverse, and the forms and approaches it takes are varied. Brunelleschi’s ability to dome the cathedral in Florence, Viollet-le-Duc’s historical and visual analysis of Gothic architecture and the development of the flying buttress have all been credited to research (Friedman, 2008; Groat & Wang, 2002). Architectural research has been characterized as being interdisciplinary in nature. The tendencies for architecture to assimilate knowledge from other disciplines and its inclusivity have been recognized as good practice and when extended to architectural research keeps the field relevant and engaging (Groat & Wang, 2002; Coyne, 2013). In contrast to its interdisciplinary nature, it
has been identified as maintaining a specificity of its own in terms of design knowledge (Rendall, 2004). Architecture inherently, involves scientific and artistic aspects; a dichotomy reflected within architectural research (Robinson, 1990). The scope of architectural research cuts across historical analyses, socio-cultural issues, and technological processes, physical and educational issues among many others.

Groat and Wang (2002) identify seven research strategies used in architectural research. These are interpretive-historical, qualitative, correlational, experimental, simulation, logical argumentation and case-study research. They also review a range of conceptual frameworks that have been adopted within architectural research. Robinson (1990) characterizes architectural research as being dominated by a dichotomous set of paradigms; science and myth. The ‘scientific’ describes research conducted following methods of science while the ‘myth’ describes research drawn from the arts and humanities. This dichotomous model has also been described within quantitative and qualitative frameworks or as being objective versus subjective.

Table 1 Tripartite Framework of Research Paradigms

<table>
<thead>
<tr>
<th>Basic Beliefs</th>
<th>Positivism/Postpositivism</th>
<th>Interpretive/Constructivist</th>
<th>Emancipatory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ontology (nature of reality)</td>
<td>One reality; knowable within probability</td>
<td>Multiple, socially constructed realities</td>
<td>Multiple realities shaped by social, political, cultural, economic, ethnic, gender, and disability values</td>
</tr>
<tr>
<td>Epistemology (nature of knowledge; relation between knower and would be known)</td>
<td>Objectivity is important; researcher manipulates and observes in dispassionate, objective manner</td>
<td>Interactive link between researcher and participants; values are made explicit; created findings</td>
<td>Interactive link between researcher and participants; knowledge is socially and historically situated</td>
</tr>
</tbody>
</table>

(Groat & Wang, 2002, p.32)

Joroff and Morse (1980) proposed a conceptual framework for considering architectural research along a nine-point continuum. In pursuing a description for a broader frame of reference for architectural research, Groat and Wang (2002) propose an alternative framework to the previous two consisting of three paradigmatic clusters - postpositivist, naturalistic (interpretivist), and emancipatory. Postpositivism describes a system of inquiry that emerged from the earlier tradition of positivism. The former presumes that objectivity is a legitimate goal that may be imperfectly realized. The interpretive/constructivist paradigmatic cluster posits that there are multiple, socially constructed realities. The ontological premise of the emancipatory cluster is similar to that of the interpretive/constructivist it however differs in that it stresses roles played by social, political, cultural, ethnic, and gender issues.

Features which characterize these paradigmatic clusters are summarized in Table 1.
Emerging Global Trends in Architectural Research

Until the seventies, architectural education was almost completely based on a master-apprentice model, with research remaining marginal with regard to both practice and academia (Dunin-Woyseth & Nilsson, 2014). This is not to suggest research was missing or its importance not recognized before then. An early call for the inclusion of research in architectural practice was made in the first issue of the *Journal of Architectural Education* in 1947, with advocacy even then for a research that was distinctly architectural (cited in Biggs & Buchler, 2008). Recent times have however witnessed a resurgence of interest and debate globally on what constitutes architectural research (Archer, 1995; Groat & Wang, 2002; AAASA, 2003; ARCC, 2012; Nilsson & Dunin-Woyseth, 2011). Discussions on how architectural research in Nigeria may possibly develop needs to consider the direction of current thinking and emerging global practices in architectural research. Consequently, this is taken as the point of departure for subsequent discussions.

Many scholars identifying the absence of a unified body of architectural research (Robinson, 1990) and recognizing architecture as a field where highly differentiated kinds of knowledge converge (Boddington, 2005; Nilsson & Dunin-Woyseth, 2011), expressed the need for a ‘more integrated specifically architectural approach’ (Robinson, 1990, p.1) in relation to research. Discussions have revolved around the nature of architectural research and what constitutes knowledge in architecture (Snyder, 1984; Duffy & Hutton, 1998; Jenkins et al. 2005; ARCC, 2012). Some have argued that architectural knowledge is distinct in two ways. First, it is combinatory and complex in nature and secondly, it concerns itself with the deontic rather than the descriptive; meaning it engages with things as they ought to be rather than as they are (Duffy & Hutton, 1998). Others have highlighted that knowledge within architecture is socially defined, being developed from the ‘social fields’ of academia or practice (Forsyth, 2005).

The end of the last century saw design increasingly being recognized as central to architecture’s epistemological grounding (Friedman, 2008). The on-going debate questioned whether with this disciplinary specificity, architectural research was not constrained by borrowing methods adopted from other disciplines (Mo, 2001). The desirability of developing research applicable to the particular needs of design have been emphasized (Cross, 1999). Architectural research has been criticised for borrowing theories and methods from other disciplines without reflecting on the specific character of the field (Lundequist, 1999 cited in Nilsson & Dunin-Woyseth, 2011). Although the importance of exploring architecture-specific knowledge has been emphasized among architects (Arets & Zaera-Polo, 2003, cited in Nilsson & Dunin-Woyseth, 2011), some of these critiques have been drawn by scholars outside the field. Linn Mo, a sociologist, highlighted that certain types of knowledge may contribute to architecture but they are never complete as they do not adequately address what architecture or its practice are all about (Mo, 2001).
Other discussions within these broader ones have focused on design in relation to research (Groat & Wang, 2002), architectural practice and its relation to research (Coyne, 2013; Lootsma, 1999, cited in Nilsson & Dunin-Woyseth, 2011), critical practice as research (Agrest, 1991) and relationships between traditional models of academic research and emerging models of practice-based research within academia (Biggs & Buchler, 2008). Questions have also been raised as to how research in areas of design practice differs from research developed in other disciplines (Archer, 1995). Archer (1995) argues that activities in practice which satisfy the demands of research may be considered as research. He establishes such criteria as if the process is knowledge directed, systematically conducted and unambiguously expressed. Groat and Wang (2002) argue that research about design processes can help inform the process, although it is not the same as holding that design itself is research. Although opinions differ on this issue, research by and through design is now accepted in universities overseas as a way of developing knowledge in the field of architecture (Rust et al, 2007; Biggs & Buchler, 2008).

Attention has also been drawn in previous works to the challenge of developing architectural scholarship which meets the demands for academic rigour as well as being relevant to practice (Nilsson & Dunin-Woyseth, 2011). Debates continue to be dominated by issues of rigour and validity (Archer, 1995; Biggs & Buchler, 2008), knowledge transfer from research to practice (Friedman, 2000; Yees, 2007; Coyne, 2013), and on the acceptability of graphical means of representation in place of written texts (Rust et al, 2007).

Although academic research is more readily understood, there is no consensus on definitions of practice-led research. An early definition considers it to be ‘research which is initiated in practice, where questions, problems and challenges are identified and formed by the needs of practice and practitioners’ (Gray, 1996). Others have defined it as ‘research in which the professional and or creative practices of art, design or architecture play an instrumental part in an inquiry’ (Rust et al, 2007). The terms ‘practice-led research’ and ‘practice-based research’ are sometimes used interchangeably, although this has been suggested to be erroneous. Candy (2006) makes a distinction that whereas, practice-led research is concerned with the nature of practice and leads to new knowledge that is significant for that practice (having as its focus to advance knowledge about or from within practice), practice-based research is an original investigation undertaken in order to gain new knowledge partly by means of practice and the outcomes of that practice. Currently, practice as a form of research, practice-led research and practice-based research as models for research are considered acceptable in many countries (Rust et al, 2007; Coyne, 2013). Architects like, Rem Koolhaas, architectural offices like OMA and Foreign Office Architects are leading the trail in presenting their work as research and developing methods
which will satisfy the fundamental criteria for research (Nilsson & Dunin-Woyseth, 2011).

### Table 2 Differences between aspects of academic and practice-led research

<table>
<thead>
<tr>
<th>S/N</th>
<th>Key Aspect</th>
<th>Academic research</th>
<th>Practice-led research</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Context for Production</td>
<td>Institutions of higher learning</td>
<td>Architectural Practice</td>
</tr>
<tr>
<td>2</td>
<td>Aim &amp; purposes</td>
<td>Develops theoretical knowledge-base; gives wider perspective for understanding the field and challenging assumptions.</td>
<td>Advances knowledge about or from within practice</td>
</tr>
<tr>
<td>3</td>
<td>Knowledge Structure</td>
<td>Theoretical disciplinary knowledge</td>
<td>Professional practical knowledge</td>
</tr>
<tr>
<td>4</td>
<td>Research Motivation</td>
<td>External pressures to achieve knowledge-base; also driven by need for career progression and tenure.</td>
<td>Driven by pragmatic concerns; and need for innovation.</td>
</tr>
<tr>
<td>5</td>
<td>Criteria for Judging Research Output</td>
<td>Academic rigour, originality; peer review</td>
<td>Relevance to practice</td>
</tr>
<tr>
<td>6</td>
<td>Dissemination of research output</td>
<td>Dissemination in peer-reviewed journals, conferences, workshops</td>
<td>Lacks rigorous means of dissemination. Knowledge utilized in projects; knowledge transferred selectively in share projects with others; technical magazines</td>
</tr>
<tr>
<td>7</td>
<td>Critique</td>
<td>Inward-looking processes; geared to serve purposes of the academic community and less of the professional good.</td>
<td>Output of innovative research remains tacit, and is not disseminated with the rigour it deserves.</td>
</tr>
</tbody>
</table>

(Anderson, 2005; Till, 2012)

The presence of a gap between architectural research in academia and in practice is well documented in literature (Till, 2012; Stevens et al, 2009; Anderson, 2005) with Dunin-Woyseth and Nilsson (2014) highlighting the problematic relation that until very recently existed between them. This relationship has been described as one characterized by 'anxiety' (Rendall, 2005), to being 'antagonistic' (Anderson, 2005), with others noting the skepticism and antipathy of one camp to another (Till, 2012; Dunin-Woyseth & Nilsson, 2014). These tensions reflect the uncertainties among researchers who although within the same discipline are operating in different ‘social fields’. Forsyth (2005) points out that because their objectives in relation to research differ, a need exists for more convergence in defining the objectives and resources required across different fields of activity. He goes further to observe that problems usually arise when resources for research are dominated by the ‘actors’ of one field. Research initiated from the academy and those originating from practice are complementary and of equal value to the development of architectural knowledge (Stevens et al. 2009; Forsyth, 2005; Till, 2012).

This gap has been attributed to several reasons. Among these are the problems associated with educating professionals within an academic setting (Akande et al, 2006), inadequacy of research content in the undergraduate curriculum (Arayela, 2000; Yee, 2007), unwillingness among practitioners to share knowledge generated in practice where it is considered intellectual property (Stevens et al, 2009) and pressures on
architectural education to develop a research base (Anderson, 2005). The gap continues to exist because practice and academia focus on the form of knowledge structure that serves their purpose. Also highlighted in literature is the importance of knowledge transfers from practice to academia and vice versa (Yees, 2007; Till, 2012). Till (2012) suggests that the raw product on which architectural knowledge is founded resides in practice however any potential value this has, may only be released through collaboration with academia.

Some of the differences between academic and practice-led research are highlighted in Table 2.

The Development of Architectural Knowledge and Research in Nigeria

The emergence of architectural education in Nigeria is briefly outlined before the development of architectural research is discussed. Architectural education in Nigeria started in Ibadan in 1952, at what was then known as the Nigeria College of Arts, Science and Technology. In 1955 the college moved to Zaria where it was later upgraded to the status of a university and named the Ahmadu Bello University in 1962. The Department of Architecture was then birthed, and the programme was re-structured to a degree awarding status of a Bachelor of Architecture from the previous situation where diplomas affiliated with the Royal Institute of British Architects (RIBA) were awarded. The link with RIBA was maintained until 1968 when the programme was re-structured into a two-tier degree programme, awarding the Bachelor of Science and Master of Science degrees in architecture (Arayela, 2000). Currently, there are twenty eight (28) schools of architecture in Nigeria. Training in research methods for architecture students is embedded in the fourth year of the Bachelor of Science degree-awarding programme and during the first year of the Master of Science degree-awarding programme (Arayela, 2002).

Despite the break in ties, the new department continued to reflect a model of architectural education closely patterned to that of the British. The Oxford Conference organized by the Education Board of RIBA in 1958 had a defining influence on architecture in the UK and by extension countries within its sphere of influence. This influence was reflected in terms of policy. The decision that architecture be taught full time in universities was adopted here. Also recommended was the promotion of research within architecture (Jenkins, et al. 2010). Prior to this period of architecture being taught in universities, knowledge was transmitted via master/apprentice relationships accompanied with the study of existing buildings Yüncü (2008).

The direction in which architectural education developed in Zaria was also influenced by the fact that all the teaching members of staff were expatriates who had received their training abroad. In the western tradition, between the renaissance and the modern movement, to be trained in architecture was to be trained in history (Crook, 1984 cited in Amole, 2004) so it was not uncommon for architectural students then (and
now) to be fully grounded in the architectural history of the west. Later on in Zaria, the historical analyses of traditional houses documented in Schwerdtfeger’s (1982) ‘Traditional Housing in African Cities, A Comparative Study of Houses in Zaria, Ibadan and Marrakech’ assumed the same level of importance in the training of students and still remains one of the most important research sources for the history of traditional architecture.

Some have suggested a lack of clarity in establishing what architectural research is, in its relatively recent presence as a taught discipline, few investigations on how architects in practice undertake research and specifically, the forms of research they require as factors which have contributed to the uneven development of architectural research in the UK (ScotMARK, 2006). Not surprisingly, countries such as the United States, the UK and Sweden, have recognized the need to increase funding of practice-led research, encourage research initiatives and increase research collaboration across practice and academia (ScotMARK, 2006; FORMAS, 2006; AIA, 2010).

How has architectural research in Nigeria fared and how may the development of research capacity in this field be evaluated? Architectural research in Nigeria is still evolving, albeit gradually. Sawyer (2004) considers research capacity as not only including individual skills developed in research, but also the quality of the research environment, funding, adequate infrastructure, research incentives as well as the time available to the researcher. Practice-led research remains to be fully explored in Nigeria to the level that it is being developed overseas. The traditional model of carrying out research in most African universities as described by Sawyerr (2004), where individuals or a few group of persons pursue research on topics of their choice, in an area of professional interest, funded under the auspices of their university is typical of architectural research in Nigerian universities. Sawyerr (2004) rightly observes that research in Africa is generally underfunded. In Nigeria, funding comes from the Tertiary Education Trust Fund (TETFUND) when researchers’ applications for research grants are successful. The research environment also does not actively promote networking among schools of architecture, nor does it indicate much inter-disciplinary research activities between architects in academics and those in practice.

Obtaining a doctoral degree is not a requirement for undertaking research, yet by virtue of being a research degree, defined in terms of original contribution to knowledge it may be considered a useful indicator of the research profile of academic staff. There has been an increase in the number of architectural educators that have earned doctoral degrees in the country in the past fifteen years - notwithstanding long completion times. This development is linked to a directive from the National Universities Commission that requires academic members of staff to acquire doctoral degrees or have their promotions pegged at a particular level (NUC, 2000). Although research activities from the universities have been abundant it is doubtful how much of this has been relevant to those in practice.
Likewise challenges facing the development of architectural research in Nigeria exist. Part of this problem is represented by architects in academia struggling to carry out research although lacking requisite research skills. Owing to pressures to pursue doctorate degrees, this problem is further compounded. With such a situation, the aims of research are bound to be defeated as this kind of research is not likely to contribute to knowledge development. The low level of awareness of the value of practice-led research among architects in Nigeria is another challenge which needs to be addressed.

**RESEARCH METHOD**

The study adopted a single case design within the case study research strategy to describe the prevailing paradigmatic stances from which academics conducted research. A case study according to Yin (1994) is “an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between a phenomenon and context are not clearly evident” (p. 13). A single case may focus on single or multiple units of analysis and data may be drawn from documentation, archival records, interviews, direct observations, participant observation and physical artefacts (Yin, 1994). The Department of Architecture, at the Ahmadu Bello University, Zaria was selected as the case in question. The rationale for this is underpinned by three reasons. The department represents the earliest place architectural programmes in Nigeria were developed and among the first to promote research activities. Secondly, it has a research unit, which although has undergone periods of dormancy, has remained a driving force in keeping the department research-focused. Thirdly, some architects engaged in professional practice serve on a part-time basis as part of the team involved in handling the doctoral students. This is potentially valuable as it provides a platform for links between academia and practice to be nurtured and issues for research to be developed based on needs identified in practice. Data was collected from the archival records, with sixteen (16) doctoral dissertations employed as the units of analysis. The scope was limited to the doctoral dissertations that were initiated and completed within the department alone.

**RESULTS AND DISCUSSION**

Three phases of doctoral degrees in the Department of Architecture at Zaria were identified from the data analysis. The first phase represents those completed during the 1980s, the second phase during the 1990s and the third phase from the turn of the century to present date. Four doctoral degrees were awarded in the first phase, three in the second phase and nine in the third phase. Three dissertations drawn from each of these phases are briefly discussed.
Cestmir Slavoj John, a Czechoslovakian teaching in the department was the first person to complete his dissertation in 1983. The dissertation titled ‘National Trends in the New Architecture’ stated its broad aim as follows:

the aim of this study is to tackle the phenomenon of national variations in the “New Architecture” as a world-wide phenomenon. Within this framework an attempt is made to find out the causes and conditions which favour the evolution of national stylistic variations generally, and why they appear in some countries in particular. (1983, p.2)

In establishing the research question that guided his study, John (1983) inquired why previous attempts to establish a ‘New Architecture’ with a national identity failed in his country yet succeeded in other countries. His methodology involved a comparative analysis of “the evolution of selected historical styles with the evolution of the ‘New Architecture’” (p.3). He draws on history to develop knowledge from a postpositivist perspective and by making comparisons he seeks causal explanations from history.

Mbina’s (1989) thesis titled, ‘European Influences on Traditional Houseforms in Old Calabar (Efikland) and its Environs” used an interpretivist perspective to provide a historical narrative of European influences on traditional houseforms in Efikland. In order to achieve the aim of the study at identifying European influences, he uses multiple sources of data collection such as case studies, written historical texts and building documentations. By focusing on houseforms that emerged within a socio-cultural framework, this study in its use of multiple tactics and approach fits Groat and Wang’s characterization of a qualitative research; the goal which is to gain a holistic overview of the context under study in its natural setting (2002, p.179).

Ahmed’s (2007) study titled, ‘Patterns of Change in Hausa Domestic Architecture – A Comparative Study of Selected Contemporary Houses with Traditional Compounds in the Walled City of Zaria’ by conducting an extensive housing survey, compares and analyses patterns of change that have emerged in Hausa domestic architecture within a time frame of forty years. This study adopts a range of methods involving observations, documentation of plans and photographs with archival documents.
### Table 3 Dissertations (PhD) Completed in the Department of Architecture, A.B.U. Zaria (1983 – 2014)

<table>
<thead>
<tr>
<th>S/N</th>
<th>Name</th>
<th>Year</th>
<th>Dissertation Title</th>
<th>Focus of Research</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>John, C. S.</td>
<td>1983</td>
<td>National Trends in the New Architecture</td>
<td>Theory-related research</td>
</tr>
<tr>
<td>2</td>
<td>Solanke, O.</td>
<td>1984</td>
<td>An Application of Borassus Flabillifer to Reinforce the Superficial Leaf of Mud Wall for better Stability, Durability and Aesthetics of Cement Plaster</td>
<td>Practice-related research</td>
</tr>
<tr>
<td>3</td>
<td>Gniadzik, J. S</td>
<td>1985</td>
<td>Traditional Houseforms as a Source for Low-cost Housing Design for Nigerians</td>
<td>Practice-related research</td>
</tr>
<tr>
<td>4</td>
<td>Ogunnaye, O. O</td>
<td>1989</td>
<td>Architectural Design with Nigerian Climatic Conditions in View – A Systems Approach</td>
<td>Practice-related research</td>
</tr>
<tr>
<td>5</td>
<td>Ogunnaye, B. P</td>
<td>1994</td>
<td>A Study of Modern Trends in some Aspects of Architecture in North Central Nigeria</td>
<td>Theory-related research</td>
</tr>
<tr>
<td>6</td>
<td>Qurix, W. B.</td>
<td>1997</td>
<td>A Study of High-rise Office Buildings in Lagos – Human-Environment Perspectives</td>
<td>Theory-related research</td>
</tr>
<tr>
<td>7</td>
<td>Mbina, A. A.</td>
<td>1999</td>
<td>European Influences on Traditional Houseforms in Old Calabar and its Environs (Efik) land 1800-1960</td>
<td>Theory-related research</td>
</tr>
<tr>
<td>8</td>
<td>Ahmed, M. D.</td>
<td>2007</td>
<td>Patterns of Change in Hausa Domestic Architecture: A Comparative Study of Selected Contemporary Houses with Traditional Compounds in the Walled City of Zaria</td>
<td>Theory-related research</td>
</tr>
<tr>
<td>9</td>
<td>Umar, K. G.</td>
<td>2007</td>
<td>Transformations in Hausa Traditional Residential Architecture: Case study of Selected parts of Kano Metropolis between 1950-2005</td>
<td>Theory-related research</td>
</tr>
<tr>
<td>10</td>
<td>Sagada, M. L.</td>
<td>2009</td>
<td>The Impact of Ahmadu Bello University Main campus on Staff Housing</td>
<td>Theory-related research</td>
</tr>
<tr>
<td>12</td>
<td>Oluigbo, S.</td>
<td>2011</td>
<td>Evaluation of Architectural Design Determinants for Sustainable Tourism Facilities in North Western Nigeria</td>
<td>Practice-related research</td>
</tr>
<tr>
<td>13</td>
<td>Abdullahi, A.</td>
<td>2011</td>
<td>An Assessment of Architectural Curricula of Selected Nigerian Universities and its Relevance to the Building Industry</td>
<td>Theory-related research</td>
</tr>
<tr>
<td>14</td>
<td>Nghai E. S.</td>
<td>2012</td>
<td>Re-design of Public Housing and Implications for the Architectural Design Process: Case study of Malali and Barnawa Housing Estates, Kaduna</td>
<td>Practice-related research</td>
</tr>
<tr>
<td>16</td>
<td>Sati, Y. C.</td>
<td>2014</td>
<td>Users’ Perception and Use of Green Spaces within Architectural Composition of Selected Neighbourhoods of Jos Metropolis</td>
<td>Practice-related research</td>
</tr>
</tbody>
</table>

(Archival records, 2014. Data room, Department of Architecture, A.B.U. - Zaria)

Ideally, the relationship between academic and practice-led research would be investigated by considering how results from academic research are utilized in practice, or how practice informs academic research on issues it considers relevant. The situation in Nigeria however does not allow such as a lop-sided development of architectural research in favour
of academic research was observed. To provide a basis for addressing the aim of the study, a comparative analysis of the dissertations was done in order to identify studies that researched issues directly related to practice (practice-related research) and those that sought to develop knowledge through analysis and interpretations of theory, history and architectural criticism (theory-related research). Table 3 presents a summary of the analysis of these dissertations.

The findings indicate that about 56% of the studies had an inclination towards theoretical knowledge development while 44% sought to relate to practical concerns in terms of how practice could be improved. The findings confirm observations by Allen (2008) that as academics ‘approach the protocols of university research – according to either scientific or a humanities model – the more they distance themselves from the real concerns of active, creative practitioners’ (p.139).

This is not to negate or downplay the value of research initiated from universities. Academic research can contribute to practice by identifying issues in practice that represent practical concerns or through the mediating influence of education; when new knowledge is transferred to students who sooner or later will enter the profession.

CONCLUDING REMARKS

Architecture is considered a discipline and a profession, differentiated from others by its body of knowledge. It is particularly important that it grow its knowledge base through research. Enhancing architecture in Nigeria by bridging the gap between academic and practice-led research was the aim of this study. Many of the problems in architectural research arise because the researchers from the different fields often have different aims in research and undervalue the knowledge developed by each other.

This paper also examined why the gap between researchers in academics and those in practice continues to exist and how this gap may be bridged. It has been pointed out that knowledge developed from activities in these two spheres are different but complementary in nature and that it is counter-productive for actors in one field to dominate the research environment (Forsyth, 2005). The situation in Nigeria is one where activities by researchers from institutions of higher learning currently dominate the scene. The value of research through design practice is yet to be fully recognized. A clearer articulation of the ways architects in practice carry out research and means of identifying the forms of research they require is recommended as this will help to establish practice-led research within the broader field of architectural research in Nigeria. This paper recommends that awareness be raised among research-oriented architects in professional practice of the possibilities in practice-led research.

Collaboration between academic and practice-led research in Nigeria is presently so minimal to the point it may be considered non-existent. Collaboration between academia and practice is required in order for
architectural research to develop (ScotMARK, 2006); in this regard, it is recommended that professional bodies in the country encourage collaboration between academic and practice-led research. This encouragement may be by providing incentives such as research grants or by recognizing and rewarding excellent research practices. The importance of disseminating architectural research as a means of informing academicians and practitioners cannot be overemphasized. This can be through journals, exhibitions and conferences.

Conferences particularly, those that bring architects from academics, practice and policy-making institutions, provide platforms for critical discussions on how to promote and establish an agenda for architectural research. These conferences are recommended as they will not only promote architectural discourse but they will also provide avenues for research outputs to be shared and disseminated. If the body of knowledge that defines architecture must develop, it is important that research evokes critical discourse and for this to occur participation must be encouraged. Duffy and Hutton point out that:

What matters most – and is hardest to achieve – is access to practice, to the contexts of action; because only here are to be found the data, the challenge and the achievement that are the matter of the discourse. (1998, p.xiv)

In conclusion, comparing architectural research in Nigeria with emerging global developments shows a wide gap still needs to be covered. More architectural firms need to integrate a research aspect to their practice, while researchers in academia should seek to design research that is relevant to theoretical knowledge development as well as that which may be adapted to fit our local context and find applications to more architects in practice.

REFERENCES


ENHANCING SAFETY: LESSONS FROM SENIOR MANAGERS IN THE NIGERIAN CONSTRUCTION INDUSTRY

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The construction industry plays a major role in the global economy. However, studies indicate that the industry is one of the most hazardous with frequent accidents and safety related problems. This study utilised semi-structured interviews among ten senior managers to examine safety practices within the Nigerian construction industry. It highlights the diversity associated with the implementation and management of safety in the Nigerian construction industry. The emerging key issues showed that the lack of knowledge and skills, as well as the absence of relevant safety policies and procedures were among the major challenges and barriers for safety in the Nigerian construction industry. Based on the analysis, it was proposed that the Nigerian government needs to introduce more appropriate safety policies and legislations. The paper proposed the adoption of lean strategies for enhancing safety and suggested that organisations within the Nigerian construction industry should also adopt informal trainings which provide further learning options for safety awareness among construction workers.

Keywords: construction safety, Nigeria, safety, semi-structured interview, senior manager

INTRODUCTION

The construction industry has been identified as a very significant industry not only because of its size and productivity but also as a result of the stimuli it generates for the delivery of economic, social and environmental objectives of organisations and nations globally. Murrie (2007) reported that the construction industry accounts for about 10 per cent of the world's gross domestic product and also provides employment for nearly 200 million people. The industry's scope encompasses a wide range of activities like; large civil engineering construction projects such as highways and bridge construction, water supply and sewerage schemes, irrigation and canal works. Construction activities are also found in the

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agricultural, educational, health and the energy sectors. From the above, the construction industry can be easily classified as the global hub of economic and social development.

Despite its strategic nature, there is ample evidence universally to illustrate that the construction industry has equally earned a notorious reputation as being one of the most dangerous industrial sectors globally. For instance, according to the Health and Safety Executive, over the past few years, the construction sector recorded an annual average of sixty deaths annually in the United Kingdom (HSE 2011a). The National Safety Council reported that about 8,993 people died between 2003 to 2011 at construction work sites in the United States, while Lingard et al. (2009) identified the accident rate to be 9.2 per cent of 100,000 workers in Australia. Mahmoudi et al. (2014) observed that the trend associated with high fatalities in the construction industry is widely prevalent in many other countries. Regrettably, evidence from past studies indicate that situation is even worse in developing countries because of the general lack of concern as well as the dearth of statutory regulations that govern the industry in such climes (Jain, 2007; Musonda and Smallwood, 2008; Idoro 2008). On a more general note, the International Labour Organisation (2005) estimated that a total of 60,000 construction fatalities occur per year around the world. This equates to one construction fatality in every nine minutes. The above indicates that the construction industry still requires to evolve more appropriate strategies and tools to continuously assess and improve its operations with respect to safety.

Within the body of literature, Jannadi (1996) identified six important factors that mostly affect the construction industry. The factors identified were: maintaining safe work conditions, establishing safety training, educating workers and supervisors in good safety habits, effective control by the main contractors of numerous subcontractors, maintaining close supervision of workers and assigning responsibilities to all levels of management and personnel. From the identified factors, educating workers and supervisors in good safety habits, establishing safety training and maintaining safe work conditions can be directly linked to construction safety. Perhaps as a consequence of this and other factors, there is now an increasing awareness and focus on construction safety. One significant result of the growing interest in construction safety is the consideration for the inclusion of safety related indicators when describing successful projects rather than merely adjudging successful construction project success just based on traditional indicators like time, cost, and quality/scope. Additionally, safety is vital because of its impact on the wellbeing and lives of not just the construction project team personnel but also those of others.

In the light of the above, this paper appraised the construction industry within the context of safety. To achieve this, the paper specifically identified challenges and barriers to safety in the Nigerian construction industry after which strategies for enhancing safety in the construction industry were proposed. The findings from this research have reasonable
implications for both project and safety management disciplines. Firstly, contemporary project management research has made strong cases for the examination of the softer features of projects like communication, cultural, social and human aspects and their impacts on the project management process within organisations (Ochieng et al 2013). One lesson learned so far is that existing initiatives need to focus on the human as well technical aspects related to safety since efforts from the human aspects come to the fore in any attempt to implement effective safety strategies within the construction industry. Also, faced with the seemingly dismal safety performance within the construction industry, researchers and practitioners have constantly reflected upon existing safety management systems and recommended new initiatives. Another anticipated practical contribution is that, there are limited studies which have examined the role of senior managers in enhancing safety (Flin 2003). Therefore senior managers including project managers who act as facilitators for project teams can gain additional insights into how to create more optimum safety climates. It will equally enable managers identify and regulate suitable safe behavioural styles before and during the commencement of future projects. This is especially relevant, since findings of past investigation reports have bestowed senior managers with considerable discretion, and immense safety accountabilities (National Commission 2011; Baker 2007). The paper is structured as follows; first, it elaborates on the literature reviewed on construction safety. After which it provides an explanation of the method used for data collection. Subsequently, the results are reported and discussed after which conclusions and limitations are highlighted.

THE CONSTRUCTION INDUSTRY IN NIGERIA

Zuofa and Ochieng (2012) observed that the construction industry is seen as a vital sector in most developing countries since it plays a key role in the provision of basic economic and social infrastructure like roads, railways, airports, hospitals, schools, housing and other critical infrastructure. According to Garba and Yadima (2008), the construction industry is also considered an active sector of the Nigerian economy because it takes a large part of government budgetary expenditure. Isa et al (2013) disclosed that organized construction industry activities in Nigeria commenced in the 1940s with few foreign companies coming into operation. Over the past four decades, Olutunji and Bashorun (2006) explained that the construction industry has made contributions to the Nigerian gross domestic product growth. Government at various levels have been the major drivers of most construction activities in Nigeria for a long period because of limited private involvement however, with the rising emphasis on bridging Nigeria’s infrastructure gap, Oluwakiyesi (2011) posits that the future growth of construction industry is still somewhat optimistic.

Generally, the nature of the construction industry is quite different from other industries because of several unique characteristics. These unique
characteristics include the nature of construction processes/phases, organisation structure, temporary working setting and the diversities exhibited from team workers. It is worth noting that the construction industry also embraces a variety of stakeholders who may directly or indirectly influence the construction process either on the construction site or off site. Another characteristic of the construction industry, that makes management of this sector more challenging, is the unfavourably high supervisor-worker ratio. A study by Levitt and Samelson (1993) posited that supervisors who develop more personal and positive relationship with workers have more favourable safety performance records. On the other hand developing such relationships that aid safety performance records may become even more difficult where there are high supervisor-worker ratios. According to Smallwood (2000), high supervisor-worker ratios are generally the hallmarks of the construction industry. All the above, in addition to the uncontrollable environment in which construction activities take place, personnel working practices and the financial and time pressures imposed upon project teams have been suggested to be major contributory factors to the poor safety records within the construction industry globally (Rowlinson and Lingard 1996; Halender and Holborn, 1991). As a consequence, despite its relevance to our individual and collective existence, construction site management and wider safety concerns have remained crucial challenges for the construction industry and its stakeholders.

**Safety in the Nigerian construction industry**

The construction industry may not be entirely uniform globally because of the wide variations in individual countries, regional and sub-regional economic structures, occupational and governmental structures around the world. However, as stated earlier, the construction industry still plays a vital role in boosting the economy of any nation. Perhaps the lack of infrastructural expansion and underdevelopment experienced in Nigeria greatly underscores the relevance of the construction industry. As established in previous sections the construction industry is a very hazardous and accident prone industry. With regards to construction safety in Nigeria, while it has been observed that there have been efforts to bring improvements, evidence abounds to highlight great deficiencies. For instance, Idoro (2008) established that after several years of independence, the health and safety regulations in Nigeria are still reflective of colonial influences. Even if, this may be justifiable in certain aspects, Idoro (2008) still decried the inability of the Nigerian government to have its indigenous versions of such regulations. Similarly, Diugwu et al. (2012) enumerated several health and safety regulations in Nigeria but concluded that there were still gaps in the health and safety management within the Nigerian construction industry. The peculiarities associated with the construction industry as well as the emergence of regulations and international standards, has driven several nations and organisations to explore strategies for the improvement of their safety performance. Furthermore, in the wake of past catastrophic disasters (for example the British Petroleum oil platform explosion in the Gulf of Mexico, the San
Jose mine in Chile, the Aegean Highway project in Greece), both developed and developing countries have further recognised the necessity of improving safety on construction sites, particularly to reduce the number of occupational accidents. As a result, Weibye (1996) and Kandola (1997) presumed that most forward thinking organisations have, moved from a reactive to a proactive approach towards safety.

Within the context of this paper, efforts have been made to add to the existing body of knowledge by way of appraising the perspectives of senior manager’s on safety within the Nigerian construction industry. Micheal et al. (2005) noted that senior managers play a crucial role towards attaining organisational safety and their commitment to safety has been identified among the keys to the success of safety initiatives within organisations. It is for this reason that the barriers/ challenges of safety performance and current improvement efforts as well as their commitments to safety in the construction industry have been discussed in this paper.

METHOD

A literature review was performed to determine what is known about the specific research problem of safety in the Nigerian construction industry. The review was conducted into a variety of issues about safety in construction industry with specific reference to Nigeria to determine the direction of the actual research. Due to the nature of the research aim, it was acknowledged that the views of senior managers in the construction industry were necessary. This allowed questions evoked from the initial research to be answered and contribute additional information to give a better understanding of the current state and challenges of safety in the construction industry from the lens of experienced professionals. The use of a qualitative method was deemed to be the most appropriate research strategy to employ. Creswell (2007) observed that researchers may find the qualitative method more suitable if the research needs to empower individuals to share their stories, hear their voices or minimise the power relationships that may occur between a researcher and research participants. Also, Amaratunga et al (2002) noted that qualitative data provides richness and creates a strong potential for revealing complexities. For this reason, interviews were conducted with the senior managers from three major cities in Nigeria to explore the challenges facing safety with the Nigerian construction industry. The review of existing literature informed the formulation of questions used for the interviews.

Table 1 provides a summary of the profiles of the ten professionals interviewed. As mentioned previously, the perceptions of senior managers in the construction industry were required to discuss questions that emanated from the initial research and to have more insights into the current issues in the industry. The participants who comprise of project managers, site managers and safety managers were carefully chosen to accurately represent the senior managers in the construction industry. The interviewees were purposefully selected (Bryman 2008), using their
current job position and relevant experience as key selection criteria. With each participant having over fifteen years of industry experience, the composition and size of the population studied was considered suitable due to the qualitative nature of the research, the data sought and the level of knowledge of the interviewees. Fellows and Liu (2008) explained that relatively small sample sizes can be acceptable, based on the assertion that smaller number of respondents with adequate understanding of the subject matter are more apt than large samples with limited knowledge. To maintain their confidentiality, all identifying information was removed during the data analysis stage.

Table 1 Selection of professionals interviewed

<table>
<thead>
<tr>
<th>Participants</th>
<th>Job title</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Project manager</td>
<td>Port Harcourt</td>
</tr>
<tr>
<td>B</td>
<td>Project director</td>
<td>Lagos</td>
</tr>
<tr>
<td>C</td>
<td>Operations manager</td>
<td>Lagos</td>
</tr>
<tr>
<td>D</td>
<td>Project manager</td>
<td>Port Harcourt</td>
</tr>
<tr>
<td>E</td>
<td>Site manager</td>
<td>Warri</td>
</tr>
<tr>
<td>F</td>
<td>Senior safety manager</td>
<td>Warri</td>
</tr>
<tr>
<td>G</td>
<td>Project manager</td>
<td>Port Harcourt</td>
</tr>
<tr>
<td>H</td>
<td>Safety manager</td>
<td>Lagos</td>
</tr>
<tr>
<td>I</td>
<td>Project site lead</td>
<td>Port Harcourt</td>
</tr>
<tr>
<td>J</td>
<td>Project manager</td>
<td>Port Harcourt</td>
</tr>
</tbody>
</table>

To generate textual data, the interviews were first recorded using a tape recorder and later transcribed. Nvivo software was used for the management of the interview data. One of the primary functions of Nvivo that emerged was the ability to add memos to sections of the data, as thoughts and connections were made during all phases of the data analysis. It also enabled the researchers to sort through the data and at the same time allowed exploration for patterns and recurring phenomena. An appropriate coding system was developed to establish the inter-related themes and statements linked to the overall objectives of the research. The collated data was analysed using textual analysis and interpreted using emerging themes and pattern interpretation.

FINDINGS

The findings are presented below under themes drawn from the analysis. Where appropriate, quotes have been drawn from the interview transcripts.

Challenges and barriers to safety in the Nigerian construction industry

From their accounts, it was recognised that there are numerous challenges and barriers affecting safety in Nigerian construction industry. It was established that safety is a crucial factor that cannot be separated from the construction work environment because of its key role. In identifying
challenges to construction safety, Participant (D) explained that, ‘take a
typical site activity for any basic construction project for instance.
Construction procedures depend on the knowledge and skills of people
planning and executing the work so you can have those workers who lack
the basic skills for working safely, there may also be supervisory negligence.
So both cases can be directly linked to the construction process while factors
like socio-political and other geographical issues may not be directly traced
to the project. However all these can have impacts on the safety of the
project and its personnel directly or superficially. Again, during the dry
season, the weather at times is extremely hot so it becomes difficult for some
of our workers to even want to use PPE we given to them’. In the above
extract, the participant demonstrated that certain challenges affecting
safety were as a direct consequence of construction operations, while
others were the results of other peripheral activities. This forms a
reasonable argument because in the real life context, some construction
issues like personnel competence and their motivation to work may be
directly linked with projects. On the other hand, legislations or political
considerations are more linked with the wider society while the vagaries of
weather may be classified as unpredictable events which may alter the
regular routine of personnel.

In general, participants also established that the nature of the
construction industry itself even constitutes a challenge for safety. Participant (I) stated that, ‘today the nature of construction sector is such
that dependencies have become inevitable. We rely on the outsourcing of
parts of our activities and processes. This outsourcing trend and growing
importance of supply chains networks because of construction complexities
has implications for the health and safety of workers of such contracting
companies and other members of the supply network’. Another challenge
attributed to the nature of the construction industry was the fragmented
nature of most construction activities. Participant (J) observed that, ‘the
highly fragmented nature of the construction industry together with the
temporary nature of projects always brings together people with various
orientations regarding safety and work ethics. We have a high influx of
skilled people from other neighbouring countries and this can act as a
barrier to safety management.

Also, Participant (A) explained that, ‘one major challenge we face comes
from the board management. There are instances where our board
perceives safety initiatives as waste of money and time. They consider
anything safety program to be more costly to the organisation rather than
being beneficial’. The participant further disclosed that in the face of
scarce resources senior management struggles to commit sufficient
amounts and the right type of resources into the management safety.

Participants B and J established that because the construction industry is
situated within the broader society, its activities are influenced by wider
socio-cultural factors such as organisational culture, historical industry
culture as well as existing industry safety legislations. According to
participants, most of these diverse influences have a major implication on
how safety is perceived and managed. Additional findings from the interviews on barriers to safety in the construction industry included: lack of government commitment, unregulated safety practices and standards, limited resources for safety management, prioritising of production over safety and corruption.

**Strategies for enhancing safety in the construction industry**

It was generally established that activities in the construction industry have an enormous impact on the way the lives of people are formed and that workers safety has remained a huge concern for the construction industry. With various expressions, most participants explained that attempts to improve the safety situation in the construction industry usually require being able to identify those factors that contribute to the occurrence of unsafe practices, injuries and illnesses and also identifying effective strategies that can be developed towards achieving safety improvements.

As observed from this theme, some participants indicated that to improve the safety situation in the Nigerian construction industry there should be a special focus on training for all project participants. According to Participant (F), ‘*this can be achieved through the human resource input as well as other external avenues*’. The participant also explained that workers should be encouraged to look out for those relevant safety training sessions organised by professional bodies and participate. Some participants suggested the need for signage on construction sites. It was common to observe that participants believed that signages strengthen the knowledge learned from safety inductions and training and that they were very supportive in reinforcing the organisations values and inherent safety culture. According to participant (E), ‘*because of the varying academic background of most project personnel, signs should be simple and carefully designed with non-judgmental phrases so as to reduce self-victimisation by site personnel where they have any shortcomings*’.

Participant F also suggested that construction safety can be enhanced by adopting lean techniques. The participant commented that, ‘*I believe Lean Construction can have a very positive impact on safety in the construction industry*’. According to the participant, ‘*considering that accidents and other hazardous events can be classified as a waste of time, several elementary and complex principles can be adapted from lean construction to enhance construction safety. After all, lean is all about reduction and rationalisation of resources which can include lost time from unsafe construction activities*’. Finally, Participant C proposed that in the absence of effective construction safety regulations and enforcement, individual companies can adopt self-regulatory styles for the safety policies during their own activities.
DISCUSSION

This study considered an understanding of the challenges and barriers to be of great relevance towards any future efforts aimed at enhancing safety in the Nigerian construction industry. The results from most interviews suggest that knowledge and skills of people planning and executing construction projects, work, legislations, influx of migrant workers, the fragmented nature of the construction industry, cost of safety implementation, management misconception of safety and varying cultures were among the major challenges and barriers for safety in the construction industry.

Regarding legislations, what emerged was that safety legislations governing the construction industry in Nigeria were skeletal in nature and relatively obsolete. These views seem consistent with the study by Agwu and Olele (2014) which revealed that Nigeria lacks requisite statutory regulations on construction safety. Also as explained by Idoro (2008), Nigeria still relies on the health and safety regulations of its colonial rulers with very limited skewing to fit present day realities. The state of safety regulations in Nigeria clearly contrasts that of other more developed societies such as the United Kingdom. For instance, within the United Kingdom, the CDM Regulations 2007 was introduced to integrate health and safety into management of the project and to encourage everyone involved to work together. Generally, safety legislations in the UK construction industry have been developed to ensure management of construction businesses from mere measures adopted in accident prevention to embrace more systematic and proactive approaches to minimising the risk of hazards. It is worth stating that the inadequacies of the health and safety regulations governing the construction industry are not peculiar to Nigeria as other developing countries still grapple with challenges. Kheni et al. (2008) revealed that health and safety within the Ghanaian construction sector is enmeshed with challenges such as inadequate government support and the lack of skilled human resources. Similarly, Nawaz et al. (2013) highlighted the non-application of safety laws, the lack of safety management plans, lack of safety and health at workplace, inadequate arrangement of first aid as well as the absence of accident reporting mechanisms to be key trends affecting safety performance in the Pakistani civil and construction industry. Generally, because of the paucity of information on the level of accidents and fatalities in most developing countries, it becomes reasonable to conclude that there are still serious safety problems within the construction industry of most developing countries including Nigeria (Larcher and Sohail, 1999).

In terms of the knowledge and skills of construction personnel, it was observed that in addition to formalised skills acquisition strategies like trainings, most construction personnel acquire skills via peer learning or team working. According to Styhre (2006), seeing, saying, showing, telling, and learning-by-using are among the numerous avenues whereby individuals acquire new skills and knowledge. This method of skills
acquisition can also be related to certain illustrations provided during the interviews. Supporting this, several participants had articulated the need to have regular on-the-job trainings as well as informal trainings/learning as a means of safety improvement. On-the-job training provides advantages in terms of flexibility and workplace relevance. Samson and Daft (2009) explained that it is a type of training in which an experienced employee adopts or mentors new employees on how to perform job duties effectively. In addition to on-the-job training, informal trainings provide an additional learning vista through casual communication exchanges and feedback among employees for the purpose of overcoming work-related learning needs. Mathis and Jackson (2011) demonstrated that it involves collective problem solving, job shadowing, coaching, or mentoring. As suggested by certain participant’s, inculcating aspects of construction safety learning can occur informally. For this reason it becomes necessary to harness the advantages of informal learning by developing a work environment that promotes informal learning among project team members.

The findings also revealed that Lean Construction has a very positive impact on safety. Suresh et al., (2012) observed that with the adoption and application of the Lean approach and concepts, UK construction companies have been able to achieve significant reductions of time for executing the project by forecasting the occurrence of certain problems and developing strategies for addressing them. As evidenced from participants and literature, accidents result in several wastes in the form of declined productivity, reduced human resource efficiency, waste of financial resources and time. However, the key principles of Lean thinking underscore the ability to deliver value to the clients while constantly improving the production process to eliminate non-value adding activities and any interruption to the flow of value, which are collectively considered as waste. When implemented effectively, lean also ensures that those incidents that affect workers comfort and hinder the flow of value-adding activities to clients are eliminated. Studies by Saurin et al. (2006) and Mitropoulous et al. (2007) suggested that the application of Lean Construction tools can improve safety on construction sites. From the above, it is justifiable to suggest that Lean strategies and tools can be adopted to play active roles towards enhancing safety in the Nigerian construction industry.

On culture, the findings demonstrated that culture embraces the values and system of meanings peculiar to a group of people which are learned and shared by them. It is perhaps because of such considerations that Hall (1999) explained that the project-based arrangements that typify the production of the built environment make the potential impact of culture even more pronounced than in any other industry. Abeyesekera (2002) described culture within construction as the characteristics of the industry, approaches to construction, competence of craftsmen and people who work in the industry, and the goals, values and strategies of the organisations they work in. In non-complex terms, culture within the
construction industry is about what is carried out, how and when it is done, who is involved and why certain things are following particular patterns. The generic overview of culture provided can be put in context with safety which forms the core of this paper. Thus, safety culture can be tersely described as those shared values, beliefs, attitudes and behaviours individuals, groups of individuals have regarding safety. According to Copper (2000), the formation or enrichment of a safety culture is dependent upon the deliberate manipulation of various organisational characteristics thought to impact upon safety management practices. Studies have concluded that key to attaining enriched safety cultures within organisations are the senior managers (Reid et al. 2008; Abudayyeh et al. 2006; Gurjeet and Gurvinder 2004; Cheng et al. 2004). Granted that construction projects will always differ in terms of complexities, location and team configurations, senior managers still have crucial roles in enshrining safety culture. This can be achieved through the formulation of organisational values and policies that influence the attitudes, values and belief of members in close relation to safety. Additionally, they need to strongly consider investing in those activities that support safety and the prevention of accidents such as safety meetings, trainings, site inspections, safety equipment and facility upgrades and purchases.

CONCLUSION

This study examined the construction industry and future proposed strategies for safety enhancement. To achieve this, the experiences of senior managers in the Nigerian industry were engaged from which a number of significant issues were identified. As established from the reviewed literature and findings, safety in construction must be a priority among Nigerian construction industry stakeholders during the pre-construction, construction and post construction phases. The study demonstrated that to keep abreast with enhancements, particularly in relation to the issue of safety, construction stakeholders must all play their roles in consolidating the industry to reach greater heights. Therefore holistic and practical approaches towards safety need to be introduced as strategic ways for construction stakeholders to attain to greater heights in future. In their views about safety, participants agreed that workers knowledge and skills, legislations, the fragmented nature of the construction were among the major challenges and barriers for safety in the construction industry. Most of these factors identified are in agreement with literature which suggests the existence of several unique attributes which are responsible for the challenges to safety in the construction industry and distinguish it from other industries.

The study showed that learning and safety awareness is of great importance. To achieve this, participants disclosed that construction organisations need to adopt appropriate training methods and also create conducive environments for safety learning and knowledge development. While it will be vital to constantly engage construction workers in formal
and structured trainings, it was acknowledged that safety learning and awareness also occurs informally and on the job. By acknowledging this fact, construction organisations need to expand their overall safety culture. Such expansions in the safety culture can instigate positive safety learning experiences not just from formal training sessions but also from informal employee interactions.

This research illustrated the views of senior managers on the extent to which safety can influence projects undertaken within the construction industry. The strength of the study is that it has provided additional insights into the influential factors that affect safety in construction projects. Although the findings may have universal applications, a number of limitations need to be noted regarding the present study. The first lies in the choice of research approaches. Future studies may be carried out using case studies and focus groups for additional depth. Also in terms of the generalizability of the findings, it is acknowledged that the challenges affecting safety and strategies for their improvement may vary among countries and regions. Therefore the findings of this study should be interpreted firstly within the context of the Nigerian construction industry before any further generalisations.

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ENTREPRENEURSHIP EDUCATION IN NIGERIAN POLYTECHNICS: CASE STUDY OF THE ARCHITECTURAL TECHNOLOGY PROGRAMME AT KANO STATE POLYTECHNIC

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In order to address the current high rate of graduate unemployment in Nigeria, the Federal Government directed all tertiary institutions through their various regulatory agencies to incorporate Entrepreneurship Education (EE) into the curricula of their programmes. The aim of this study is to appraise the state of implementation of entrepreneurship education in the Architectural Technology Programme of Kano State Polytechnic. Case study was employed in carrying out the research; the Director of Entrepreneurship Study Centre, Head of the Department of Architectural Technology and three (3) lecturers of the five (5) teaching the theoretical aspects of the entrepreneurship education formed the respondents of this study; structured interview and direct observation were the instruments used in collecting data for the study; two experts from the Department of Business Administration, Bayero University, Kano validate both the interview schedule and observation checklist; content analysis was used for analysis of the data collected. Findings reveal that the Kano State Polytechnic has introduced the Entrepreneurship Education into the Architectural Technology programme along all its other programmes. This shows compliance with the directives of the Federal Government of Nigeria. Furthermore, having appraised the implementation of the policy in the Architectural Technology programmes, the study unfolds that the implementation pattern is similar in all programmes of the Polytechnic. Hence, the architectural technology programme pattern of implementation is not different from other programmes. Thus, the findings of this study could be applicable to all other programmes offered in the Polytechnic. Some of the recommendations from the study are that the Polytechnic should employ the services of EE curriculum expert to introduce some variations in the structure of the curriculum to carter for the peculiarities/needs of the programmes and, the Kano state government should provide adequate funding to enable the polytechnic procure current teaching aids and provide all the necessary facilities at the Entrepreneurship Study Centre (ESC).

Keywords: architectural technology, curriculum, entrepreneurship education

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INTRODUCTION

Although there had been series of reviews of both the curriculum and National Policy on Education with the view of making education more relevant to our national development, this seemed not be working as Nigeria is currently being faced with a new challenge, which is non-availability of jobs after graduation (Akudolu, 2010). The problem of unemployment of graduands of Nigerian higher education institutions continue to be seen as failure of the institutions curricula. Furthermore, Yolaye (2008) observes that:

... many (the 6-3-3-4) of the curricula in Nigerian educational system, particularly at the tertiary level, are not geared towards effective national and economic development, because the graduates of such programmes are not easily employed or self-employed and in most cases have to wait for many years after graduation to secure jobs (if any). Hence, the rate of unemployment among university and polytechnic graduates in Nigeria is as high as 71.4 percent.

Of course the high percentage of unemployment in Nigeria did not just happen in one day, but overtime due to refusal of the stakeholders to properly address the problem through a long term plan (Akudolu, 2010). In 1992 the rate of unemployment was 20%, but by 2009 it rose to 70% (World Bank Report, 2009 in Akudolu, 2010). Furthermore, Akudolu (2010) saw the problem from a different perspective as he unfolded that with more than 200 tertiary institutions in Nigeria, only 10 percent of graduates can be absorbed in the Nigerian Labour Market in both the private and public sectors due non availability of vacancy. This implies that there is the need to come up with strategies that could address the problem of graduate unemployment if at all we want not only to grow and develop further, but to reduce/eliminate the vices which are seen as destructive elements that go along with unemployment. Hence Hajia Uwani Yahaya, who is the Director for Students Support Services at the National Universities Commission (NUC), stated that “The best way to solve the current problem of unemployment is by ensuring that students in institutions of higher learning undertake compulsory entrepreneurship study.” (Yahaya, 2011). But this is already one of the goals of tertiary education as enshrined in the National Policy on Education (NPE). The policy is already in place, what needs to be done is to have a strategic plan and an action/implementation plan toward its realization.

In 2006 the Federal Government gave a presidential directive that all tertiary institutions are to introduce compulsory entrepreneurship education, regardless of area of specialization in form of general studies (Yahaya, 2011). The NUC was saddled with the responsibility of supervising and coordinating the Entrepreneurship education in Nigerian institutions of higher learning, in collaboration with NBTE and NCCE. According to Yahaya (2011), the overall objective is to continuously foster
entrepreneurship culture amongst students and faculty with a view to not only educate them, but also support graduates of the system towards establishing and also maintaining sustainable business ventures, including but not limited to, those arising from research.

STATEMENT OF THE PROBLEM

The National Universities Commission, National Board for Technical Education and National Commission for Colleges of Education saddled with the responsibility of ensuring compliance with the government directive, came up with the following activities:

1. Establishing entrepreneurship study in all high institutions,
2. Establishing the curriculum for the course,
3. The development of teachers’ guide,
4. Instruction manual and students’ handbook for the students as well as capacity building for at least ten lecturers. (Hamitle, 2006)

The National Board for Technical Education (NBTE), an agency in charge of overseeing the operations of the polytechnics in Nigeria drew up a curriculum for the entrepreneurship education along with teachers’ manual and instructional guide and directed all polytechnics to adopt. However, five years after the introduction of the curriculum, it came to light that some polytechnics were yet to comply with the directives and where there is compliance, the status of compliance was yet to be ascertained (Robert and Faben, 2015). This study was to appraise the implementation of entrepreneurship education of architectural technology programme in Kano State Polytechnic with a view to unfolding the problems and prospects of entrepreneurship education in the training of architectural technologists in the polytechnics.

AIM AND OBJECTIVES

The aim of this study was to appraise the state of implementation of entrepreneurship education in the Architectural Technology Programme in Kano State Polytechnic with a view to unfolding the problems and prospects of entrepreneurship education in the training of architectural technologists in the polytechnics, through the following objectives:

1. Identify and review the framework of the entrepreneurship education as implemented in the Architectural Technology Programme of Kano State Polytechnic.
2. Assess the adequacy of human and material resources used in the implementation of the entrepreneurship education curriculum.
3. Assess the perceptions of the teachers to determine their opinions regarding Entrepreneurship Education as a means of solving graduate unemployment in Nigeria.

RESEARCH QUESTIONS
a. What is the structure of Entrepreneurship Education curriculum used in teaching EE in the Architectural Technology Programme?
b. What is the delivery strategies used in the implementation of the Entrepreneurship Education in the Programme?
c. Are the facilities used in the delivery of Entrepreneurship Education adequate?
d. How competent are the teachers delivering the entrepreneurship Education?
e. What is the perception of teachers regarding Entrepreneurship Education as a means of solving graduate unemployment in Nigeria?

SCOPE OF THE STUDY
The scope of this study is the implementation of entrepreneurship education at both the National Diploma (ND) and Higher National Diploma levels of the Architectural Technology Programmes of the Kano State Polytechnic. It looked at both human and material resources used in the implementation of the programme. The subjects of the study were the teachers of Entrepreneurship Education. Facilities used in the implementation of the curriculum in the Architectural Technology Programmes were also appraised.

LITERATURE REVIEW
Entrepreneurship and Entrepreneur
Entrepreneurship as an area of specialization which gave birth to entrepreneurship education that aimed towards producing entrepreneurs such that on their own provide jobs instead of becoming job seekers. These therefore, necessitate the need for understanding this basic concepts before delving into the main subject of this study, which is curriculum implementation of entrepreneurship education.

Entrepreneurship
Entrepreneurship has been defined by scholars from different perspectives. The willingness and ability of an individual to seek out investment opportunities, to establish and to run an enterprise successfully is referred to as entrepreneurship. To Mainoma and Aruwa (2008), entrepreneurship is “a function which involves the exploitation of
opportunities which exist within a market”, while Aruwa (2004) defined entrepreneurship as having the ability to accept risks and production of goods and services through the combinations of factors of production. A similar definition by Egele (2011), defined entrepreneurship as an effort towards value addition through recognition of business opportunity using both communicative and management skills to utilize human and material resources to produce a product or offer services.

Nwangwu (2007) in the same vain affirms that entrepreneurship is a process of bringing together the factors of production, which include land, labour and capital so as to provide a product or service for public consumption. Thus entrepreneurship is the personal quality that enables people to start a new business or vigorously and innovatively expand an existing one, thereby maintaining and vitalizing the growth of an economy. If entrepreneurship is the enabler, that person who displays the qualities is envisaged as the entrepreneur.

Entrepreneur

According to Ahmad, Baharun and Abd Rahmani (2004) the term “entrepreneur” in English has its origin in the French verb “entreprendre”, meaning to undertake. A simple definition of an entrepreneur by Egele (2011) sees an entrepreneur as the person that launches a venture and manages it. By this definition any person who starts and runs a business is an entrepreneur regardless of the size of business. This could either be small, medium or large enterprise. Another definition by Egele (2011) defined entrepreneur as a person who takes the financial risk of starting and managing an enterprise. In other words, features of an entrepreneur are starting and running a business regardless of its size, risk taking, with the aim of meeting up the need(s) in the society in order to make profit. It is in this regard that the European Commission (2007) presents entrepreneurship as ‘an individual’s ability to turn ideas into action (Akudolu, 2010). The entrepreneurs produce or provide service to serve socio-economic need(s) and is being rewarded with profit as benefit derived.

It implies that entrepreneurs need to be equipped with some essential knowledge and skills in the area of venture to start up, management and sustainability; it then become clear that it requires some training and education in order to prepare the entrepreneur to be successful and this comes through entrepreneurship education.

Entrepreneurship Education, Curriculum and its Implementation

Arogundade (2011) defines entrepreneurship education as the willingness and ability of a person or persons to acquire educational skills to explore and exploit investment opportunities, establish and manage a successful business enterprise.

Entrepreneurship education then, should be viewed broadly in terms of the skills that can be taught and characteristics that can be engendered in students that can help them develop new and innovative plans. It focuses on the features that are needed to conceive of and start up a new business
venture; thus the skills taught in business education are also needed by entrepreneurs as well. However, in business education the curriculum generally addresses important functions of running a business rather than aspects of starting a business.

What distinguishes entrepreneurship education from other forms of education is its emphasis on realization of opportunity. This is usually achieved through effective curriculum design and implementation (Onojetah and Amiaya (2013)).

This study adopts the curriculum definition of Onojetah and Amiaya (2013) that defines curriculum as the set of courses and their contents offered in a school or higher institution. Hence, the NBTE syllabus for entrepreneurial education shows that the courses are meant to cover: meaning and concept of entrepreneurship; objectives and purpose; types and key competences for entrepreneurship; how to generate business ideas; propagate, manage and evaluate business or an enterprise in Nigeria and other developing counties; history and development of Information Technology (IT) in Nigeria; investment and support agencies and their roles; as well as; business planning and succession plan (NBTE, 2007). Students of Architectural Technology in the country’s polytechnics, who would qualify to become the core of intermediate library manpower, otherwise called architectural technicians and technologist, take entrepreneurial courses at the National Diploma programme (i.e. ND) and during the their Higher National Diploma (HNDII). This makes the entrepreneurship education programme to cut across the two segments of polytechnic education. According to Hamitle (2006), “the curriculum has addressed most of the general characteristics of any training curriculum which emphasizes education for a living i.e. training for the acquisition of specific skills and knowledge to perform identified tasks.” It is worth noting that, the effort and programmes to make architectural technicians and technologist employable, creative and versatile through entrepreneurship education is commendable (Nnadozie, Akanwa, and Nnadozie, 2013).

As stated above, the goal of entrepreneurship education can be achieved successfully through effective curriculum design and implementation. If a pass mark is given to the curriculum design, then, what about its implementation?

Curriculum implementation is about translation of the curriculum objectives from paper to practice – that is the process of putting what has been planned in the curriculum document into practice (Okebukola, 2005). In other words, it refers to the teaching and learning that takes place within the school environment through the school’s facilities, guided by the curriculum document. Which according Robert and Faben (2015), “when this is done appropriately and according to the curriculum plan, the implementation can be termed effective and it is the effective implementation that guarantees the actualization of the curriculum objectives”
Thus, in order to achieve the goals of EE in the polytechnics, NBTE listed in great detail, the infrastructural facilities, workshops, laboratories and instructional materials and equipment for effective teaching and learning entrepreneurship courses – the items must be available for the use of both students and lecturers (Robert and Faben 2015). This implies that both human and material resources must be available, in the right proportion, for the goals of entrepreneurship to be achieved. If so, what is the state of human and material resources in the running of entrepreneurship education for architectural technology programme in Kano state polytechnic? This was the question that this study attempted to answer.

Review of similar studies (Obisanya, 2010; Heloise, 2009; Cheung, 2008; Lee, 2005; Oduwaiye, n.d.) on Entrepreneurship Education reveals the following:

1. That approaches in appraising entrepreneurship education differ not from other appraisal studies where the purpose is to determine the focus or perspective to be emphasized.

2. That case study and survey are some of the major research methods often used in appraising entrepreneurship education in tertiary institutions.

3. Making recommendations as part of the contribution of entrepreneurship education studies, forms vital outcome of appraisal studies in improving existing situations in tertiary institutions.

**RESEARCH METHODOLOGY**

Case study method has been identified as the most suitable research approach where in-depth exploration of a case is the goal (Blaxter, Hughes and Tight, 2000). Thus, case study method was adopted for the execution of this study; the respondents of this study were the Director of Entrepreneurship Study Centre, Head of the Department of Architectural Technology and three (3) lecturers of the five (5) teaching the theoretical aspects of the entrepreneurship education in the polytechnic. Both the human and material resources used in the implementation of the entrepreneurship education form the subject of the study, which include teachers, students, facilities and relevant documents used.

In order to find answers to the research questions, structured interview and direct observation were chosen as the research instruments for the collection of primary data for the study. Structured interview schedule was used in interviewing the Director of Entrepreneurship Study Centre, Head of the Department of Architectural Technology and three (3) lecturers of the five (5) teaching the theoretical aspects of the entrepreneurship education in the polytechnic. Also direct observation with the aid of checklist, which according to Henry, Celen and Mine (n.d.) is the best method for assessing school's facilities/buildings, was adopted to assess the facilities used for the implementation of the Entrepreneurship Education Curriculum. The facilities include the
Entrepreneurship Study Centre, auditoriums and lecture halls. Thus, direct observation was done to ascertain their state with a view to understanding their adequacy or otherwise.

Moreover, the curriculum for EE was reviewed in order to understand its structure regarding its aims, objectives, and compartmentalization as well as unfold from the curriculum, the facilities required for effective implementation.

Content analysis was used in analysing the data collected from the interviews to understand the how the entrepreneurship education curriculum is being implemented in the polytechnic with particular emphasis on the Architectural Technology Programme.

DATA PRESENTATION, FINDINGS AND DISCUSSION

The presentation of data, findings, and discussion are in line with the research questions for guidance.

Question one: What is the structure of Entrepreneurship Education curriculum used in teaching EE in the Architectural Technology Programme?

The Kano State Polytechnic adopted the NBTE Entrepreneurship Education for all its programmes at both ND and HND level. At the ND level curriculum, the course title is ‘Introduction to Entrepreneurship’ taken in the second semester of year one (NDI); the course covers all the components of entrepreneurship with the main aim of creating in the students, awareness of the role of entrepreneurship in the society, and to serve as a motivating factor for them to start to think of self-employment as an alternative source of employment. This is followed by skills acquisition component of the curriculum offered at the second semester of year two (i.e. NDII). The skill acquisition is provided by the Entrepreneurship Study Centre of the Polytechnic. Every student is expected to learn a trade out of the eight (8) offered at the centre through linkages to a master craftsman. Linkages become necessary where the trade chosen by a student is not offered at the centre before completing the diploma programme.

At the HND level, the title of the course is Entrepreneurship Development taken at the first semester of year one (HNDI); the general goal of the course is to equip the students with necessary entrepreneurial skills for self-employment with the following general objectives (except from the curriculum): on completion of the course, the student should be able to 1) understand the roles of entrepreneurship in the development of the economy; 2) know the levels of aspiration, perseverance and personal efficacy of an entrepreneur; 3) understand the various existing industry and support agencies in Nigeria; 4) know the functions of management and the roles of a manager in an enterprise; 5) understand the strategies of
consolidation and expansion of business enterprise; and 6) understand the practical aspect of running a business. These courses form the theoretical aspects of the curriculum. Every HND student is also expected to acquire skills of a particular trade at the second semester of year two (HND) before graduation just as explained above for the ND.

Consequently, it is clear that the curriculum used in the delivery of EE for the Architectural Technology programme is not different from that of other programmes in the Kano State Polytechnic, and the polytechnic adopted the NBTE curriculum. Furthermore, the curriculum is designed to be offered at both the ND and HND programmes of the AT in the same way as other programmes. Skills acquisition also forms a component of the practical aspect of the Entrepreneurship Education offered in the polytechnic in line with the NBTE Entrepreneurship Education Curriculum.

Question Two: What is the delivery strategies used in the implementation of the Entrepreneurship Education in the Programme?

To answer this question, the three lecturers out of the five teaching the theoretical aspects of the entrepreneurship education in the polytechnic and the Director of the entrepreneurship study centre were interviewed. It unfolds that the traditional lecture method of teaching where the lecturer facilitate the teaching and learning process by talk and show method (using the white board and marker), is what is used as the main strategy in implementation of the EE in the AT programmes. They also believe that supplementing the traditional method with other methods, in particular educational technology (incorporation of ICT in the teaching strategies), will go a long way in enhancing the teaching and learning process.

Question Three: Are the facilities used in the delivery of Entrepreneurship Education adequate?

To answer this question three approaches were used i.e. physical observation, responses of the Head of Department, Director of Entrepreneurship Study Centre and the lecturers teaching the Entrepreneurship Education. The physical observation was used in assessing the adequacy of the lecture rooms/studio and halls for the conduct of examination for the theory aspect of the curriculum, while physical observation was also used in assessing the facilities at the Entrepreneurship Study Centre in relation to the practical aspect of the Entrepreneurship Education Curriculum. Responses from the head of department and lecturers were used in ascertaining the adequacy of the teaching aids i.e. the use of Information and Communication Technology (ICT) in complementing the traditional method of teaching. Also, both the Director and lecturers responses were used in complementing the physical observation in ascertaining the adequacy of facilities at the Entrepreneurship Study Centre.
The Department operates the dedicated lecture room/studio approach, where each class has been allocated a dedicated lecture room for both lectures and design class/activities usually known as studio. In other words, there are a total of four lecture rooms/studios for the ND I, ND II, HND I and HND II. While the School Auditorium and Workshop are used during examinations. The observation reveals that there are adequate number of stools and drawing boards in the lecture rooms/studios. But for Auditorium and Workshop where examination is conducted, there are no adequate space for tables and chairs for the conduct of examination, hence not conducive; also, the construction of the Auditorium is not completed and seems to be abandoned, yet still used during the examination. It was observed that the Auditorium cannot accommodate the students during the conduct of examinations, as some students were seen with their tables and chairs during the examination, outside the defined space of the Auditorium. This implies that though the lecture rooms are adequate for the delivery of EE in the Department, the Auditorium and Workshop are found to be inadequate for the conduct of examination.

Regarding the teaching aids, the Head of Department and lecturers unfold that there are no teaching aids in the department provided for the delivery of Entrepreneurship Education. The lecturers are of the view that when teaching aids such as projectors and internet could enhance teaching and learning, they are left with no option other than to carry on without them because they have not been provided by the Polytechnic. When asked about excursion, all the lecturers responded that they do not embark on excursions as there are no adequate buses in the school; hence excursion is not part of the Entrepreneurship Education.

On visit to the Entrepreneurship Study Centre, it was observed that the structures provided can be grouped into two i.e. the completed and the uncompleted. Two of the six structures that are completed, are the administrative block and fish pond. While the admin block is being put to use the fish pond is about completion stage, hence yet to be put to use. The other four remaining structures are under various stages of completion.

The admin block accommodates the Director’s office and office for other supporting staff. Presently, part of the admin block is temporarily used as leather workshop, and can accommodate no more than twenty students at a time. Where more than twenty students choose leather work for their skill acquisition, the space provided will not be adequate and that answers why some of the students are assigned to other masters outside the centre. The fish pond can also accommodate only about 50 students at a time, so with more than two hundred students likely to subscribe for fish farming, certainly, the pond is not adequate. The four uncompleted structures said to be for poultry farming, also cannot adequately accommodate more than 50 students at a time for the acquisition of the poultry skills. Hence, this point to the fact that the centre even after completion, cannot be said to be adequate as it may have to continue to rely on masters’ workshop/farm outside the centre for the skills acquisition of the substantial number of students.
The responses of both the Director and lecturers reveal that the provision of facilities at the centre is not adequate, as they strongly believe that much is left to be done regarding the issue of facilities at the centre, especially considering the fact that this component of the EE is very critical to making students self-employed and employers of labour rather than job seekers and employees.

Question Four: How competent are the teachers delivering the entrepreneurship Education?

To answer this question, the Director’s and lecturers’ responses were analysed. Out of the six lecturers involved in the delivery of the theoretical aspects of the entrepreneurship Education, four were graduates of economics, one of political science and one of accountancy, none of them with qualification in teaching. Only two of the lecturers attended a workshop on capacity building in relation to entrepreneurship education. It is obvious from the area of specialization of the lecturers, that they are not trained to teach entrepreneurship education. It is therefore observed that, further training either part time or full time, will go a long way towards enhancing the capacity of lecturers, to better prepare them to teach entrepreneurship.

On the practical aspect, the traditional method of master/pupil approach is what is being used in the skills acquisition. The assumption is that since the master is an expert, then he/she could train others towards acquiring the particular skill she/he specialized on. Responses from the lecturers indicated that they are partially getting the desired outcome. This is an indication that the pragmatic approach is not yielding the desired result as such the masters’ may have the expertise but not the competency desired.

Question Five: What is the perception of the teachers regarding Entrepreneurship Education as a vehicle to solving graduate unemployment in Nigeria?

To answer this question, the perceptions of the lecturers were sought regarding EE as a vehicle for solving graduate unemployment in Nigeria today. All of them were unanimously positive that the goal of entrepreneurship education would be achieved by motivating the graduates to be employers of labour and not end up as job seekers.

First, they acknowledged that the structure of the curriculum comprising theoretical and skill acquisition components, has set out a clear goal of equipping the students with competency in terms of knowledge, skill and attitude, which will serve as a motivating factor to becoming self-employed after graduation. Secondly, it prepares the students to identify opportunities and begin to think of self-employment even before graduation. It also sensitizes not only the students, but the society to accept graduate self-reliance as the best alternative and to create the
enabling social environment that will make it easier for those that choose to be self-reliant.

Teachers are also unanimously of the view that to achieve the goal of entrepreneurship education there must be adequate by the government i.e. the Kano state government, who owns the Polytechnic. They observed that the current funding of EE in the Polytechnic is not adequate. Even when the teachers are optimistic that EE can serve as a vehicle to ending graduate unemployment problem, its implementation must be supported with adequate funding.

**CONCLUSION**

From the foregone it is clear that the Kano State Polytechnic has complied with the government directives of introducing Entrepreneurship Education in its programme structure and has also established an Entrepreneurship Study Centre to support the skill acquisition component of the Entrepreneurship Education towards achieving the goal of the Entrepreneurship programme. Furthermore, Entrepreneurship Education offered by the Architectural Technology programme is not different from that of the other programmes in the Polytechnic as all the programmes in the Polytechnic use same curriculum, and the lecturers from schools of general studies deliver the curriculum. The lecture rooms where the architectural technologists are taught the theoretical component are adequate, but the Auditorium and Workshop are not adequate for the conduct of examinations. Also, that the facilities provided at the Entrepreneurship Study Centre are not adequate. The capacity of the lecturers and masters need to be built so as to achieve effective implementation of the Entrepreneurship. Finally, adequate funding is desirable as the current funding is not adequate for the effective implementation of the Entrepreneurship Education.

**RECOMMENDATION FROM THE STUDY**

In order to enhance the EE implementation programme in the Kano state polytechnic, and by extension in all other tertiary institutions with similar challenges/problems, the following recommendation are made:

1. The polytechnic should employ the services of EE curriculum expert to introduce some variations in the structure of the curriculum to cater for the peculiarities/needs of the programmes.

2. The lecturers should be trained in the area of teaching methodology to make them more effective and efficient in the implementation of EE curriculum.

3. The Kano state government should provide adequate funding to enable the polytechnic procure current teaching aids and provide all the necessary facilities at the ESC.
SUGGESTION FOR FURTHER STUDY

1. There is the need for a more comprehensive study of all the programmes offered by the polytechnic to facilitate generalization of the findings of this study.

2. There is also, the need for a comparative study with other similar institutions so as to place/ascertain the status of the implementation of EE in the Kano State Polytechnic along with other institutions within the North-West Zone and other zones across the country.

REFERENCES


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ESTATE SURVEYORS AND VALUERS
PERCEPTION OF LAND ACQUISITION
PROBLEM IN KWARA STATE

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The significance of land that is free from litigation in the construction Industry cannot be over emphasised, either for housing or infrastructural facilities provision. The study evaluates the problems of land acquisition in Nigeria with reference to Kwara State. The opinions of the 26 Estate Surveying and Valuation firms were sought through questionnaire with a response rate of 84.6% (that is 22 out of 26). The data was analyzed with descriptive statistics. Findings from the study reveal that description of the land to be acquired in acquisition notice; basis of valuation used for the assessment of compensation payable and delay in the payment of compensation are major problem of land acquisition in Kwara State. The study among other things recommended that the acquisition notice should be explicit enough to provide the required information to the general public and the Land Use Act should be expunged from Nigeria Constitution as to facilitate its amendment.

Keywords: compensation, kwara state, land acquisition/revocation

BACKGROUND

Various studies such as (Olaniyan, 2015; Adi, 2014; Famuyiwa andOmirin, 2011; Nuhu andAliyu, 2009) have shown that land is a prerequisite for Urban renewal and Urban development. The Supreme Court of Nigeria decided cases have illuminated the thick cloud on land revocation/ compulsory acquisition that revocation procedure must be followed for there to be a legal revocation/ compulsory acquisition (see Adole vs. Gwar 2008). Land revocation/ compulsory acquisition which in many literature is been referred to as power of eminent domain. Government in this part of the world takes over private land for developmental projects such as for schools, hospitals, roads etc. these projects are been referred to as over ridding public interest (Section 50 of the Land Use Act of 1978).

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The study of Ogedengbe (2014), Famuyide and Omirin (2011), Nuhu and Aliyu (2009), and Kakulu, Bryne and Viitanen (2009) have shown that a lot of challenges is facing land revocation in Nigeria. Also the study of Odame (2008) shows that the some of the problems in Nigeria also manifest in Ghana. Also the study of Wilbad (2010) in Tanzania testified to this.

The core professional that was statutorily recognized by the Land Use Act of 1978 (LUA) as relates to land revocation is the Estate Surveyors and Valuers (sections 5 and 29). Estate Surveyors and Valuers are statutory member of the Land Use and Allocation Committee, and one of the committee functions is to advise the Governor on issue that relate to compensation on revocation. Also, Estate Surveyors and Valuers in the state ministry of land which the Act refers to as Appropriate Officer were saddled with the responsibility of determining rate to be used for computation of compensation payable for economic trees and crops and unexhausted improvements on land.

Issues have been raised from various perfected on the LUA such as status of holders of land before 1978 (see the Supreme Court judgement in Yakubu vs. Ajiboye); power of the federal and state government; issue of rent (Atilola, 2013) and many others. Studies Ogedengbe (2014), Famuyiwa and Omirin (2011), Nuhu and Aliyu (2009), and Viitanen and Kakulu (2009) are germane gamine on LUA, but none of these studies have looked at the perception of Estate Surveyors and Valuers. The study of Alias and Daud (2009) and Alias, Kamaruzzaman and Daud (2010) perceptions of professionals in Malaysia. A similar study conducted in Osun state, Nigeria by Olaniyan (2015) focused on procedural lapses in compensation practice where he examined problems encountered by Estate Surveyors and Valuers in compensation practice, the study is however limited to Osun State. Their study covers more than one professional and differ in location to Nigeria. Sule (1999) study can be said to be a study that look at the problem of land revocation in Kwara State, but he does not sought the opinions of Valuers and it is a study based on personal observation as a staff of the then ministry of land and housing, now Kwara State Bureau of Lands. To this effect, the study provides a professional view of the issues hindering land revocation in Nigeria with a focus on Kwara State which is one of the oldest states in the country.

**LITERATURE REVIEW**

The problem of land acquisition is polygonal, authors across the globe have identified the varieties of them. This section of the paper discussed the problems of land revocation/ acquisition. Sule (1999), identified inadequacy of notice, non-payment of compensation, non-use of the appropriate compensation law(s), neglect of the resettlement in lieu of cash compensation, claimants not allowed to engage private estate surveyor and valuer and the use of unskilled labourers for assessment exercise as
the major challenges of land acquisition by government. In another study by Nuhu (2008) it was concluded that the implementation of Public Land acquisition and payment of compensation in Nigeria has generated controversies, lapses and disputes in the past. Inadequate revocation notices, Inadequate Compensations, Illiteracy of the Claimants, Inadequate funding of the Compensation exercise, Non-payment of interest on delayed payments, problems of conflicting Claims, Use of low rates for assessment of economic Trees and Crops, Non-enumeration for some Crops/ economic Trees, problem of identifying claimants (owners), disallowance of Surveyors to represent Claimants, communication problem, non-payment for undeveloped land, corruption of Government Officers etc were problems identified from the findings in the study. In Larbi (2008) the conclusions from the study tended to tilt towards policy frameworks in solving the problem and the paper did not solicit information directly from the concerned individuals.

Kakulu, Bryne and Viitanen. (2009) identified - ambiguity and lack of clarity of the relevant statutes, unsuitable prescribed methods of assessment, over-valuation and under-valuation of interests, lack of standards and clear definition of the functions of Government Agencies amongst others. Kakulu et al.’s study concentrated heavily on the research procedures employed, and on demonstrating how phenomenology as a diagnostic research could be applied to real estate research using that particular study as a demonstrative tool. There wasn’t any empirical application demonstrated. There was no presentation as to the procedures used in analyzing or explaining either the qualitative or numerical data gathered for the study. Further, the authors were interested in disseminating the discrepancies between Real estate professionals’ valuation figures and actual values Ambaye (2009) appraised the adequacy of compensation in Ethiopian. The study reveals that compensation paid is not adequate because of the method of valuation adopted, which is cost replacement this which is against the provision of the country constitution that guarantees the right of holder of land for commensurate compensation, that which reflect the market value of the property. The inadequacy of the compensation had created insecurity of land holding.

Alias and Daud (2009) and Alias, Kamaruzzaman and Daud (2010) examined the perceptions of the professionals land acquisition procedures in Malaysia. The research explored issues of land rights and land acquisition compensation of indigenous peoples in Peninsular Malaysia. The study argued that acquisition of native lands is inevitable as land is scarce to meet the national growth agenda and socio-economic developments. Using questionnaire survey, the research adopted the descriptive and inferential analysis technique to present the results. It was found that, the practice of payment of compensation to acquisition of the land tends to be unstructured, and disparity exists among the different states. The study shows that laws of Malaysia are deficient with regard to the indigenous people’ rights to fair and just compensation. Hence, the
determination of compensation is entirely at the discretion of the various authorities, while some authorities apply the legislation rigidly others are too generous.

Wilbard (2010) summited that “one of the most valuable lesson drawn is that the process involved in land acquisition for public use unless supported by clear, Institutionalised and inclusive protocols, which are transparent and predicable, my result in unintended and undesirable negative consequences and grievances triggering conflict between government and landowners”. He however recommend that policy and legislative reforms are necessary in order to review the current top-down approaches to compulsory land acquisition practices in Tanzania.

A recent study in Nigeria by Famuyiwa and Omirin (2011) summarized the problem in this form “ Inadequate revocation notices, inadequate compensations (non-payment of market value), Illiteracy of the Claimants, Inadequate funding of the low rates for assessment of economic trees and crops, Non-enumeration for some Crops/economic Trees, problem of identifying claimants (owner), disallowance of Surveyors to represent Claimants, communication problem, non-payment for undeveloped land and corruption of Government Officer are the challenges of acquisition procedure”.

The summary of the above is that land acquisition can be view from three angles which are notice, assessment and compensation, this is in line with the view of Sulyman (2014).

METHODOLOGY

The main instrument employed was questionnaire which was designed to collect information on the problem of land revocation from the 26 practicing Estate Surveyors and Valuers firms. The factors investigated were based on notice, assess and compensation in line with Sulyman (2014) This represent 84.60% of the firms in Kwara State as contained in the register (2014) of the practicing firms in the state. The data were analyzed with descriptive statistics (Percentage table, Relevant Important Index (RII)) as used by Oyedokun (2012) and Olaniyan (2015).

FINDINGS AND DISCUSSION

The background information of the respondents shows that 75% of the respondents are Principal/Managing Partners and 25% are branch managers; 31.25% of the respondent holds B. Sc/ B. Tech +ANISV+RSV, 25% holds M.Sc. +ANISV+RSV and HND +ANISV+RSV; 12.5% holds HND and they are in tutelage stage in the Institution and 6.25% holds ND+ANISV+RSV. As regard the length of practice by the firms, 50% of the respondent have being practicing between 1 and 10 years, 37.5% for between 21 and 30 years, while 12.5% for between 11 and 20 years. The respondent where asked about the frequency of involvement in land
acquisition, 50.1% said they are involved occasionally, 14.3% of the respondents says they are involved very often, also 14.3% are for often involvement and not often involvement.

What can be inferred from the above is that majority the respondents have the experience, education qualification and professional qualification that might warrant sampling their opinion in the research area.

The responses of practicing firms of Estate Surveyors and Valuers on the problems facing land acquisition in the state based on three factors and each factor were having 4 variables is presented in table 1 below:

### Table 1: Factors Responsible for the Challenges of Land Acquisition in Kwara State

<table>
<thead>
<tr>
<th>S/N0.</th>
<th>Factors of the Challenges</th>
<th>RII</th>
<th>Rank in Group</th>
<th>General Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NOTICE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i</td>
<td>Stating the purpose of use of the land to be acquired</td>
<td>0.97</td>
<td>1st</td>
<td>1st</td>
</tr>
<tr>
<td>ii</td>
<td>Description of the land to be acquired</td>
<td>0.94</td>
<td>2nd</td>
<td>3rd</td>
</tr>
<tr>
<td>iii</td>
<td>Time to submit claim</td>
<td>0.82</td>
<td>3rd</td>
<td>10th</td>
</tr>
<tr>
<td>iv</td>
<td>Eviction from the acquired land</td>
<td>0.82</td>
<td>3rd</td>
<td>10th</td>
</tr>
<tr>
<td>2</td>
<td>ASSESSMENT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i</td>
<td>Basis of valuation</td>
<td>0.95</td>
<td>1st</td>
<td>2nd</td>
</tr>
<tr>
<td>ii</td>
<td>Methods of valuation</td>
<td>0.90</td>
<td>2nd</td>
<td>4th</td>
</tr>
<tr>
<td>iii</td>
<td>Non-use of prevailing law(s)</td>
<td>0.84</td>
<td>4th</td>
<td>9th</td>
</tr>
<tr>
<td>iv</td>
<td>Using of competent hands for the assessment</td>
<td>0.90</td>
<td>2nd</td>
<td>4th</td>
</tr>
<tr>
<td>3</td>
<td>COMPENSATION</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i</td>
<td>Non-payment of compensation</td>
<td>0.86</td>
<td>2nd</td>
<td>7th</td>
</tr>
<tr>
<td>ii</td>
<td>Delay in payment of compensation</td>
<td>0.90</td>
<td>1st</td>
<td>4th</td>
</tr>
<tr>
<td>iii</td>
<td>Non-payment of interest for delay payment</td>
<td>0.85</td>
<td>3rd</td>
<td>8th</td>
</tr>
<tr>
<td>iv</td>
<td>Non-implementation of the resettlement provision</td>
<td>0.82</td>
<td>4th</td>
<td>10th</td>
</tr>
</tbody>
</table>

Source: Field Survey 2014

In table 1 above, the general rating shows that none stating the purpose of use of the land to be acquired was ranked 1st with RII of 0.97 follow by basis of valuation and description of the land to be acquired with RII Of 0.95 and 0.94 respectively. Whereas, factors such as time to submit claim, eviction from the acquired land and non-implementation of the resettlement provision were ranked 10th position and having RII of 0.82 each.

On grouping basis, that is problems based on notice, assessment and compensation. Stating the purpose of the use of land to be acquired, basis of valuation and delay in payment of compensation were ranked 1st in each group. While the least problem in the groups are time to submit claim, and eviction from the acquired land that were ranked 3rd under notice; non-use of prevailing law(s) was rank 3rd in assessment and, non-
implementation of the resettlement provision was ranked 4th in compensation group.

What can be deduced from the above problems of land acquisition/revocation are as follow:

i. That most of the notice of acquisition/revocation does not state the purpose of the public use of land to which the propose acquisition is intended for. The purpose stated does not conform to the provision of section 50 of the LUA as to what constitute public use and in some instances no notice at all;

ii. That the basis of valuation commonly adopted is the replacement which give rise to the use of cost replacement method that does not reflect the market value (commensurate compensation or fair compensation);

iii. That the way and manner at which the land were described, if there are notices, does not draw the attention of holders of land to the notice as a result of the language used and the technicality in the description which are alien to the holders of land, and;

iv. That land holders does not receive compensation and when it was paid, the payment is not within a reasonable time. This act has made them to be worse off in term of “time value of money” coupled with the fact that what is being paid is not the fair market value of the interest.

CONCLUSION

The study so far had identified 4 major problems hindering land revocation in Kwara state which are purpose of revocation, basis of valuation, description of the land to be revoked and delay in payment of compensation. Also the study had inferred from the Supreme Court judgement of Adole Vs. Gwar that for revocation to be legal and complete, there must be notice of revocation, assessment and compensation.

The implication of findings of the study is that, if the current practice of land revocation/compulsory acquisition continues in the state it might lead to undesired negative consequences and grievenance while triggered conflicts between government and land holders and between allottees of the revoked land and the initial holder. The secondary effect is that a lot of construction site either public or private will witness abandonment and abandonment itself has negative effect on the built environment.

In conclusion, the way forward of preventing the predicted conflicts, it is suggested that the LUA should be expunged from Nigeria constitution so that the below recommendations can be made without having to go through the rudiments of constitution amendment.

The recommendations are as follow:
i. The language for the revocation notice should be less technical for easy understanding by all;

ii. The mere using of the term “overriding public interest” in acquisition notice should stop, the real purpose of the acquisition (as spelled out in Section 50 of LUA) should be adopted;

iii. Section 29 of the LUA should be amended so that market value basis will replace the cost of replacement basis;

iv. Section 28 of the LUA should be amended, for there to be a maximum period from the date of revocation notice and payment of compensation.

v. The acquisition authority should make sure that acquisition is “effective”, by making sure that fund needed for the acquisition are available before embarking on acquisition.

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EVALUATION OF CLAY ROOF TILES PRODUCED WITH SAW-DUST, CASSAVA STARCH AND MAKUBA

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Nigeria has for many years been over dependent on conventional and imported building materials which are rather costly and beyond the affordability of the common man. The prices of building materials are increasing by leaps and bounds daily, and consequently these affect the cost of producing housing units. A look inward reveals that Nigeria has a good number of agro-allied wastes, Industrial wastes and mineral deposits such as clay, saw-dust, Makuba and Cassava starch, to mention but a few. The aim of this study is to evaluate the properties of clay roof tiles produced using laterite, saw-dust, Makuba and cassava starch. Clay was the primary material; Laterite was added to reduce shrinkage; saw-dust serves as filler and in order to reduce the density of the roof tile. Makuba and Cassava Starch were compared as the main binders in the mix matrix. Absolute volume method of mix proportioning was adopted in the design of the mix. The water/binder ratio of 0.7 was used in the production of all the tiles. Equal quantities of clay roof tiles were produced using clay/binder replacement level of 0%, 2.5%, 5%, and 10% of Makuba, Cassava Starch and the mixture of Makuba and Cassava Starch. Finding indicates that clay roof tiles produced using 2.5% Makuba as a binder gives the optimum result in terms of abrasion resistance, water absorption, and flexural strength. The study therefore concluded that the performance of Makuba is better as compared to cassava starch in clay roof tile production. To improve the water absorption and binding property, Makuba (parkia biglobosa) should be blended with cement or combined with other pozzolanas in clay roof tile production.

Key Words: cassava starch, clay roof tile, makuba, sawdust

INTRODUCTION

It must be recognized that housing is an essential human need; after air, Water and Food, (the three necessities of life). In recent time, building a house has become too costly, especially when it comes to roofing stage. This perhaps cost almost half of the total construction work. Personal house ownership is almost beyond the average Nigerian. The most glaring reason is the expensive nature of building materials especially roofing materials.
Roofing sheet is one of the most popular conventional materials for most construction works. Thus any change in its price portents significant effects on the total cost of construction, (Abubakar, 2010). Hence the needs to encourage and improve the use of locally available materials become so necessary.

Adam and Agils (2003) have observed that construction is usually beyond the means of both the rural and urban poor. In Nigeria, the problems besetting construction industry as opined by Hashim (1992) are numerous; these include scarcity and cost of construction materials, high demand for housing, lack of promotion of the use of locally available materials etc.

Another problem that has recently commanded the attention of various governments in the country is the deteriorating environment, cause by agricultural and industrial wastes to mention a few. Some of these materials are not easily decomposed and their accumulation is a threat to the environment. Example of these waste materials are rice husks, saw dust, coconut fibre, maize comb, makuba etc, (Biswas, 2008). To overcome the environmental hazard caused by these waste materials, they can be used as locally available construction materials especially in production of roofing sheets.

Research efforts by Oyeleke and Bankole (2000) in the production of roofing tiles using coconut fibers as a discontinuous reinforcement, sawdust as a filler materials, cement as a binder and water as solvent is a good demonstration of the use of agricultural residue in the production of roofing tiles. The final results show that coconut fibre husk and sawdust are satisfactory in the production of roofing tiles.

A research work carried out by Maminat (2001) on concrete plain roofing tiles gives the average breaking load of 562N, this average breaking load falls within the requirement of normal failure load of not less than 498N as recommended by BS 473:Part 1: (1967) at an age of 28 days.

Opara (2011) also undertook a study in the production of ebonite roofing tiles using Rice Husk, Marble dust pulp, cement and water in appropriate proportions. He tried to compare his roofing tiles to asbestos roofing tile sheets. He obtained a mean compressive strength of 13 N/mm² which was satisfactory in accordance with BS 1191, 6463: Part 4 and ASTM 204. Hence the tile is cost effective, strong, maintenance free, resistance to corrosion and heat.

It is in line with the above that this study focused in evaluating the suitability of clay roof tiles produced using saw dust, Makuba and cassava starch for use in low cost building construction. This was achieved by determining the production process of the roof tiles using clay/laterite, sawdust, Makuba and cassava starch; obtaining the mix proportioning of the materials and assessing the physical and mechanical properties of the finished product.
MATERIALS AND METHODS

Materials

The materials used for this research included clay and laterite as the primary materials, sawdust as a lightweight material, Makuba, cassava starch and water. The materials were subjected to some physical properties test in the laboratory to determine their suitability.

1) Clay

Clay was obtained from Boma District of Samaru, Sabon Gari Local Government Area of Kaduna State. The clay is dark in colour; it is collected from the depth of about 2.8m from the ground level. Clay is actually the primary material used in this study.

2) Laterite

The laterite used in this experiment was obtained from burrow pit in Samaru along Ahmadu Bello University Teaching Hospital, Zaria, Samaru Local Government Area of Kaduna State. Depth of collection of sample ranged from 2.8-2.9m of the ground level. Latere is introduced to the clay in small quantity in order to reduce the excessive shrinkage property of the clay, and hence reduce shrinkage crack of the primary material.

3) Saw Dust

Saw-dust are grained of wood formed when wood are sawn to various sizes for the purpose of building and other civil engineering construction work. It is also classified as one of the light weight material due to its lightness in nature. The saw dust is introduced into the roof tile matrix to reduce the weight of clay and laterite as the primary materials and hence enhance the light weight property of the roof tiles. The saw-dust is obtained from saw mill in Samaru, Samaru Local Government Area of Kaduna State.

4) Makuba

The additives used in this work is the husk obtained from the dried fruit of a tree called parkia biglobosa (Makuba). The extract from the plant was analyzed in the laboratory in order to determine its physical and mechanical properties before it’s used in the production of clay rooftiles. The plant material was obtained in the form of husks from the ripe fruits of the plant after the seeds had been removed. Although the makuba was added to the clay in powdered form to serve as a binder and mixed with clay to produce tiles.

5) Cassava starch.

The starch used in this research as additive is locally manufactured by market women made with cassava, which are disease, paste and draught resistant, low cyanide content, early maturing and high yielding. The starch is prepared with hot water in the form of pap and poured in the clay mixed and left to mature for two weeks before use to cast tiles.
Methods
Mixing and Spreading
Manual mixing method was adopted in preparing the Boma clay/laterite and saw-dust for placing; the procedure adopted in the manual mix began with measurement of the clay and pouring it on a clean floor surface of the laboratory. This was followed by measuring of laterite which was thoroughly mixed together with the clay, this was then followed by the measurement and mixing of saw-dust until uniform colour was achieved. Makuba and cassava starch were also added and mixed thoroughly, this is to ensure the achievement of uniform colour. Water was measured in order to achieve the required water/binder ratio and added to the already mixed materials mentioned earlier. The water/binder ratio used in this study was 0.7. A little quantity of water 800mls was added in order to take care of water absorbed by floor surface. The whole process of mixing and sampling was in accordance with EN 1304: 2005 and mix proportioning table is giving in table 1.

Trial mixes was first prepared and used immediately to cast clay roof tiles. The mix was used immediately to produce roof tiles and the tiles produced were air cured in an open space consequently, major cracks were experienced on both surface of the tiles and buckling. After the first trial test, another trial mix of clay roof tiles was produced; this time around the clay mix was mixed and covered with polythene sheet for seven days. After which 500mls of water was added to the slurry and mixed thoroughly, then the tiles were cast in the laboratory under a control room temperature of 25°C and less wind movement. The clay roof tile was therefore in an enclosed atmosphere and covered with polythene to enable it dry gradually to avoid cracks and shrinkage. The clay roof tile produced under this condition indicates serious buckling but zero cracks. To correct the serious buckling experienced, another trial mix test was conducted. In this case all the conditions described above were strictly adhered to, but the finished clay roof tiles was allowed for four days to gain some strength before turning and subjecting the tiles to a constant weight of about 10kg. The objects were removed after 14 days. This process yielded positive results as no cracks and buckling were experienced.

The result of trial mix experienced above was finally adopted for the production of subsequent clay roof tiles.

Experimental Tests Conducted on Materials
Specific Gravity Determination
The specific gravity test was done according with ASTM D 2395-83. Five trial samples were tested for clay, laterite, saw-dust, Makuba and cassava starch respectively. The specific gravity of material is defined as the ratio of the weight of a given volume of that material to the weight of an equal volume of water (ASTMD, 1916).

Bulk Density
This test was carried out according with BS 812: Part 2: 1975 specification. Bulk density is the density of an aggregate when it is parked together in a
bulk (Neville, 2000). The test was considered as compacted and loose bulk density. For compacted bulk density, measurement involves filling the cylinder in three stages each being compacted with a rod for twenty five (25) times before adding the next layer. The procedures are the same for clay, laterite, saw dust, Makuba and Cassava Starch.

**Experimental Tests Conducted on Clay Roof Tiles**

**Abrasion Resistance Test**
This test is important in assessing the level of resistance of particles surface to wear, i.e. particle loss from surface of specimen (Heebink and Hassett, 2001). The apparatus for this test are weighting balance and wire brush.

**Water Absorption Test**
This test was conducted according with ASTM C70 – 79. The suitability of this tile aim at avoiding high water absorption, tests were carried out by immersing the tile in water for a period when it stops bubbling. The apparatus are water tank and weighing balance. This test is important in determining the water absorption rate of the tiles.

**Flexural Strength Test**
This test was performed as described in BS 538: 1994. The roof tile was place on the two lower bearers the first bearer is in the position normally occupied by the batten; the second bearer is separated from the first by a distance equal to two thirds of the overall length (L) of the tile as shown in plate 3.4. The load application bar is placed parallel to the two lower bearers and equidistant from each other. Apply the test load progressively at the rate of about 2kg until the sample fails.

The flexural strength shall therefore be calculated using the formula as stated below:

\[ \mu = \frac{M_{\text{max}}}{Z} \]

Where \( \mu \) = the flexural strength
\( M_{\text{max}} \) = is Maximum Moment due to the applied load
And \( Z = \frac{bd^2}{6} \)

Where b = width of the tiles
d= thickness or depth of the tiles

**Mix Proportioning of Materials**
The mix proportion was conducted according to BS 1377, (1990) aimed at determining the proportion of materials in each specimen. The materials are clay, laterite, saw- dust, Makuba, cassava starch and water. Procedures are by absolute volume method of mixing. Result of each mix at each percentage is taken and recorded.
Clay roof tiles were produced in the laboratory using clay binder replacement level of 2.5%, 5%, and 10%. Clay roof tiles prepared of 0% binder replacement level was produced to serve as the control. Three different binders were compared i.e. Makuba, cassava starch and a mixture of Makuba and cassava starch. The three different clay tiles were prepared and tested after 28 days curing periods. Indoor curing was adopted for all the clay roof tiles. The water/binder ratio used in the production of all the clay roof tiles was 0.7.

RESULTS AND DISCUSSION

Results of Specific Gravity and Bulk Density of Materials

The result obtained shows that; the Boma clay has an average specific gravity of 2.0, while that of laterite is 2.6, that of saw-dust is 1.1, that of Makuba is 0.86, the specific gravity test results of saw-dust and that of Makuba shows that the materials are light in weight. Similarly the result of bulk density also indicates that the Sawdust and Makuba are less dense than clay and cassava starch.

From the result, in contrasting with the related literature reviewed, of which the average specific gravity of Boma clay, laterite, makuba and saw-dust are 2.62, 2.82, 0.92 and 0.62 respectively. The result yielded positive outcome, as no cracks and buckling were experienced after the experiment was conducted.

<table>
<thead>
<tr>
<th>Materials</th>
<th>Specific gravity</th>
<th>Bulk Density Kg/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Makuba</td>
<td>0.86</td>
<td>604</td>
</tr>
<tr>
<td>Cassava starch</td>
<td>1.56</td>
<td>1152</td>
</tr>
<tr>
<td>Saw-dust</td>
<td>1.1</td>
<td>219</td>
</tr>
<tr>
<td>Laterite</td>
<td>2.6</td>
<td>1481</td>
</tr>
<tr>
<td>Clay</td>
<td>2.0</td>
<td>1575</td>
</tr>
</tbody>
</table>

Source: Experimental work, 2012

Results of Abrasion Resistance

The Abrasion resistance results from figure 1 indicate that the weight lost of roof tiles made of 2.5% Makuba has high abrasion resistance of which the percentage weight loss is 0.35%. This is followed by the weight loss of mixture of 2.5% Makuba and Cassava starch which has the percentage weight loss of 0.9%. This is also followed by the weight loss of 5% Makuba which has the percentage weight loss of 0.98%.

The least in performance in terms of abrasion resistance is the tiles produced with 10% cassava starch binder replacement, with the percentage weight loss of 4.29%. This is also followed by the tiles produced with the binder replacement of 10% mixture of Makuba and cassava starch which has a weight loss of 3.22%. This implies that as the percentage
binder level (Makuba, Cassava or Mixture of Makuba and Cassava) increases the abrasion resistance decreases.

![Graph](image_url)

**Figure 1:** Variation of percentage weight loss of Makuba, Cassava Starch and makuba/cassava starch Clay Roof Tiles with Percentage Binder Replacement.

**Results of Water Absorption**

The result of water absorption shown in figure 2 indicates that the water absorption of clay tiles with binder replacement level of 2.5% Makuba is 1.41%, Cassava Starch is 3.29% and mixture of Makuba and Cassava Starch is 2.14%. At binder replacement level of 5%, the water absorption of Makuba is 3.13%, that of Cassava Starch is 5.83% and that of mixture of Makuba and Cassava is 3.62%. At 10% binder replacement level, the water absorption of Makuba is 14.78% that of Cassava Starch is 20.98% and that of mixture of Makuba and Cassava starch is 13.56%. This implies that at all replacement level the water absorption of clay tiles produced with Makuba as a binder has lower water absorption value as compared to Cassava starch and the mixture of Makuba and Cassava starch.

**Result of Flexural Strength**

From the results shown in figure 3 the average failure load of clay roof tiles at 2.5% Makuba prove to be the best with average failure load of 37Kg and flexural strength of 9.67N/mm². The results obtained of flexural strength of 2.5% Makuba clay roof tiles (9.67N/mm²) is slightly close to the flexural strength of plain roof tiles (14.06N/mm²) produced using cement, fine aggregate and water by Maminat (2001). This implies that 2.5% Makuba.
SUMMARY OF FINDINGS.

The following are the summary of findings obtained from the results of laboratory test.

I. The Abrasion resistance result indicated that 2.5% Makuba clay roof tiles produced in this study have higher resistance to abrasion.

II. The water absorption capacity of 10% cassava starch clay roof tile specimen was higher than all other specimen with a percentage weight gain of 20.98% followed by 10% Makuba clay roof tile with percentage weight gain of 14.98%. The best result in terms of water absorption is 2.5% Makuba clay roof tile with the percentage weight
gain of 1.41%, next is 2.5% of mixture of Makuba and cassava starch with the percentage weight gain of 2.14%.

III. Finding also revealed that flexural strength of clay roof tiles made with 2.5% Makuba meet the average failure load of 925N, which falls within the range specified by B.S 473, (1967)of values of failure load not less than 498N.

IV. Finding also indicates that clay roof tiles produced using 2.5% Makuba as a binder gives the optimum result in terms of abrasion resistance, water absorption, and flexural strength.

CONCLUSION

This study revealed that clay roof tiles could be produced using Makuba, Cassava starch, and a Mixture of Makuba and Cassava starch as a binder; with the best result obtained using 2.5% Makuba as the optimum replacement. The study therefore ascertained the performance of Makuba as good binder as compared to cassava starch in clay roof tile production.

RECOMMENDATIONS

Based on the findings made, the following recommendations are suggested.

I. The clay roof tile produced is recommended for indoor usage.

II. To improve the water absorption and binding property, Makuba (parkia biglobosa) should also be blended with cement or combined with other pozzolanas.

III. Since cassava starch can combine favorably with other material chemically without losing its adhesive qualities, chemicals admixtures that could improve cementitious effects in the paste should be introduced to enhance resistance to water penetration of cassava starch clay roof tiles.

IV. Further studies should be undertaken to reduce the excessive buckling of clay roof tiles during curing in order to stop the placement of weight on the tiles.

V. Further research work should be carried out on the production of clay roof tiles with less major cracks when curing in open-air.

VI. The use of saw-dust should be avoided due to its high water absorption.

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EXPLORING HEALTH AND SAFETY PRACTICES ON SOME NIGERIAN CONSTRUCTION SITES

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Globally, construction industry has poor safety records indicating that, construction workers are three times more likely to be killed and twice as likely to be injured as workers in other occupations. The costs of these accidents which usually amount to considerable share of the contract price are usually borne by the sponsors of the projects. Many of such accidents in the Nigerian construction industry could be attributed to poor safety measures resulting from weak regulations and low level of compliances. This study attempts to investigate the implementation of accident preventive actions on some selected construction sites based on requirements compiled by the European Agency for Safety and Health at work. Data for analysis were obtained through field observations and direct interviews of operatives and personnel from the selected sites in the six geographical zones of Nigeria via purposive sampling technique. Descriptive statistics was used with the aid of Origin 5.0 software for windows for analysis. Results of the study indicate an average compliance of 45% to the preventive actions by the sites investigated. Two construction sites had the highest percentage of compliance of 71% while the lowest compliance of 17.9% was recorded on one construction site. These poor results could be attributed to the low level of awareness among stakeholders, non existence and/or weak regulations, poor compliance and poor health and safety plans and programmes. It is recommended that effective health and safety standards and guidelines be enforced to reduce accidents on construction sites with the view to ensuring safe working conditions.

Keywords: accident, construction site, health and safety, Nigeria.

INTRODUCTION

Construction is a risky business prone to accidents due to the physical environment of the work, nature of operations involved, types of materials and methods used for construction and the utilization of sophisticated equipments. The European Agency for safety and health at work EASHW
(2004) reported that thirteen (13) workers in every 100,000 construction workers are being killed in construction as against five per 100,000 in the all-sector average. Agwu and Olede (2014) also asserted that globally, construction workers are 3 times more likely to be killed and twice as likely to be injured as workers in other occupations. In the United States, Nunnally (2011) reported that construction sector which consists of about 5% of the workforce accounts for some 20% of work fatalities and 12% of disabling injuries. The International Labour Organization ILO (1992) also reported that one out of six fatal work related accidents occur on construction sites and no fewer than 60,000 fatal accidents occur on construction sites annually around the world. Similar conclusions were also drawn by Keller and Keller (2009). In Nigeria, there are no reliable data on cases of accidents related to construction due to poor records but circumstantial evidences have shown that construction related accidents are alarming as a result of exposure of workers to several different health problems such as back pain, hand-arm vibration syndrome, cement burns, vehicle accident and falling from heights.

However, safety and health of every worker is crucial for any organization to thrive towards achieving its objectives because unsafe working conditions jeopardize employees’ ability to efficiently discharge their duties. Site accidents have been observed to demotivate workers, disrupt site activities, delay project process, affect overall project cost and consequently affect productivity and the reputation of the firm concerned (Okolie and Okoye, 2012). Therefore it is imperative to provide and maintain high quality safety standard at workplace.

**STATEMENT OF RESEARCH PROBLEM**

Health and Safety Executives, HSE (2000) reported that construction workers in the United Kingdom are approximately five times more likely to be killed and two times more likely to be injured as compared to average of all other industries, while in the United States construction workers are over three times more likely to be killed than all-industry averages and one in every six construction workers can expect to be injured every year (Kartam, 1997) with an estimated total annual costs of $31 billion (Nunnally, 2011). Che-Hassan et al. (2007) reported that the industry accounts for 22% of all fatal accidents in the USA, about 30-40% of the overall industrial accidents in Japan, 50% in Ireland and 25% in the UK. Baldacconi and Santis (2000) also contended that in Italy, fatal accidents in the industry represent 25% of total accidents occurring in the industry. The industry alone according to Okolie and Okoye (2012), accounts for 30% of all fatal industrial accidents across the European Union (EU). HSE (2004) further established that the construction sector across the world has higher records of fatal injuries and major accidents as compared to other sectors. Even though there is no reliable data relating to construction accidents in Nigeria, previous studies have indicated that accidents and injury rate are quite high as compared to other industries in
the country (Agwu and Olede, 2014; Aniekwu, 2007; Kalejaiye, 2013; Olutuase, 2014 and Dodo, 2014). This ugly trend often leads to site closures, loss of man-hours, payment of compensation and loss of reputations which affects the performance of the industry and its contribution to national development.

HEALTH AND SAFETY PRACTICE IN THE NIGERIAN CONSTRUCTION INDUSTRY

Health and Safety on Construction sites
It is imperative to provide safe working conditions to construction workers due to intrinsic hazards and risks associated with every work situation (Olutuase, 2014). Oresegun (2009) observed that the performance of any construction personnel is usually a function of safe working condition which according to Kheni et al. (2008) deals with both physical and psychological well being of workers on sites and other persons whose health is likely to be adversely affected by construction. Therefore it is necessary to provide and maintain relevant measures that would ensure high level of health and safety on construction sites to provide protection against risk and hazards emanating from high technological advancement in the construction industry. The European agency for health and safety at work EASHW (2004) recommends that employers and project supervisors must cooperate in order to protect employees' health and safety. The EASHW (2004) provide a minimum requirement for preventing accidents on small construction sites. The check list of the preventive actions contained in EASHW (2004) if properly implemented would go a long way in preventing accident at sites.

Health and Safety Regulations
Effective regulations are fundamental in ensuring employees state of work in the delivery of construction projects in safe atmosphere. Idoro (2008) and (2011) observed that almost all the existing safety and health regulations in Nigeria originated from foreign countries. The Factories Act of 1990 is an adaptation of the UK Factories Act of 1961 (Idoro, 2008) while the Occupation Safety and Health OSH Act of 1970 was said to originate from America. The control of substances hazardous to health regulation of 1988, the PPE at work regulations of 1992, and management of health and safety at work regulations of 1999 are all British regulations (Idoro, 2011). The first effort in terms of regulation relating to health and safety at work in Nigeria was the Factories Act of 1958 (Dodo, 2014). This Act was repealed and replaced by Factories decree 16 and workman compensation decree No. 17 which became effective in 1990. The Factories Act of 1990 (Article 47 and 48) contains regulations governing the provisions of Personal Protective Equipment (PPE) for workers. Idoro (2011) concluded that neither the Factories act of 1990 nor the PPE (EC directive) 1992, sufficiently capture the construction sites and their operations, which indicated that construction works in Nigeria is unregulated in terms of occupational health and safety.
Enforcement of Health and Safety Regulations
The enforcement of any type of regulation is basically crucial for ensuring the efficacy of such regulation. Idubur and Osiamoje (2013) stated that “regulation devoid of enforcement is tantamount to no law”. This by implication means that lack of proper enforcement of health and safety regulations often permits non-compliance which consequently contributes to poor state of occupational health and safety (Umeakafor et al., 2014a; 2014b). The Federal ministry of Labour and Productivity (Inspectorate Division) is responsible for the enforcement of these regulations whose main focus is the protection of health and welfare of people in the workplace and people that may be adversely affected by the activities of the workplace. The enforcement of occupational safety and Health in Nigeria has not been effective over the years, which could be attributed to lack of proper funding and lack of basic resources and training (Dodo, 2014), lack of safety culture, lack of implementation culture (Umeakafor et al., 2014a; 2014b and 2014c), culture dimensions (Okolie and Okoye, 2012) and lack of training (Adenuga et al., 2007 and Akpan, 2013). The benefits of enforcement of occupational health and safety regulations are evident in countries with remarkable health and safety records like the UK, USA and Germany. Even though there is no reliable data to establish the level of compliance and enforcement of health and safety regulations in Nigeria, anecdotal evidences have indicated that enforcement and compliance to regulations is not a typical activity which is considered as a contributor for the low performance of the Nigerian construction industry.

Health and Safety Management
A proactive safety management system has the core attributes of systematic identification of hazards, assessment and control of risks, evaluation and effective implementation of risk control measures (Bluff, 2003). The integration of health and safety measures into the total quality management system within the construction sector could significantly contribute to cost efficiency, quality assurance, environmental sustainability and better employer-employee relationship (Okolie and Okoye, 2012). The adoption of health and safety management system demonstrates in practical terms the readiness of any organization to bring to minimum the frequency and severity of accidents, ill health and damage to property (Diugwu et al., 2012). Health and safety management system therefore highlights and emboldens the awareness of responsibilities and aspects of occupational safety and health as well as the impact of health and safety standards on the performance of organizations. Diugwu et al. (2012) is of the view that the potency of health and safety management system depends on the existence of functional health and safety laws which guarantees the health, safety and welfare of workers and visitors. Diugwu et al., (2012) further observed that there is a serious gap in health and safety management in Nigeria due largely to dysfunctional laws causing apparent lack of regulations which conforms with the assertion of Idoro (2011) that the country is lacking requisite statutory occupational health and safety laws, reiterating that even those in force are skeletal in nature and non functional. Olutuase (2014) also concluded that the
existing safety management system is poorly organized and characterized by ineffective and poor documentation. This is further demonstrated by the frequency of number of accidents being recorded by construction companies (Olutuase 2014).

Common Accidents on Construction Sites
Accidents according to Aniekwu (2007) are unplanned and unexpected events, which result from mistake somewhere, somehow and by somebody. The causes of accidents on construction sites are a subject of many studies across the world (Ezenwa, 2001; Aniekwu, 2007 and Laryea and Mensah, 2010). Laryea and Mensah (2010) categorised construction related accidents causing factors as those at the Macro level consisting of factors such as lack of enforcement, lack of accident data; Mezzo; consisting of factors including inappropriate procurement and supply chain arrangements and Micro level factors such as inadequate competent supervisors, lack of training of personnel among others. Aniekwu (2007) identified major accident causing factors as use of faulty tools and equipments, non compliance with standards, improper scaffolding, lack of experience and improper storage of dangerous and flammable substances. The eccentric problems causing accidents on construction sites in Nigeria are improper keeping of records, non reporting of accidents by employees, unsafe practices by contractors and lack of safety management as a whole on the side of the clients (Okolie and Okoye, 2012 and Olutuase, 2014).

RESEARCH METHODOLOGY
The primary data for the research was obtained through field observations and structured interviews while the secondary data constitute information obtained through extant literature, reports and factsheets of national and international organizations. Thirty construction sites, five in each of the six geopolitical zones of Nigeria were selected for investigation via purposive sampling technique. The sites were visited in 2014 to obtain first-hand information relating to health and safety practices with emphasis on actions taken to prevent accident in accordance with global best practices. Accident Preventive actions compiled by the European Agency for Health and Safety at work EASHW (2004) was adopted and used to examine the practices of the construction sites for conformity. Construction personnel at all the construction sites visited were interviewed to corroborate the field observation. One representative each of client, contractor and consultant and an operative was selected for the interview at each site. The data were then analysed using descriptive statistics.

RESULTS AND DISCUSSION
The results of the field observation supported by the responses of site operatives on the preventive actions against construction related accidents
is presented in Table 1, Table 2 and Figure 1. Table 1 Preventive Actions against accidents on Construction sites

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Table 1 continued

Average % of Yes = 45%

Health and Safety on Construction sites
The results of the survey revealed that only 45% (18 actions out of 39) of the preventive actions were observed to be implemented by the thirty construction sites investigated across the country, whereas the remaining 55% (21 out of 39) are not been implemented resulting in poor safety status of the construction sites. The highest level of implementation of 71% corresponding to 28 preventive actions was recorded by two construction sites. This was followed by 64% corresponding to 25 preventive actions recorded by other two construction sites. The least level of implementation...
was observed on one construction site with only 7 actions (17.9%) been implemented. This result suggests that serious measures are to be taken by stakeholders to ensure compliance with safety standards with the view to improving performance. Similar call has also been made by Umeokafor, et al. (2014b) stating that compliance to safety and health standard is low due to lack of adequate regulations, lack of commitment and inadequate enforcement. Actions that are poorly implemented with up to 40% level of implementation and those whose poor implementation are observed to be associated with common and frequent accidents on construction sites are discussed.

Improper storage of dangerous and flammable materials is one of the major factors contributing to accidents on construction sites in Nigeria (Aniekwu, 2007). Majority (60%) of the sites visited have proper methods for storing dangerous and hazardous substances while the remaining 40% do not store such substances properly. The study also indicated that 60% of the sites lack actions in place to prevent exposure to dusts like cement dust saw dust among others. In addition to creating a safety hazard due to loss of visibility, dust may be responsible for a number of lungs diseases. Silica dust and asbestos are particularly dangerous and produce specific lungs diseases such as asbestosis and silicosis (Nunally, 2011). Therefore it is imperative to properly store dangerous and flammable substance on construction sites to prevent accidents associated with such substances.

The utilization of appropriate PPE at work reduces accidents. From the results of the survey, only 23% (7 out of 30) of the construction sites visited have their employees using helmet and foot wears. Some of the employees interviewed attested to their knowledge of the significance of the use of PPE in preventing accidents but contractors do not usually provide them. The study also indicated that only six (20%) of the construction sites visited have the workers using the right PPE for their work. Commonly used PPE are reflective vests, hard hats, and safety boots.

The lack of sound policies in respect of utilization of plants and equipment is evident in many sites with 66.6% of the sites investigated not having their equipments properly labelled. Plants and vehicle operators in most situations are not trained and licensed to carry out their responsibilities. The results indicated that only 16 (53.3%) construction sites have an indication of trained personnel in charge of plants and equipment. Proper handling of plants and heavy equipment on construction sites is essential in avoiding vehicular and equipment accidents.

Restriction of access to construction sites by fencing to prevent accidents is a globally accepted practice to comply with safety and health standards, but the situation is pitiful in Nigeria as only 40% of the sites visited are fenced while the remaining 60% are left unfenced providing unnecessary access to public without due control. The provision of safe access to the place of work within the site is also an important practice but only 33.3% of the sites are able to comply with that requirement while the remaining
67.7% do not have safe access routes within the sites for workers to their specific places of work.

The study further indicated that most of the construction sites (57%) do not have proper signs and symbols displayed to indicate authorization or otherwise which is an unsafe practice with only about 43.3% of the sites visited having proper signs and symbols in place. 70% of the sites have their hoists, lifts and scaffolds been handled by competent persons in charge of erecting, checking and dismantling. While only 10 sites have mechanisms in place for checking the status of scaffolds and ladders periodically or after adverse weather such as a high wind to ensure safety. Falling from heights is one of the frequent and commonest accidents on construction sites but only 50% of the sites investigated have plans and appropriate measures in place to prevent workers from falling and being struck by falling object. Furthermore, twenty construction sites (67%) have precaution and protection against falling into excavations by providing markings and coverings for such dangerous areas while 17 (57%) sites also have adequate measures in place to prevent collapse of excavations and preventing vehicles from falling into excavations. This is done by competent persons in charge of checking and inspection of excavations on those sites.

The provision of welfare facilities is the responsibility of the contractor which is very essential and impacts positively on the performance of construction workers. This practice is poorly implemented with only eleven 37% of the sites have adequate welfare facilities. The ILO (1992) recommends that within a reasonable access of every construction site, sanitary and washing facilities, accommodation for taking meals and for taking shelter during adverse weather conditions are to be provided.

The study showed poor concern for fire precaution by contractors as only 8 sites (27%) have implemented the practice by providing fire extinguishers and escape routes in case of fire. The interviewee opined that the incidence of fire is not usually recorded on construction sites being the reason for most of the sites ignoring fire precaution. Regular inspections should be made of places where there are fire risks. These include the vicinity of heating appliances, electrical installations and conductors, stores of flammable and combustible materials, hot welding and cutting operations.

Assessment to reduce upper arm disorder was observed in only two construction sites (7%). This indicates poor status of implementation of the practice. A precaution to prevent noise and vibrations is also poorly executed by contractors as none of the sites have such practice. It showed no action was in place to prevent noise and vibration. From the study 8 sites (27%) have other safer ways of doing work such as using moving object rather than using ladder.
CONCLUSION

Construction safety and health is an integral part of the construction process which requires adequate attention in Nigeria. The study indicated that the current status of health and safety practices on some selected construction sites in Nigeria is skeletal to ensure absolute safety of employees at work. This poor status of health and safety on the investigated sites could be attributed to lack of functional legislation and adequate enforcement. The study revealed that only 45% of the preventive actions are being implemented by construction sites toward ensuring safety of workers from work related accidents. Preventive actions such as use of appropriate PPE, precaution for fire accidents, inspection of scaffolds and ladders, exposure to noise and vibration are poorly implemented in most of the sites investigated.

It can be deduced from the study that the poor implementation of safety measures and actions are associated with the common types of accidents such as falling from height, cement burns, vehicular accidents among others. It is therefore paramount to comply with globally acceptable safety standards in preventing accidents and ensuring safety and health of workers.

REFERENCES


Facilities Management (FM) entails enhancing the performance of users in a set environment by optimising organisational targets. It involves managing user behaviour, provision of pleasant user experience and an aim to improve facilities performance by the operators. This paper focuses on the African urban marketplace environment (MPE) as a facility, chosen due to its cultural significance within the African setting and its effect on the behaviour of the society in which it exists. The environmental management theme is a reoccurring issue in this facility, with solid waste management of concern. There is evidence to suggest that the performance of the facility hinges on attitudinal actions of the stakeholders towards waste. This paper therefore aims to provide an understanding of the dynamics of marketplaces in order to identify key underlying issues that affect attitudes of direct users of the marketplace. The study adopted the use of literature searches, observation and semi-structured interviews. As furtherance to this study, the findings will be used to develop a model for facilities managers to enhance the quality of the facility in order to improve their performance. As an added benefit, it is anticipated that the change in attitudes of the users of MPE could have a significant effect on their general attitude towards waste beyond the African marketplace environment.

Keywords: African marketplace, attitude, facilities management, solid waste management, stakeholders

INTRODUCTION
The African marketplace is a space with deep cultural significance. It possesses a unique heritage and is considered to be the focal point of economic and social life in African societies (Wambugu, 1995). Everyone irrespective of their social status has contact with the marketplace in one way or the other (Ladipo et al., 1990). Apart from trading activities, people meet at the marketplace in Africa for various reasons, which include; settling of disputes, meeting friends and next of kin, catching up on the latest news, exchanging of ideas, learning, religious activities, traditional
festivals, political activities and social gatherings (Nelson, 1998, Henrich, 2006). Based on its configuration, it provides an opportunity for most organisations and government programmes such as immunisation programmes, family life education, political campaigns aimed at educating and reaching out to the public to be carried out at the marketplace (Wambugu, 1995).

One significant challenge faced in the management of the marketplace is solid waste management. The market managers are faced with a challenge that is a matter of public concern that calls for government intervention, which is how best to manage solid waste in marketplaces in order to provide a safe and clean environment.

In Nigeria, municipal solid waste management (MSWM) is a challenge faced by all stakeholders and tiers of government (Ogwueleka, 2009, Olanrewaju and Ilemobade, 2009, Abila and Kantola, 2013). Waste is usually not segregated and is littered, dumped and heaped indiscriminately along major roads (as illustrated in Figure 1), in open spaces, stream channels and river banks (Ogbonna et al., 2007). The practice is no different in the marketplace environment (MPE) as markets are characterised by littering and fly dumping as illustrated in the image on the right hand side in Figure 1.

This causes environmental pollution, poses a risk to public health and defaces the physical environment. Usually, when it rains, most of the waste is washed away thereby causing blockage to drains and culverts and also pollution to ground and surface water (Ayotamuno and Gobo, 2004).

Research into marketplaces has tended to focus on social and economic impacts (Hill, 1966, Good, 1973, Smith, 1979, Jerome and Ogunkola,
Some researchers have also discussed the opportunities the marketplace presents as a vehicle for developmental strategies and interventions (Ladipo et al., 1990, Nezic and Kerr, 1996, Morales, 2011). However, there is a paucity of research that analyses the marketplace as a facility needing adequate management, especially with regards to the management of solid waste. Where research has been offered on solid waste management of marketplaces, it has focused on the composition of market waste (Bammeke and Sridhar, 1989), the introduction of sustainable waste management practices for markets (Olaseha et al., 2005) and waste from related facilities such as abattoirs (Emeka et al., 2009, WorldBank, 2009). This paper argues that in MPFs, effective facilities management is essential to the mitigation of solid waste pollution and its associated health risks.

Facilities Management (FM) is defined by the British Institution of Facilities Management (BIFM) as “the integration of processes within an organisation to maintain and develop the agreed services which support and improve the effectiveness of its primary activities”. In other words, FM entails the appropriate integration and maintenance of systems that form part of an organisation and will result in the provision of the right environment that aids the efficiency of the organisation and at the same time provide a pleasant environment for the users/occupants of the facility in order to improve their performance. Thus, the aim of FM essentially is to provide services that support the organisation to achieve its primary objectives.

The practice of FM is dynamic and requires the facilities manager to have a clear understanding of the core business or primary objective of the organisation taking into consideration the environment in which the organisation exist in order to develop an appropriate FM strategy. Waste management is a key component of FM. Waste not properly managed in facilities could result in environmental pollution with direct consequence to the performance of the user with detrimental effect to achieving the objectives set or the purpose of the facility.

In the management of marketplaces, literature suggests that the lack of adequate solid waste infrastructure and the attitude of the users are key contributory factors to inadequate solid waste management (Adekunle, 2012). It is argued that the absence of the necessary infrastructure for effective waste management practice is a major barrier that has encouraged poor attitudes toward waste (Babayemi and Dauda, 2010, Achi et al., 2012, Stanley et al., 2012). Other researchers have argued that, even with the provision of the necessary infrastructure, such poor attitudes still exist amongst most urban dwellers (Agwu, 2012). Barr (2007) argues that in as much as the presence of an effective economic, technical, legal and environmental infrastructure is important, in order to have an effective waste management strategy, it is also fundamental to identify and clearly have an understanding of factors that influence the stakeholders’ attitudes and behaviour toward solid waste. However, a fairly technocratic approach to the issues of solid waste management
which dominates the literature envisions that generally for every problem there is a technical fix (Schubeler et al., 1996, Barton et al., 2008, Asase et al., 2009, Achi et al., 2012). To affect better waste management practices, a number of fixes are suggested, including: improving infrastructure and access (Ezeah and Roberts, 2012), adopting new technologies (Kyessi and Mwakalinga, 2009), the sharpening and enforcement of regulations (Asase et al., 2009, Momodu et al., 2011), and the implementation of new financial models and incentives (Stanley et al., 2012). However, Barr (2007) has noted that there is still a pressing need to have an understanding of the underlying factors that influence people’s attitudes toward waste management. Based upon in-depth research, this paper will bridge this gap of knowledge identified by Barr (2007).

RESEARCH QUESTIONS

As a result of the existing gap in knowledge regarding an understanding of the factors that underpin people’s attitudes towards waste management in MPEs, this paper seeks to answer as to:

- Why do we still have markets where waste is a problem? It seeks to identify the key underlying issues that affect attitudes of the key stakeholders towards waste.

RESEARCH METHODOLOGY AND CONTEXTS

Existing research relating to solid waste management in marketplaces or related facilities have mainly utilised qualitative or quantitative or both research designs: The World Bank (2009) study relied on a qualitative design, utilising observation as the data collection technique. It was argued that this method was most appropriate for this study because the research area was under-studied and lacked data.

Olaseha et al. (2005) adopted a quasi-experimental survey including interventions. The study utilised a mixed data collection technique that utilised observation, interviews and questionnaires as the primary data collection technique. Research by Bammeko and Sridhar (1989) utilised a quantitative design using base line data and experiments in order to determine the characteristics of waste in twelve markets in Ibadan, Nigeria.

The study described in this paper adopted the qualitative research design, adopting a single case study design with multiple cases. The essence of using multiple cases is to collect data that will provide an in-depth understanding of the dynamics of urban marketplaces with particular reference to solid waste management given that the research area has not been given considerable attention. The study utilised the use of observation and semi-structured face-to-face interviews as data collection techniques. The data collection technique was most suitable in collecting
data that will provide contemporary data on the dynamics of the MPE and waste management practice in MPEs.

The study area Port Harcourt, usually referred to as the “garden city” is the capital of Rivers State and located in the Niger Delta region of Nigeria. It is the third largest city in the southern part of Nigeria and is regarded as one of Nigeria’s most important industrial and commercial cities (Ayotamuno et al., 2010). Port Harcourt has an annual mean temperature of 29°C (Inderiah et al., 2006), and is bounded mainly in the eastern, western and southern sides by swamps, creeks and rivers (Ayotamuno and Gobo, 2004). Port Harcourt city is formed of two Local Government Areas; Port Harcourt city and Obio/Akpor Local Government Areas (Agwu, 2012) and has an estimated population of 2,340,000 (Demographia, 2015).

Port Harcourt is the operational base for multinational oil and gas businesses. The finding and extraction of oil in the Niger Delta in 1950’s led to rapid influx of migrants (UN-Habitat, 2009). With a heavy concentration of human population as well as industrial and commercial activities, land use became complex and the solid waste generated increased in volume and variety (Ayotamuno and Gobo, 2004).

A World Bank (2009) global report on livestock markets, slaughterhouses and related waste management practices identified a number of challenges developing countries face in the management of solid waste pollution. The study focussed on the generation, treatment and disposal of livestock and slaughter waste with the aim of developing global guidelines for potential World Bank interventions in the livestock market and slaughter sector. The study established that research on waste management in African marketplaces is an area that has been neglected despite the high risk to public health and environmental problems posed by waste in this facility. This paper thus seeks to develop an understanding of how the market culture influences the attitude of market users towards solid waste management.

Upon preliminary enquiries from the Local Government Council, the number of authorised markets in Port Harcourt was established. Four cases that met the study criteria – market frequency, location, and market type were selected. The markets were selected because they were mixed markets that operated at least six days a week and they are located in the core areas of the city. The locations of the cases are illustrated on the map in Figure 2.

The selected cases comprised of two old markets and two remodelled markets. For the purpose of this study they will be referred to as; old market (South), old market (North), remodelled market (South) and remodelled market (North).

This paper reports the preliminary findings from the qualitative data obtained of MPEs in Port Harcourt, Nigeria. It adopts a combined pragmatist and critical realist approach, thus providing a new perspective to analysing marketplaces (as facilities) and also providing an understanding as to how social structures determine the attitudes of users.
The research was conducted over a period of eight weeks, and included observations of MPEs and series of semi-structured face-to-face interviews with key stakeholders in order to provide an in-depth understanding of the dynamics and the settings of MPEs with particular reference to solid waste management practices. The data collection process began with preliminary enquiry so as to select cases that met the study criteria and determine the structure of market management.

After initial enquiries, primary data collection began with observation, which was divided into two phases. Phase 1 was the fact-finding phase which entails collating information or intelligence gathering such as the physical settings of the MPE, the facilities, and management operations etc. This enabled the researcher to map out the strategy and activities for the next phase. Phase 2 was the actual observation aimed at gaining insights into the settings and dynamics of the MPE and to determine the current solid waste management practices at MPE. A total of thirty six days were spent undertaking this phase.
Face-to-face interviews were conducted after data from the observation was collated. The essence of this was to incorporate queries that evolved in the course of carrying out the observations. The interviewees were categorised into five (5) groups: (a) buyers and visitors (n=12), (b) traders (n=15), (c) regulators, including market superintendents, chairmen of market management committee and associations, and State sanitation authority officers (n=6), (d) waste handlers and contractors (n=3), and sensitisation groups, including health organisations, banks, and political parties (n=6). A total of forty three interviews were recorded of which thirty nine were useful for analysis. The interviews were transcribed and further organised and analysed with the application of thematic coding, a qualitative analytical tool in order to identify themes, concepts and relationships within the data and also between the data and literature. The process was enhanced with the use of computer-assisted qualitative data analysis software – NVivo.

SUMMARY OF FINDINGS

MPE Infrastructure and Services
In the urban areas, the State Government builds markets and transfers its ownership to the Local Government Council (LGC). In managing markets, the LGC deploys their staff referred to as market superintendents to markets and their duties includes; the allocation of stores/sheds, record keeping, collection of revenue (this includes monthly store rentage, sanitation and security fee), provision of a conducive trade environment, and addressing complaints arising in the marketplace.

The MPE has an association made of a chairman and executive members. The chairman and members of the executive are elected by the traders to oversee their welfare and also act as representative of the traders in dealing with the Local Government Council. The MPE also has a market council made of elderly and long standing traders. They assist in decision making regarding market welfare.

Old Markets
The old markets comprise of a combination of lock-up shops and open sheds and are predominantly dominated by women. A section of the market is represented in Figure 3.

The old markets are not connected to the national grid supplying electricity nor to the public mains of water supply or independent water supply (borehole). Most traders that can afford it, have generator plants for the supply of electricity and traders who stay until dark (late evenings) rely on torchlights or “bush lanterns” (Lanterns with exposed flames fuelled with kerosene - paraffin). The traders rely on “mai ruwa” (People who move around with water for sale mostly in 20 litres jerry cans transported in hand pushed trucks) or pure water (Sachet water which is usually 500 millilitres per sachet) for their daily water supply.
markets are serviced with open drainage and there are no car parks for shoppers or solid waste receptacles.

Figure 3: A Section of Old Market South and North Respectively.

The old markets are in poor condition as they are characterised by very old and shabby sheds, congested space, uneven and muddy paths and external roads, open and filthy drainages, waste litters and fly dumping at various corners of the market. As a result of the deplorable state of the external road, traders display their goods on the road thereby obstructing vehicular movements.

New Markets
The remodelled markets comprises of a combination of lock-up shops and open sheds as shown in Figure 4.

Figure 4: Remodelled Market South and North respectively.

The new markets are serviced with; toilets, water (internal borehole installed on premises), electricity from national grid, covered drains, car park, fire hose and extinguishers, banks, cafeteria and refuse dump areas.
Generally, they are in good condition and offer a convenient environment for trading activities.

**WASTE HANDLING PRACTICES**

Data from interviews reveal that waste collection approach in marketplaces as described by the waste handlers is in the evenings either by truck placement or the evacuation of waste at authorised areas. However, findings and observation reveal that marketplaces are busy and are at the peak of transactions and other non-trade activities between the hours of 9:00am till 5:00pm. It is thus marketplace custom that waste is disposed of in the mornings or/and evenings. Traders do not attend to their waste till they close for the day or more often before the start of trade activities the following morning. This is contrary to waste collection times and has an implication on solid waste management practices in marketplaces as the resulting effect is indiscriminate dumping and littering.

Convenience and collection times are key issues raised by the stakeholders regarding their waste management practice. Extract from interviews reveal that the timing for waste disposal is inconveniencing as a result of the busy nature of market activities. These are significant factors responsible for the act of indiscriminate disposal and the poor handling of waste by traders. These factors were also established in studies by Ogwueleka (2009), Regassa et al. (2011) and Ayuba et al. (2013) as one of the factors responsible for the inefficient solid waste management practices in African cities.

Further investigation also revealed the practice of re-use and recycling by traders within the marketplaces. Materials such as cartons, polythene, shells of seafood, remnant from dried seafood, plastic buckets and bottles are the common materials re-used or recycled in old markets. Discussions with traders revealed that, the traders do not necessarily have knowledge of these elements of waste management or understand the implication of their actions regarding waste management. But further discussions with traders revealed that these practices are based on economic benefits and it aids their trade activities as materials such as cartons can be reused to display or package goods purchased by buyers.

**Consultation**

Communication and consultation between waste handlers and market stakeholders is a key contributory factor to the problem of solid waste pollution in MPEs. Waste handlers disclosed that the market users are not always consulted before decisions are made regarding waste collection services. However, decisions to aid waste management practices, such as bagging of waste, are passed on to the market users via the market leaders. One of the waste handlers gave an example of closing unauthorised dump areas; a decision that did not require consultation with the stakeholders. This presents a classic problem of implementation.
It depicts how much consideration is given to stakeholders before decisions are made regarding waste at marketplaces. Extracts from interviews with the waste handlers reveals proper consideration is not taken into account as to why and what is responsible for the actions of the waste generators. This also suggests the use of discretionary power; a decision based on the waste handler’s perception as to what is “right” for effective management of waste at the marketplace.

Although Guerrero et al. (2013), in a study of effective waste management in cities in developing countries recommend that in order to have a well-functioning waste management system, communication transfer between the various stakeholders is of high importance. What this research has shown is that ‘policy-making community’ is wider and communication flows between parties in different directions and is asymmetric. Waste handlers exercise power in the disposal of solid waste materials. This means we need to understand the everyday practices of those who implement waste handling procedures as part of the customary practices and social structures of the MPE. They are a part of the problem and part of the solution. The actions of the waste handlers reveals the problematic use of top-to-bottom approach in the management of waste in marketplaces and confirms the findings of Palczynski (2009) that the involvement of stakeholders during the decision making and throughout the waste management process is an important element that is lacking in African societies.

CONCLUSIONS

This paper has provided insights to the setting and dynamics on a selection of marketplaces in Africa with emphasis on solid waste management. The study identified the understanding of marketplace custom as regards the disposal of waste as a significant factor in enhancing waste management practices in marketplaces. The research reveals that addressing waste management concerns in marketplaces requires an in-depth understanding of market custom and operations. It also reveals that the concerns of inappropriate handling of waste in markets are highly associated with non-consultation of market users regarding waste management approaches.

The implication of the current approach to solid waste management in markets indicates that, we will continue to have markets in which waste is a problem which raises concerns regarding hygiene and risk to public health.

Findings from data indicates that currently, marketplace customs are not duly considered while developing waste management strategies and makes a case for the introduction of FM approach in the management of markets.

The FM approach provides that in developing strategies for organisations, the facilities manager requires a clear understanding of the nature of the business, culture and environment in which the business exist in order to
develop appropriate strategies. This in turn will enhance the use of the facility and provide a pleasant user experience.

Furtherance to this study is the identification of the factors that could bring about a shift in the attitudes of the market stakeholders and those factors that should be prioritised by the facilities manager in the management of waste in marketplaces.

Interestingly, the data collection for the study went seamlessly except for the insecurity issues surrounding the study area. Care had to be taken and strategies put in place to address the insecurity concerns. Also, as identified by Hill (1963), gaining the attention of the direct market users (especially the traders) is one of the major challenges faced in the data collection phase. When they (traders) are not negotiating or concluding transactions, they are either chatting or having heated conversations with fellow traders and their hands are not idle as they could be seen either peeling off the husk of their goods, sieving their goods, washing their goods or putting a perfect touch to their goods on display. It thus seem inconveniencing for them to attend to any other duty not related to trade.

REFERENCES


FACTORS INFLUENCING MATERIALS SELECTION FOR HOUSING PROJECTS IN THE GHANAIAN CONSTRUCTION INDUSTRY: STAKEHOLDERS’ PERSPECTIVE

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Selection of suitable building material options are being influenced by various stakeholders in the construction industry. The process of selecting these material options can be very complex, being influenced and determined by numerous preconditions, decisions, and considerations. It should however, be noted that stakeholders are legally responsible for the project and their importance can be reflected by the various ways they influence the adoption of innovation strategy. Therefore, this research attempts to identify the possible factors that influence the selection of building materials for housing projects from the perspective of stakeholders in the Ghanaian construction industry. 47 possible factors influencing the selection of building materials for housing projects were identified through literature review. Interviews were carried out prior to the questionnaire survey to examine the relevance of the identified factors in the Ghanaian context. The interviews were conducted amongst eight purposively selected top architectural and structural engineering firms operating in Ghana. Questionnaires were also distributed to a sample of 150 stakeholders in the Ghanaian construction industry, out of which a total of 138 were returned and then analysed using Statistical Package for Social Sciences (SPSS). Relative Importance Index was used to rank the selected factors according to their order of importance. The ten most important building materials selection factors identified in this study are: strength, durability, initial cost, appearance (aesthetic value), water resistance, owner’s/user’s choice, availability of materials, resistance to decay, heat resistance, and fire resistance. The research concluded that stakeholders in the construction industry should consider all the important factors identified in this study when selecting building materials for housing project in Ghana.

Keywords: building material, Ghana, housing project, selection factor, stakeholder

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INTRODUCTION

Selection of building materials is one of several factors that can have impact on the success of a housing project. The process of selecting the materials for housing project is being influenced by a number of factors (Wastiels and Wouters, 2008). Objective factors such as design considerations and cost constraints can play a role in the selection of materials (Florez, 2010). However, there may be subjective factors that could also impact the selection of materials. This suggest that in choosing the right material, there is not always a single definite criterion of selection, which means designers have to take into account a large number of material selection factors (Rahman et al, 2008 and Trusty, 2003).

Nassar et al., (2003) asserted that selecting inappropriate materials may impact the performance of the building. On the other hand, the proper selection of building materials for the construction of houses is said to reduce the cost of building, can promote better quality of building structures, ensure faster construction solutions and foster new economical development.

It was indicated in the 2000 Ghana Population and Housing Census report that more than half of the population in Ghana lives in deprived houses where the materials and products used for the construction of the houses were of low quality and less sustainable (Ghana Statistical Service, 2002). This suggests the need for proper selection of quality and sustainable building materials for housing projects. Sustainable materials are materials with high recycled content, high reused content (Mora 2007, Zhou et al, 2009), low-emitting contaminants, rapid renewable periods (Glavic and Lukman 2007), and harm of contaminants free (Zhou et al, 2009). In addition, sustainable materials are characterized as low consuming, easy to build with (Dammann and Elle, 2006), low reparable and highly prolonged (Ljungberg, 2007; Mora 2007), safe to use (Zhou et al, 2009; Mora, 2007; Ljungberg, 2007), highly satisfying to the user (Ljungberg, 2007), something the public needs (Glavic and Lukman, 2007), do more with less (Glavic and Lukman, 2007), socially and creatively awarding (Glavic and Lukman, 2007), and as trend braking (Ljungberg, 2007) among others. It should be noted that the use of sustainable building materials for the construction of houses, can offer a set of specific benefits to the owner of a building such as reduced maintenance and replacement costs, reduced energy conservation, improved occupant’s health and productivity, lower costs associated with changing space configurations, and greater flexibility in design.

In attempts to facilitate a constructive material selection process, most studies have generated material selection factors for assessing the performance of a variety of building materials for housing delivery. Research indicates that majority of the existing building material selection models incorporated few factors for decision making and that has resulted in structures that are vulnerable, fragile, and difficult to maintain. Hence this research attempts to identify as much as possible factors that
influence the selection of building materials for housing projects from stakeholders in the construction industry perspective.

**Aim of the Study**
This research attempts to identify the possible factors that influence the selection of building materials for housing projects delivery in Ghana. The paper sought to generate a schematic of material selection consideration factors that looks into specific aspects that concern stakeholders in the construction industry.

**LITERATURE REVIEW**
Material selection has been identified as an area which can have significant impact on the sustainable performance of a building. According to Akadiri (2011) selection of suitable building material options are being influenced by various stakeholders in the construction industry. It should however, be noted that stakeholders are legally responsible for the project and their importance can be reflected by the various ways they influence the adoption of innovation strategy. Wastiels and Wouters (2008) also asserted that selecting suitable building material options can be a very complex process, being influenced and determined by numerous preconditions, decisions, and considerations.

**Building Materials Selection Consideration Factors**
Every building project involves the choice of building materials or means used for the selection process (Flórez et al, 2009). As with the design process, cautious consideration of contextual preconditions is crucial to selecting appropriate building materials (Rahman et al, 2008). Therefore, the available information or data on building material and product options must be constantly evaluated to make well-considered and justifiable material choices, during the design-decision making and selection processes (Trusty, 2003; Chan and Tong 2007). Rahman et al. (2008) and Trusty (2003) opined that in choosing the right material, there is not always a single definite criterion of selection, which means designers have to take into account a large number of material selection factors.

Stulz and Mukerji, (1981) asserted that the starting point for any house design is the selection of “appropriate materials”, where availability plays an important role. Treloar et al., (2001) also opined that an appropriate choice of materials for a design process plays an important role during the life cycle of a building. According to (Stulz and Mukerji, 1981), "Appropriateness" of a building material can never be generalised. Factors such as industrialisation of the country, material origin, material price, transport facilities, and volume of elements made of selected material, climate compatibility, understanding of properties and handling, workers skills, social acceptance will determine appropriateness. "Appropriate" building materials should also consider resource level, durability, reparable and recyclability during the service lifetime. Service life can be defined as aesthetic, economic, functional, physical (use and
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maintenance) and technical performance. Stulz and Mukerji, (1981) further stated that important factors to bear in mind in the selection of “appropriate building materials” are:

- Resources: Local or imported (partially or totally), quality and durability.
- Manufacturing: Time and delivery, factory distance.
- Construction: Level of skill and/or knowledge, maintenance and/or restoration, equipment and techniques, natural hazards, safety conditions.
- Cost: Market price, transport price, construction.
- Environment: Amount of energy consumption during manufacture, renewable or non-renewable resource, wastage and pollution.
- Social Factor: Acceptance by beneficiary/user and authorities.

In attempts to achieve greater degree of proficiency in the material-selection process, and facilitate a constructive material selection process, most studies have generated schematics of basic material selection factors or variables for assessing the performance metrics of a variety of building materials. A recent survey by Florez et al. (2009) revealed that a number of studies on the attributes of building materials have been carried out, indicating the use of objective and subjective measures in defining the performance metrics of building materials. Research studies investigating the reasons why material and building Performance fail, for example Florez et al. (2009); Rahman et al. (2008); Wastiels and Wouters (2008), and Ljungbeng (2007), provide lists of material-selection factors or variables believed to contribute to the performance quality of building materials.

Following on from studies in the past is Rahman et al. (2008), who developed a multi-criteria decision making model (MCDM) that considers the performance criteria of new technologies or materials, with which decision makers are able to solve combinational problems associated with the material-selection process. The system objective, however, delved more specifically into the design of a knowledge-based model that considers the life-cycle of materials and technologies at the least cost.

Van Kesteren, et al. (2005), presented a material-selection consideration model where product-personality, use, function, material characteristics, shape, and manufacturing processes are represented as the elements that are considered by the designer during the material selection process. The article by Wastiels et al. (2007), doubts the validity of their model to architecture. They maintained that architecture is not only concerned with the attributes or process of formation of the material, but also the interaction with the user. The theme is developed further by Ashby and Johnson (2002), who introduced the intangible qualities of materials such as ‘aesthetic attributes’ in the material properties list for material or
product designers when describing material aspects such as transparency, warmth, or softness. Wastiels and Wouters (2008) argue that their interest is limited to an occasional description of the phenomena without providing a clear and comprehensive overview that might be useful to architects or designers.

Wastiels and Wouters (2008) proposition was reinforced by generating a schematic of basic material selection considerations that looks into specific aspects that concern the user experience or sensory stimulation, such as the material’s colour or texture for architectural design projects. However, in the presented framework, no pronouncement is made upon what categories of materials are considered and how considerations from these different categories influence each other.

Fernandez (2006) presented an article that explained more directly the links between the decision-making process and material or product service life. In it, he demonstrated how contemporary architects make choices based on the performance attributes of existing models, implying that they do not choose for materials but rather for ‘material tools or systems’. He maintains that limiting the material performance to the specification of systems impedes the essential qualities inherent in the materials. The results of his study suggested that databases should primarily consider additional dimensions and factors with which other types of material or products could be effectively validated.

The development of a material selection model that measures how sustainability dimensions affect the construct of sustainability from the perceptions of architects by Florez et al. (2009) framed subjective factors or variables such as product’s appeal, resourcefulness and functionality as dimensions that play influential roles in the evaluation of material sustainability. Their study however, did not specify how potential users may differentiate between sustainable and non-sustainable materials or products.

The article by Cagan and Vogel (2002) suggested six categories of factors or variables that contribute to material value or performance such as emotion (sensual, power, and sense of adventure), aesthetic (visual, tactile, and auditory), product identity (personality, sense of impact, and social), ergonomics (ease of use, safety, and comfort), core technology (enabling and reliable), and quality (durability). Ljungberg (2007) argued that even though it is ideal that every material satisfies these conditions, they do not offer enough granularities to measure the performance credibility of a material or product.

Another research by Chueh and Kao (2004) demonstrated that the major dimensions of product quality include factors such as performance, features, reliability, conformance, durability, serviceability, aesthetics, tangibles, assurance, empathy, value, involvement and responsiveness. Their research however, supports consumer perception as a major contributing factor in determining material choice and performance.
Table 1: Building Materials Selection Consideration models Developed by Some Researchers

<table>
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<tr>
<th>Author(s)</th>
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<tr>
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</tr>
<tr>
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<td>Integrated system in which factors such as trend breaking, low reparable, safety and users' satisfaction, were used to measure material performance.</td>
</tr>
<tr>
<td>Abeysundara et al., 2009</td>
<td>Developed a model for the quantitative analysis of a range of sustainable building materials based on environmental aspects (embodied energy), economic issues (market price and cost) and social variables (thermal comfort, aesthetics ability to construct quickly, strength and durability).</td>
</tr>
<tr>
<td>Seyfang, 2009; Bevan and Woolhey, 2008; Kennedy, 200</td>
<td>Suggested the use of multi-criteria decision-making methodology for assessment of the decision-making process in selecting building materials under issues which relate to technical factors and low construction cost.</td>
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</table>

Source: Author's Compilation from Existing Literature

Ljungberg (2007) developed an integrated system in which factors such as trend breaking, low repara bility, safety and users' satisfaction, were used to measure material performance. Conversely, Glavic and Lukman (2007) used the mixed integer optimization approach for building material selection, considering subjective requirements in construction projects. This system used sustainability index- expressed by a set of binary scores, to aid decision makers optimize the selection of material types.
Abeysundara et al. (2009) on other hand, developed a model for the quantitative analysis of a range of sustainable building materials, based on environmental aspects (embodied energy), economic issues (market prices and cost) and social variables (thermal comfort, aesthetics, ability to construct quickly, strength and durability). The result of their analysis however showed preference to environmental parameters in the decision-making process over social and economic factors.

Given key insights from the background analysis and information provided in table 1, it was apparent that majority of existing models incorporated a few factors or variables which were not enough to help decision makers in their decision taken when selecting building materials for housing projects. Many efforts to bridge the existing gap identified have been initiated (Hulme and Radford, 2010; Fernandez, 2006; Cooper, 1999); but, almost as many appear not to have been accomplished. As follow-ups to the previous studies, this research is undertaken to identify as much as possible factors that will help or guide the decision makers to select appropriate and suitable building materials for housing delivery.

**RESEARCH METHODOLOGY**

To identify and prioritise factors that influence the selection of building materials for housing delivery in Ghana, a thorough review of literature was conducted. Through the literature review, forty-seven factors were identified (Florez et al., 2009; Abeysuntara et al., 2009; Seyfang, 2009; Bevan and Woolhey, 2008; Wastiels and Wouters, 2008; Rahman et al., 2008; Ljungberg, 2007; Van Kesteren et al., 2005; Chueh and Kao, 2004; Kennedy, 2004; Cagan and Vogel, 2002; Ashley and Johnson, 2000). Since the factors gathered from the literature had been sufficiently tested and used in similar studies in other countries, they were used as basis for this study.

To help in collecting research data for the study, a research approach involving semi-structured interviews and a questionnaire survey was adopted. These two approaches were adopted due to the fact that using different or more than one approach for collecting research data lead to greater validity and reliability than using a single methodological approach (Denzin 1970). Also, the idea of combining these methods is to make the study more realistic.

Interviews were carried out prior to the questionnaire survey to examine the relevance of the identified factors in the Ghanaian context. The semi-structured interviews were conducted amongst eight purposively selected top consultants from architectural and structural engineering firms operating in Accra. The interviews led to the confirmation of 47 factors identified from the literature as relevant to selection of building materials for housing projects in Ghana. These factors were further investigated in the questionnaire survey. The survey targeted three categories of stakeholders within the construction industry, specifically Practitioners (Architects, Quantity Surveyors and Structural Engineer), Clients, and
Contractors. Purposive sampling procedure was applied to select the sample for these three categories of stakeholders.

Closed-ended questions were mainly prepared but options were given for respondents to add to the list of possible answers. The respondents were asked to score the importance of the 47 potential factors that influences the selection of building materials on a Likert rating scale of 1 to 4, where 1 = ‘Not Important’, 2 = ‘Slightly Important’, 3 = ‘Important’, and 4 = ‘Very Important’. This 4 point scale was chosen to prevent respondents from providing neutral answers. A total of 150 questionnaires were personally distributed by the researchers to respondents in the Greater Accra Region of Ghana where the concentration of the stakeholders is highest. Eighty-eight (88) of the total questionnaires were dispensed to Practitioners (Architects, Quantity surveyors and Structural engineers), Thirty-two (32) to Contractors, and Thirty (30) to Clients. In total, 138 questionnaires (92%) were retrieved from the respondents for analysis.

The data gathered were analysed using Statistical Package for Social Sciences (SPSS 16.0) and Microsoft excel software (2013). Descriptive statistics such as percentages were used to summarize information from respondents. Also relative importance index method (RII) was used herein to determine Practitioners, Clients, and Contractors’ perception of the relative importance of the identified factors influencing the selection of building materials.

RESULTS AND DISCUSSION

Fifty-nine percent (59%) of the respondents who fully answered the questionnaires were Practitioners, 20% of them were Clients while the remaining 21% were Contractors. 49% of the respondents’ professional experience ranges between 10 years to 11 years.

The survey data consisting of the 47 building materials selection factors were analysed and grouped into seven (7) major areas: environmental/health factors, cost/economic factors, sensorial factors, socio-cultural factors, technical factors, performance capacity factors and general factors. The results of the study provide an indication of the relative importance index and rank of factors influencing the selection of building materials for housing projects in Ghana.

The perspectives of Practitioners, Clients and Contractors of the 47 factors influencing the selection of building materials were analysed based on the relative importance index. The relative importance index and ranks of building materials selection factors by all the respondents are presented in Table 2. The overall relative importance index is also presented in Table 2.

Generally, all stakeholders agreed that the top ten most important factors influencing the selection of building materials for housing delivery in Ghana are:
Based on the groups of building materials selection factors, the respondents generally agreed that the top three most important groups of factors are:

- Performance capacity factors
- Cost/ Economic factors
- Technical factors

The following discussion is focused on the seven groups of building materials selection factors in descending order of their ranking.

**Performance Capacity Factors**
The *performance capacity factors* of building materials selection factors were ranked highest by all stakeholders put together. *Strength* was determined by all respondents under the performance capacity factors as the most influential factor in the selection of building materials for housing delivery in Ghana. *Strength, durability, resistance to decay,* and *water resistance* which are all under the *performance capacity factors* were all ranked within the top ten most important factors influencing the selection of building materials for housing delivery in Ghana. These results confirm that of Abeysundara and Babel (2009), who established that factors that greatly affect the selection of building materials for the construction of houses are good mechanical properties such as strength and durability.
### Table 2: The relative importance index (RII) and rank of factors influencing the selection of building materials for urban housing delivery in Ghana

<table>
<thead>
<tr>
<th>Material Selection Factors</th>
<th>Practitioners</th>
<th></th>
<th>Clients</th>
<th></th>
<th>Contractors</th>
<th></th>
<th>Overall</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RII</td>
<td>Rank</td>
<td>RII</td>
<td>Rank</td>
<td>RII</td>
<td>Rank</td>
<td>RII</td>
<td>Rank</td>
</tr>
<tr>
<td>1. Environmental/Health Factors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental compatibility</td>
<td>0.748</td>
<td>45</td>
<td>0.758</td>
<td>41</td>
<td>0.785</td>
<td>32</td>
<td>0.764</td>
<td>40</td>
</tr>
<tr>
<td>Waste prevention</td>
<td>0.778</td>
<td>40</td>
<td>0.784</td>
<td>36</td>
<td>0.826</td>
<td>29</td>
<td>0.796</td>
<td>35</td>
</tr>
<tr>
<td>Health and Safety of user</td>
<td>0.892</td>
<td>23</td>
<td>0.851</td>
<td>29</td>
<td>0.869</td>
<td>19</td>
<td>0.871</td>
<td>25</td>
</tr>
<tr>
<td>Habitat disruption</td>
<td>0.832</td>
<td>36</td>
<td>0.685</td>
<td>45</td>
<td>0.669</td>
<td>42</td>
<td>0.729</td>
<td>45</td>
</tr>
<tr>
<td>Toxicity</td>
<td>0.778</td>
<td>40</td>
<td>0.688</td>
<td>43</td>
<td>0.756</td>
<td>38</td>
<td>0.741</td>
<td>43</td>
</tr>
<tr>
<td>Ozone depletion potential</td>
<td>0.818</td>
<td>38</td>
<td>0.782</td>
<td>37</td>
<td>0.645</td>
<td>43</td>
<td>0.748</td>
<td>42</td>
</tr>
<tr>
<td>Pollution</td>
<td>0.853</td>
<td>32</td>
<td>0.852</td>
<td>28</td>
<td>0.773</td>
<td>36</td>
<td>0.826</td>
<td>33</td>
</tr>
<tr>
<td>2. Cost/ Economic Factors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial cost</td>
<td>0.957</td>
<td>3</td>
<td>0.963</td>
<td>3</td>
<td>0.945</td>
<td>6</td>
<td>0.955</td>
<td>3</td>
</tr>
<tr>
<td>Maintenance cost</td>
<td>0.915</td>
<td>16</td>
<td>0.911</td>
<td>14</td>
<td>0.922</td>
<td>11</td>
<td>0.916</td>
<td>15</td>
</tr>
<tr>
<td>Disposal cost</td>
<td>0.857</td>
<td>31</td>
<td>0.885</td>
<td>23</td>
<td>0.830</td>
<td>27</td>
<td>0.857</td>
<td>27</td>
</tr>
<tr>
<td>Labour cost</td>
<td>0.906</td>
<td>20</td>
<td>0.902</td>
<td>19</td>
<td>0.910</td>
<td>13</td>
<td>0.906</td>
<td>16</td>
</tr>
<tr>
<td>3. Sensorial Factors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Appearance (Aesthetic value)</td>
<td>0.952</td>
<td>5</td>
<td>0.943</td>
<td>7</td>
<td>0.960</td>
<td>2</td>
<td>0.952</td>
<td>4</td>
</tr>
<tr>
<td>Texture</td>
<td>0.754</td>
<td>43</td>
<td>0.785</td>
<td>35</td>
<td>0.620</td>
<td>44</td>
<td>0.720</td>
<td>46</td>
</tr>
<tr>
<td>Colour</td>
<td>0.904</td>
<td>21</td>
<td>0.908</td>
<td>16</td>
<td>0.942</td>
<td>7</td>
<td>0.918</td>
<td>14</td>
</tr>
<tr>
<td>Temperature</td>
<td>0.868</td>
<td>28</td>
<td>0.836</td>
<td>31</td>
<td>0.784</td>
<td>34</td>
<td>0.829</td>
<td>31</td>
</tr>
<tr>
<td>Acoustics</td>
<td>0.847</td>
<td>34</td>
<td>0.733</td>
<td>39</td>
<td>0.747</td>
<td>39</td>
<td>0.776</td>
<td>38</td>
</tr>
<tr>
<td>Odour</td>
<td>0.879</td>
<td>27</td>
<td>0.687</td>
<td>44</td>
<td>0.683</td>
<td>41</td>
<td>0.750</td>
<td>41</td>
</tr>
<tr>
<td>Roughness</td>
<td>0.767</td>
<td>42</td>
<td>0.775</td>
<td>38</td>
<td>0.778</td>
<td>35</td>
<td>0.773</td>
<td>39</td>
</tr>
<tr>
<td>Fineness</td>
<td>0.676</td>
<td>47</td>
<td>0.786</td>
<td>34</td>
<td>0.542</td>
<td>45</td>
<td>0.668</td>
<td>47</td>
</tr>
<tr>
<td>4. Socio-cultural Factors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compatibility with cultural/traditions</td>
<td>0.865</td>
<td>29</td>
<td>0.845</td>
<td>30</td>
<td>0.785</td>
<td>32</td>
<td>0.832</td>
<td>29</td>
</tr>
<tr>
<td>Owner’s/User’s choice</td>
<td>0.938</td>
<td>6</td>
<td>0.946</td>
<td>5</td>
<td>0.958</td>
<td>3</td>
<td>0.947</td>
<td>6</td>
</tr>
<tr>
<td>Communal identity and setting</td>
<td>0.842</td>
<td>35</td>
<td>0.768</td>
<td>40</td>
<td>0.744</td>
<td>40</td>
<td>0.785</td>
<td>37</td>
</tr>
<tr>
<td>Cultural implications of material</td>
<td>0.753</td>
<td>44</td>
<td>0.816</td>
<td>33</td>
<td>0.819</td>
<td>30</td>
<td>0.796</td>
<td>35</td>
</tr>
</tbody>
</table>
Cost/Economic Factors

The Cost/Economic factors of building materials selection factors were ranked the second most influential group of factors in building materials selection by the three groups of stakeholders. Initial cost was determined by all respondents as the third most influential factor in the selection of building materials for housing delivery in Ghana. Initial cost which is under cost/economic factors was ranked within the top ten most important factors influencing the selection of building materials for housing delivery in Ghana. UN-HABITAT (2008) observed that the high cost of building materials among other factors underline the difficulties of housing delivery in Ghana. This then suggests the cost of materials as an influential factor in the selection of building materials. However, there is the need for a
suitable selection of quality low cost and sustainable building materials for housing delivery in Ghana.

**Technical Factors**
Practitioners, Clients, and Contractors together ranked technical factors as the third most influential group of factors in the selection of building materials for housing delivery. Within this group, Practitioners and Clients ranked Maintainability as the first most important factor in the selection of building materials. Contractors on the contrary ranked maintainability as the second most important factor in building materials selection. For labour availability, the Contractors rated ‘labour availability’ as the first most influential factor in the group whereas Practitioners and Clients rated it as the second most influential factor in the selection of building materials. Practitioners and Contractors ranked speed of construction as the third most important factor in the selection of building materials. Clients on the other hand, ranked ease of construction (buildability) as the third most important factor in building materials selection. Ademiluyi and Raji (2008) were of the view that physical characteristics of a house often depend on the technological know-how of the builders.

**General Factors**
General factors as building materials selection factors group was ranked the fourth most important group of factors in the selection of building materials by the three groups of respondents. Within this group, Practitioners, Clients, and Contractors all ranked availability of materials as the most important factor in the selection of building materials. Contractors ranked Conformance with national policy as the second most influential factor in the selection of building materials. On the contrary, Practitioners and Clients ranked Location of Site/Area climate as the second most influential factor in the group. These findings confirm that of Ademiluyi and Raji (2008) who asserted that physical characteristics of a house depend on the area's climate, the surrounding terrain, and the available building materials.

**Socio-Cultural Factors**
Practitioners, Clients, and Contractors together ranked socio-cultural factors as the fifth most essential building materials selection factor group. Within this group, Practitioners, Clients and Contractors all ranked owner's/user's choice as the most influential factor in the selection of building materials. According to Gardi, (1973), Adedeji, (2010) and Kwofie, et al., (2011), housing delivery has been greatly influenced by ethnicity and geographical location. It should be acknowledged that cultural factors such as culture of a community in accordance with the lifestyle of its people, a group's preferences and values or an individual owner's social status, personal taste and financial resources, influence housing delivery. It is imperative to note that housing is an essential indicator of historical culture of any society (Adedeji, 2010).
Environmental/Health Factors
The Environmental/Health factors group was ranked sixth by all the respondents. Practitioners, Clients and Contractors all agreed that within the environmental/health factors group, health and safety of user was the major factor that influences the selection of building materials under this group. Building materials should pose no or very minimal environmental and human health risks (González and Navarro, 2006). Nonetheless, the results indicated that respondents do not consider environmental and health factors in selecting building materials for housing delivery. González and Navarro (2006) estimated that the selection of building materials with low environmental impacts can reduce carbon dioxide emissions by up to 30%. They further stated that building materials should satisfy the following criteria: rational use of natural resources; energy efficiency; elimination or reduction of generated waste; low toxicity; water conservation.

Sensorial Factors
The sensorial factors group was ranked the lowest by the three groups of respondents. Regarding all the factors in the group, all three groups of respondents ranked appearance (aesthetic value) as the most important building materials selection factor. The three groups of respondents further rated colour of material as the second most important building material selection factor under this group. As indicated by the respondents, the sensorial factors is generally not considered so much in the selection of building materials for housing delivery in Ghana. Nevertheless Abeysundara and Babel (2009) in their study established that building selection factors that greatly influence the selection of building materials for the construction of houses are thermal comfort and aesthetic characteristics.

CONCLUSION
This research focused on stakeholders’ perspective of factors influencing the selection of building materials for housing projects in Ghana. The study sought the views of various stakeholders in the Ghanaian construction industry on the relative importance of the factors influencing the selection of building materials. The study showed that, out of a total of 47 building materials selection factors identified, the top ten most influential factors in the selection of building materials for housing projects in Ghana are as follows: strength, durability, initial cost, appearance (aesthetic value), water resistance, owner’s/user’s choice, availability of materials, resistance to decay, heat resistance, and fire resistance. The 47 building materials selection factors identified in the study were grouped into seven categories and ranked accordingly. The results also indicated that, all the respondents agreed that Performance capacity factors group of building materials selection factors was the most influential group of factors. Cost/Economic factors group was considered the second most influential building materials selection group of factors.
followed by technical factors. It is worthy to note that the appropriate selection of materials can influence the original cost, maintenance, durability and, of course, appearance of a building. The research concluded that stakeholders/decision makers should consider all the important factors identified in this study when selecting building materials for housing projects in Ghana.

REFERENCES


The purpose of this paper is to investigate the forces that influence the performance of housing market in Nigeria with a view to giving insight to investors, developers and other stakeholders on the effects of various factors on residential property performance. Relevant data for the study were gathered through questionnaires administered on registered estate surveying and valuation firms in Lagos, the economic capital and Abuja, the political capital of Nigeria. The data were analyzed using descriptive statistics, multi attribute utility approach and relative influence index. The results showed that location with relative influence index of 0.27 was the most influential factor affecting the performance of housing market in Nigeria. Others were economic (0.259), building attributes (0.237), and market conditions (0.234). The relative influence of underlying subcomponents under each broad category of factors is presented. The knowledge of the property performance influencing factors is expected to benefit the investors and other stakeholders in real property market and stimulate a healthy national economy.

Keywords: housing market, investors, Nigeria, property performance

INTRODUCTION

There has been little empirical research on the factors that influence residential property investment performance in different areas of African cities and this has perhaps limited the interest of foreign investors. Studies on residential property generally consider the performances without considering the forces that account for the variation in the performance over the year.

In this period of global economic meltdown characterized with uncertainty and volatility in the investment scene, knowledge about performance factors is essential for sound investment decision making. This is to address the lapses in most of the property investment decisions which often result in cases of voids, a high rate of foreclosure by lending institutions and other problems. This study aims to investigate the factors that influence the performance of direct investment in residential properties. The investigations were limited to the views expressed by members of Nigerian Institutions of Estate Surveyors and Valuers (NIESV) who deal in property as investment analysts, property managers

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Oyewole

and consultants. Nigeria, the most populous country in Africa became the continent largest economy in 2014 having experienced economic growth at an average seven percent in the last decade (African Housing Finance Year Book, 2014). The objective of this study is to identify the economic, locational, market and other forces that may support investment decision making by explaining their relative influence on the performance.

This type of study is particularly important because of the need to provide information on forces that drive housing market in an emerging economy like Nigeria.

LITERATURE REVIEW

Previous studies have focused more on the performance of housing investment. The forces driving the performance were hardly investigated. In one of its earliest studies, Hutchison (1994) compared the return on housing investment with returns on other types of investment such as equities and gilts over the eight years period of 1984 to 1992. This is with a view to consider whether housing has been a successful investment for the home owners during the period of measurement. The study found that on aggregated UK basis, housing had shown positive overall returns over this holding period and has proved to be a good hedge against inflation, although underperforming the returns from UK equities. The outcome of the study also showed that the housing returns from the northern region were higher than those from the southern part of the country, with the latter also showing a higher volatility of return. Meanwhile, the study failed to identify the drivers of housing investment.

Rosen (1996) examined fundamental and investment demand for rental apartment in the United States in 1990s. The paper proceeded by reviewing the trends in demographic and economic factors such as population by age group, household formation, household type by age of householder, house prices, mortgage rates, housing stock, vacancy rates, inflation and taxation policy. The study concluded that population, costs of home ownership, real rents and investment values were significant influences on apartment market in the United States of America. Apart from the fact that the study was carried out in a developed economy, other factors such building features and location were not considered.

Liang et al (1996) assessed the performance of apartment in efficient mixed-asset portfolios consisting of bond, stocks and real estate. The study employed a “hedged” apartment REIT index to track the performance of apartment real estate and found that the index reflected the returns of apartment REITs after the effect of equity REITs and the stock market are removed from the apartment REIT return. It was also demonstrated that the hedged apartment REIT index captured a substantial amount of the volatility unique to apartment real estate. The hedged apartment REIT index did not suffer from appraisal-smoothing problem and apparent seasonality of appraisal-based indices. The study concluded that it
appeared that the hedged apartment REIT index could be employed as a proxy for apartment real estate in portfolio allocation decisions. However, the study failed to examine the variables that influence the performance of the asset.

Ben-Shahar (2003) compared the performance of housing investment and financial assets in Israel focusing on transaction price index over the period 1990-2000. The study found that housing investment performed better than stocks and bonds. Furthermore, housing investment portfolio was found to substantially reduce the risk embedded in the optimal investment portfolio. However, the study found that the annual average return on a diversified investment in stocks was approximately two and four times greater than that on diversified housing and bond portfolios respectively.

Hwa (2003) examined the performance of Malaysian residential property sectors over a thirteen years period (1989 – 2001). Focusing on risk-return and comparing risk-adjusted performance of residential with equity investments, the study found that detached houses provided higher capital appreciation with higher risk compared to other forms of housing. The study also found the opportunity to invest in residential property was greatest in states of Kuala Lumpur, Penang and Johor. Furthermore, it was discovered that the best risk-adjusted performance came from detached and semi-detached houses in Kuala-Lumpur which performed better than shares on inter-asset comparison basis. However, the study failed to examine the drivers of the performance and the relative importance of the drivers. Montezuma (2004) examined housing investment in an international portfolio context. The paper provided an introduction to housing property investment at a macro level and reviews the main empirical issues related to housing investment. The paper reported that unsecuritized housing investment not only generated risk-adjusted returns comparable to those of bonds and shares, but also exhibited low levels of correlation with classic assets groups of institutional portfolios. However, the study did not examine the factors responsible for the performance.

Lee (2008) investigated the performance of residential property in Australia over a period of twelve years (1996-2007). This was with a view to examine the effectiveness of housing as a property investment vehicle. The author employed Sharpe and Sortino ratios to assess the risk-adjusted performance of housing and major financial and real estate assets. The study found that housing was an effective property investment vehicle in which it delivered the highest risk-adjusted returns and revealed negative correlation with major assets. Apart from the fact that the study was carried out in a more transparent and matured property market, the factors responsible for the performance were not examined.

Petinger (2013) outlined the factors that influence UK housing market as economic growth, unemployment, interest rates, consumer confidence,
mortgage availability, supply, and geographical factors. However, Petinger (2013) could be faulted on the ground of not being empirical.

Mbachu and Lenono (2005) examined the factors influencing market values of residential values of residential properties in the CBD of Johannesburg, South Africa. The authors sought and analysed the views of South African property owners association using multi attributes utility approach and content analysis. The result showed that location, market conditions, micro and macroeconomic dynamics and building features were the most influential factors affecting the residential property values in the study area. Though the study identified and examined the relative importance of the influential factors, it failed to consider the investment performance which is the trust of this study.

Golob, Bastic and Psunder (2012) investigated factors driving real estate market in Slovenia. Using data obtained through structured questionnaire, the study showed that economic growth, interest rates, construction quality, speed of real estate sales and accessibility of funding sources were the main factors influencing real estate market. Meanwhile, the study did not highlight the relative importance of the impact factors.

Ong (2013) measured the relationship between macroeconomic variables and housing price in Malaysia. Employing data from Valuation and Services Department of the Ministry of Finance from 2001 to 2010, the study found that Gross Domestic Product (GDP), population and real property gains tax (RPGT) were the key drivers of housing prices in Malaysia. The result of the study also suggested that housing bubbles in Malaysian residential property market were becoming bigger and stronger. However, the study failed to consider other variables such as location and physical features that influence housing prices.

Overseas Property Investment Corporation (2005) found that there was little or no mortgage financing in Egypt owing to high registration fees, lack of critical legal infrastructure, restriction of bank loan to housing, lack of valuation information among others. The study found that location and physical features were the main major drivers of housing market. In Ghana, another West African country, Bank of Ghana (2007) found that cost of inputs and land acquisition were the main drivers of persistent house price in Ghana. The study concluded that Ghana’s housing sector remained undeveloped and bedeviled by problem of land acquisition, over priced houses by private developers, prolonged land title, lack of access to credit and registration processes among others. The weakness of the study lies in its failure to examine the impact of other key factors such as physical characteristics and location on Ghana housing market.

In Nigeria context, Bello (2003) analysed the relative performance of residential property investment and investment in securities in Lagos. He examined the performance of the assets in terms of average annual return, risk adjusted return, income growth and capital appreciation. The result of the study ranked investment in stocks above that of residential property in
terms of rate of return in absolute terms and risk adjusted return. The finding of the study also indicated that the risk associated with residential property was lower than that of stocks. Meanwhile, the study did not consider the drivers of the performance.

Oloke, Simon and Adesulu (2013) study sought to investigate the relationship between locational, structural and physical characteristics on property values. The study employed percentages and relative importance index and found that travel distance and cost did not affect property value as other factors such as interstate highway, number and size of bedroom, conveniences, drainage and security. However, the geographical scope of the study is restricted to a neighbourhood in Lagos state which cannot be used to present a picture of factors influencing property value in the country. The study also failed to consider other important factors such as economic variables and market conditions whose impacts on property values cannot be ignored.

While the majority of aforementioned studies have provided significant information on the performance of housing investment, little research has been undertaken particularly in Nigeria on the drivers of housing investment performance.

RESEARCH METHODOLOGY

The study adopted a survey approach to permit a generalization of the results to the housing market in Nigeria. The survey was carried out in 2014 by the use of structured questionnaires to source for information for the study. The study adopted survey approach owing to unavailability of quality property transaction data in the country. The investigations were limited to the views expressed by members of Nigerian Institution of Estate Surveyors and Valuers in Abuja, the Nigerian capital city and Lagos, the nation’s economic nerve Centre. These Surveyors and Valuers deal in property as consultants and managers. The estate surveyors and valuers were considered because of their role as intermediaries between the investors (producers) and tenants (consumers) in the property market. The major reason for selecting Abuja and Lagos is that the majority of real estate transactions in Nigeria are conducted in these areas. Port Harcourt which used to be the third metropolitan city where property market was active in the country was exempted owing to the spate of violence which bedeviled the city in recent years. In addition, Abuja and Lagos represent the political and economic headquarters of Nigeria where 54 percent (300 of 560) of real estate practicing firms are located.

Sixty percent of the target population in each of the two locations was sampled based on the current edition of Nigerian Institution of Estate Surveyors and Valuers. This shows that 180 questionnaires were administered on estate surveyors and valuers which represented 60% of firms in the study areas and 32.4% of the total number of estate surveying firms in the country. The questionnaires were personally administered by
trained research assistants to the manager and or senior estate surveyor and valuer of each firm. Most of the questions used Likert type of scales to elicit respondents’ perceptions. The survey instrument adopted a five-point scale. Thus the responses ranged from not at all influential=1 to most influential = 5.

The ratings of the respondents were analyzed using Multi attribute method with a view to establishing a representative or mean rating point assigned to each attribute. The analysis draws from Multi Attribute Utility approach of Chan and Ive (2002) cited in Mbachu Lenono (2005). The analysis involves the computation of Mean Rating Point (MR) which indicates the level of significance of each attribute. In each computation, the total number of respondents (TR) rating each attribute was used to calculate the percentages of the number of respondents associating a particular rating point to the attribute as shown below.

\[
MR_j = \frac{1}{n} \sum_{k=1}^{8} (R_{jk} \times R_{jk})
\]

Where,
- \( MR_j \) = Mean rating point for sub factor j
- \( R_{jk} \) = Rating point k (ranging from 1 to 5)
- \( R_{jk} \% \) = Percentage response for rating point k for sub factor j

The higher the mean rating point for a factor, the greater the degree of influence.

In addition, relative influence index (RII) was utilized to compare the MR values of the factors. It is computed as a unit sum of influencing factors. This is shown below:

\[
RII = \frac{MR_j}{\sqrt{\sum_{j=1}^{n} MR_j}}
\]

Where:
- \( RII \) = Relative influence index for sub factor j. The higher the RII of sub factor j, the greater the relative influence of the sub factor.

**ANALYSIS OF RESULTS**

Of the 180 questionnaires distributed, 112 were returned. This represent a response rate of 62.22% which give the sample a confidence interval better than ±or-5.0 (De vaus 1996). The estate surveyors and valuers mean years of experience was 15.47 years, which indicated that on the average the surveyors had enough years of experience to provide
reliable opinion on what they perceived to be forces influencing the performance of residential property market in Nigeria. In addition, the profile of the respondents showed that majority are largely educated and professionally qualified. Their opinion could be of high value. This is evident from the 82% having first or high degree, and 91% having professional qualification to practice estate surveying and valuation profession in the country.

FACTORS AFFECTING RESIDENTIAL PROPERTY PERFORMANCE

The analyses of the factors determining residential property performance are showing table1 to table4. Using a five point return scale respondents rate the relative level of influence of a residential property. The responses were subjected to multi attribute analysis as described in the methodology section. The result is as described below.

**Economic factors influencing residential property performance.**

The result in Table1 shows that rate of employment with a mean rating point of 4.804 ranked first among economic sub factors influencing the performance of a residential property. It is also indicated that Gross Domestic Product with a mean rating point of 4.75 and rate of interest with a mean rating point of 4.29 ranked second and third respectively. Inflation rate and exchange rate of national currency ranked fourth and fifth with mean rating points of 4.25 and 3.089 respectively. The implication of the result is that residential property market performs better when the economy is prospering and characterized with high rate of employment, Gross Development(GDP) and above average rent. The result shows that a lower unemployment will enhance the performance of housing market. Similar findings are also documented by Miller and Peng (2006) in US and Lee (2009) in the Australia housing market.

<table>
<thead>
<tr>
<th>Factors</th>
<th>Very Influential</th>
<th>Influential</th>
<th>Somewhat Influential</th>
<th>Of little Influence</th>
<th>Not Influential</th>
<th>Mean rating</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP</td>
<td>84(75.0)</td>
<td>28(25.0)</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>4.75</td>
<td>2</td>
</tr>
<tr>
<td>Interest rate</td>
<td>50(53.6)</td>
<td>24(21.4)</td>
<td>28(25.0)</td>
<td>0.0</td>
<td>0.0</td>
<td>4.29</td>
<td>3</td>
</tr>
<tr>
<td>Employment rate</td>
<td>90(80.4)</td>
<td>22(19.6)</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>4.80</td>
<td>1</td>
</tr>
<tr>
<td>Exchange rates</td>
<td>0.0</td>
<td>56(50.0)</td>
<td>28(25.0)</td>
<td>10(8.9)</td>
<td>18(16.1)</td>
<td>3.09</td>
<td>5</td>
</tr>
<tr>
<td>Inflation rates</td>
<td>56(50.0)</td>
<td>28(25.0)</td>
<td>28(25.0)</td>
<td>0.0</td>
<td>0.0</td>
<td>4.25</td>
<td>4</td>
</tr>
</tbody>
</table>

Note: The figures in brackets are percentages of Responses

Understandably, the exchange rate is the least influential factor affecting housing market. In other words, the exchange rate of the national currency (Naira) to other famous currencies like American dollar and
British pound sterling has the least influence on housing market performance. This result might not be unconnected with the absence of foreign investors in the Nigerian housing market.

**Influence of Building characteristics on housing performance**

The result in Table 2 shows that the state of repairs ranked first among the building characteristics influencing housing market performance. It constitutes the most significant factor with a mean rating point of 4.893.

### Table II: Building characteristics influencing Residential Property Performance

<table>
<thead>
<tr>
<th>Factors</th>
<th>Very Influential</th>
<th>Influential</th>
<th>Somewhat Influential</th>
<th>Of little Influence</th>
<th>Not Influential</th>
<th>Mean Rating</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Conditions</td>
<td>28(25.0)</td>
<td>56(50.0)</td>
<td>28(25.0)</td>
<td>0.0</td>
<td>0.0</td>
<td>4.000</td>
<td>5</td>
</tr>
<tr>
<td>Quality of Finishes</td>
<td>80(71.4)</td>
<td>30(26.8)</td>
<td>2(1.8)</td>
<td>0.0</td>
<td>0.0</td>
<td>4.696</td>
<td>2</td>
</tr>
<tr>
<td>Age of property</td>
<td>56(50.0)</td>
<td>28(25.0)</td>
<td>28(25.0)</td>
<td>0.0</td>
<td>0.0</td>
<td>4.250</td>
<td>3</td>
</tr>
<tr>
<td>Building Services</td>
<td>64(57.1)</td>
<td>26(25.0)</td>
<td>22(17.9)</td>
<td>0.0</td>
<td>0.0</td>
<td>3.492</td>
<td>6</td>
</tr>
<tr>
<td>State of Repairs</td>
<td>100(89.3)</td>
<td>12(10.7)</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>4.893</td>
<td>1</td>
</tr>
<tr>
<td>Fixtures and Fittings</td>
<td>0.0</td>
<td>26(25.0)</td>
<td>60(53.6)</td>
<td>26(21.4)</td>
<td>0.0</td>
<td>2.250</td>
<td>7</td>
</tr>
<tr>
<td>Design and specifications</td>
<td>26(25.0)</td>
<td>63(56.3)</td>
<td>23(18.7)</td>
<td>0.0</td>
<td>0.0</td>
<td>4.063</td>
<td>4</td>
</tr>
</tbody>
</table>

Next in influence is the quality of finishes with a mean rating point of 4.696. The third most significant factor in this group is the age of the property with a mean rating point of 4.250. Design and specification rank next with a mean rating point of 4.063. Other influencing factors are structural conditions, building services and fixtures and fittings with mean rating points of 4.000, 3.492 and 2.250 respectively. This result suggests that property maintenance is crucial to residential property performance.

**Location factors influencing housing performance**

Among the groups of factors in this subgroup, the presence of infrastructure and social amenities with mean rating point of 4.804 constitutes the most significant factor influencing housing performance. Next in the degree of influence is the crime level with a mean rating point of 4.601. The third most influential factors are scenic beauty of environment and availability of transportation facilities with mean rating point of 4.536. The last in the degree of influence is traffic congestion with a mean rating point of 3.821. The result implies that the presence of infrastructure and amenities such as health centers, electricity and schools is the major consideration when people are searching for accommodation.
The most interesting aspect of the results is the growing importance attached to the crime level among location factors influencing residential property performance. This factor surprisingly ranked higher than scenic beauty of environment and transportation facilities. The result might not be unconnected with increasing crime rate in the country and the desire of the populace to put their safety into consideration when looking for accommodation.

### Table III: Locational features influencing Residential Property Performance

<table>
<thead>
<tr>
<th>Factors</th>
<th>Very Influential</th>
<th>Influential</th>
<th>Somewhat Influential</th>
<th>Of little Influence</th>
<th>Not Influential</th>
<th>Mean Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infras. and social amenities</td>
<td>90(80.4)</td>
<td>22(19.6)</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>4.804</td>
</tr>
<tr>
<td>Traffic congestion</td>
<td>40(35.7)</td>
<td>26(25.0)</td>
<td>26(25.0)</td>
<td>20(14.3)</td>
<td>0.0</td>
<td>3.820</td>
</tr>
<tr>
<td>Scenic beauty Of environment</td>
<td>60(53.6)</td>
<td>52(46.4)</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>4.536</td>
</tr>
<tr>
<td>Crime level</td>
<td>84(75.0)</td>
<td>15(13.4)</td>
<td>10(8.9)</td>
<td>3(2.7)</td>
<td>0.0</td>
<td>4.601</td>
</tr>
<tr>
<td>Transportation facilities</td>
<td>60(53.6)</td>
<td>52(46.4)</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>4.536</td>
</tr>
</tbody>
</table>

**Market conditions affecting housing performance**

Under this group of factors, demand and supply level with a mean rating point of 4.536 constitutes the most significant factors influence the performance of a residential property. Next in the influence is the experience of estate manager with a rating point of 4.250. The third and fourth factors in the order of significance are property market conditions and general business confidence level with mean rating point of 4.178 and 3.345 respectively. The interesting aspect of the result is the growing importance of property manager’s experience on the performance of property market. The result seems to agree with the findings of Kurzrock et al [2009] in Germany. This implies that experience in management is crucial to residential property investment performance.

### Table IV: Market conditions influencing Residential Property Performance

<table>
<thead>
<tr>
<th>Factors</th>
<th>Very Influential</th>
<th>Influential</th>
<th>Somewhat Influential</th>
<th>Of little Influence</th>
<th>Not Influential</th>
<th>Mean Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand And Supply</td>
<td>60(53.6)</td>
<td>52(46.4)</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>4.536</td>
</tr>
<tr>
<td>General Business confidence level</td>
<td>28(25.0)</td>
<td>10(8.9)</td>
<td>46(41.1)</td>
<td>28(25.0)</td>
<td>0.0</td>
<td>3.345</td>
</tr>
<tr>
<td>Experience of Estate Manager</td>
<td>56(50.0)</td>
<td>28(25.0)</td>
<td>28(25.0)</td>
<td>0.0</td>
<td>0.0</td>
<td>4.25</td>
</tr>
<tr>
<td>Property Market conditions</td>
<td>50(44.6)</td>
<td>32(28.6)</td>
<td>30(26.8)</td>
<td>0.0</td>
<td>0.0</td>
<td>4.178</td>
</tr>
</tbody>
</table>
Relative influence of the factor groups
In addition to rating the relative influence of the sub factors under each group, respondents were also requested to rate the relative influences of the major factors. The result in Table 5 shows that location with a mean rating point of 4.902 emerged as the most influential factor affecting housing performance in Nigeria. The second most influential factor according to the result is economic factor with a mean rating point of 4.710. The physical attributes of the property and market conditions came third and fourth with mean rating point of 4.303 and 4.250 respectively. To ascertain the contribution of each major group to housing performance, the researcher employed the Relative Influence Index (RII) technique to obtain the relative index of the factors. The result which is also in line with the former shows that location with the relative index of 0.27 accounts for 27 percent of influence on residential property performance.

Table V: Relative Influence of factor groups on Residential property performance

<table>
<thead>
<tr>
<th>Factors</th>
<th>Mean Rating</th>
<th>Relative Influence Index</th>
<th>Percentage</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>4.902</td>
<td>0.270</td>
<td>27.0</td>
<td>1</td>
</tr>
<tr>
<td>Macro-economic Factors</td>
<td>4.710</td>
<td>0.259</td>
<td>25.9</td>
<td>2</td>
</tr>
<tr>
<td>Physical characteristics</td>
<td>4.303</td>
<td>0.237</td>
<td>23.7</td>
<td>3</td>
</tr>
<tr>
<td>Market conditions</td>
<td>4.250</td>
<td>0.234</td>
<td>23.4</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>18.165</td>
<td>1.000</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

Next are economic factors which accounts for 25.9 percent of influence. The third and the last are the physical attributes of buildings and the market conditions with relative importance indexes of 23.7 and 23.4 respectively.

CONCLUSION
Existing literature on property investment performance is predominantly in the area of its actual performance (direct or indirect) or its relative performance with other investment media. Little study has been done on the factors influencing the performance. This study aims to examine the performance of Nigerian housing market from the perspectives of estate surveyors and valuers who are the major property transaction specialists in the country. The major factors specially considered are economic factors (micro and macro), physical attributes, location and market conditions.
From the results of investigations and analyses carried out, certain findings were made. On economic factors, it was found that employment rate was the most important factor influencing the performance of residential property. The availability of building services was perceived as
the most important factor among physical attributes influencing housing market in Nigeria. Among the market conditions, demand and supply level of property was the most influential factor determining the performance of residential property. The most important of location factors influencing residential property performance is the availability of infrastructure and social amenities. In order of relative influence, location emerged as the most important factor with a relative influence index of 0.27. Others are economic factors, building attributes, and market conditions with relative indices of 0.259, 0.237 and 0.234 respectively. The findings of the study should provide an insight to investors, developers and other stakeholders on the influence of various factors on Nigerian housing market.

REFERENCES


FACTORS RESPONSIBLE FOR MORTGAGE DEFAULT IN NIGERIA: A COMPARATIVE STUDY OF COMMERCIAL BANKS AND PRIMARY MORTGAGE INSTITUTIONS

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This study is aimed at examining reasons for mortgage default in Nigeria. Primary data was used for the study which was collected from 14 Commercial Banks and 21 Primary Mortgage Institutions (PMIs). Data was analyzed with descriptive statistics. The findings from the study reveal that most commercial banks declare their borrowers defaulters after missing 2 repayment, while the PMIs make such declaration after missing 3 repayment. Also the findings reveal that net-income to repayment, credit history, interest rates and mortgage charges are the most prominent factors responsible for default for the commercial banks; while mortgage charges, net-income to repayment, loan duration and credit history were the prominent factors for default for the Primary Mortgage Institutions. The study however recommends among other things the enactment of an Act for the establishment of Credit History Bureau in Nigeria and long term loan duration in the country.

Keywords: commercial bank, default factor, mortgage Nigeria, PMI

INTRODUCTION

The failure to payback mortgage installment as at when due by borrowers affects the recycling of fund by financial institutions. Not only this, the survival of the lender is also at jeopardy as this might lead them out of business when substantial fund is not available to them to operate. The global economic meltdown that has its root in the subprime mortgage is a witness to this, The United States Conference of Major (2008) and Mayu (2009) established that, one of the major reasons behind the global economic meltdown was the subprime mortgage a situation where those who lack financial strength were given mortgage, the sneezed from this subprime mortgage makes many national economy catch cold.

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The failure to fulfill the repayment arrangement as contained in the mortgage agreement is known as default (Okoror, 2000; Bello and Adewusi, 2009; Ahmed 2013; Rais et al 2013). But for the purpose of this study, the definition of Li (2005) which considered default as nonpayment of principal and interest will be the scope of the study. Atilola and Nubi (2010) averred that for the housing stock deficit and the attendance infrastructure in Nigeria be addressed; a vibrant mortgage system (both primary and secondary) must be operational at its full capacity. The current transformation agenda of Nigeria President, Goodluck Jonathan affects mostly those that are kin on construction industry, that is, Housing and Infrastructure that requires a lot of fund which would be sought through mortgage or some contemporary finance model. This however suggests that investors both local and international would be engaged directly or indirectly, and they will like to know how volatile or vulnerable the Nigerian mortgage market is, which this paper intended to provide.

The study aims to identify where borrowers/mortgagors default in their installment and the objectives are: determining the stage at which lenders declares the borrowers defaulter and identifies what causes default among the borrowers. The uniqueness of the study is anchored on it approach by comparing two distinct group of financial institutions which recent study in Nigeria such as Oyedokun (2012) and Ahmed (2013) did not cover in their study. Part of the study of Oyedokun (2012) examine the causes of default in PMIs without considering the commercial bank. Whereas, Ahmed (2013) considered both PMIs and commercial bank, but not on comparative basis. This study however fills the gap of existing body of knowledge on comparative basis, the factors responsible for mortgage default in Nigeria mortgage market of PMIs and commercial banks.

REVIEW OF LITERATURE

This section of the paper concentrates on the point of declaration of a borrower as defaulter and factors that trigger default of mortgage in commercial banks and PMIs.

Stage of Declaring Defaulters

Many borrowers might not be able to make repayment either as a result of delay in salary, non-vibrant business or illness. These unforeseen incidents warranted lenders to give borrowers some time to pay their installment, this additional time to pay installment is called grace period, after which they are declared defaulter (Rais et al 2013). The study of Oyedokun (2012) reveals that the average allowable default period of PMIs is above 3 months. The 3 months can be inferred to be 3 repayments when repayment is on monthly basis, that which is common to repayment of mortgage. However, this study did not cover commercial banks which this current study included. The submission of Rais et al (2013) as to the period borrowers are in default is 30 days, which is a month. Their view is to all lenders without any segregation among groups
of lenders. From the study of Ahmed (2013) that covers the commercial banks and PMIs, it was revealed that borrowers are in default after 3 repayments. However, this study does not differentiate the two group studied, which this current study evaluates.

**Factors Responsible for Mortgage Default**

Authors such as Gill (1999), Cairns and Pryce (2005), Bandyopadhyay and Saha (2009), Hashian and Welach (2010) had classified the factors responsible for mortgage default into macro and micro and/or ability-to-pay and housing equity. Recent study of Oyedokun (2012) classified it into five that is, borrowers related factors, lender related factors, loan related factors, property related factors and macro-economy related factors. These various classifications are interwoven, the need to assess each authors work and identify factors responsible for mortgage default is necessary.

Nubi (2003) paper “Flying with one Wing: Dilemma of Mortgage Bank” reveals that, mortgage charges and competence of mortgage originators contributed to default risk in Nigeria. This suggests that additional charges such as processing fees, insurance and the likes had increased the borrowers repayment above his/her financial comfort zone, which invariably lead to default. As regards the competence of mortgage originators, this is some lapses in the packaging of the loan like what was witnessed in the subprime mortgage of United States of America. Cairns and Pryce (2005) worked on a critical review of the UK mortgage default literature, that was not backed by any empirical study, but from their submission on those past literature that was carried out based on empirical studies, factors such as employment, change in income, divorce, illness, mortgage payment protection insurance, interest rate, dependents, liquidity of the mortgage property and age are the drivers of default in UK.

Li (2005) study was on Chinese financial innovation of mortgage market, known as securitization, which is buying and selling of mortgage asset in the secondary market. This to some extent is talking about unbundling the mortgage market and reducing default risk. Li (2005) shares the view of Nubi (2003) where he described the Nigerian mortgage market as unbundling of the mortgage market and he concluded that mortgage market in Nigeria is “flying with one wing”. Li (2005) study only identified credit rating system as a source of default.

Bandyopadhyay and Saha (2009) examine the functional role of various micro and macro-economic as well as situational factors that determine residential housing demand and risk of borrowers default. They sample 13,487 housing loan accounts from Housing Finance Institutions (HFIs) in India. Their empirical study reveals that default is mainly driven by change in market value of the property vis-à-vis the loan amount and EMI to income ratio. Other factors that trigger default in India as identified in their study are marital status, employment situation, regional location, city location, age profile and house preference. The study in china by Mayu (2009) focused on the macroeconomic factors analysis on China personal housing mortgage loan default, using statistical description. Data used was collected from commercial banks in Yanti and Bozhou in China. His
work revealed that interest rate, income growth and unemployment have no significant effect on default rate in the study area due to the country policy on mortgage.

From the study of Smith (2010), the essence of borrowers’ credit scores as related to mortgage default was examined and the study serves as a precursor to potential default and prepayment. What Smith (2010) called credit score is what most literature called credit history rating of borrowers. Data for the study was gotten from Fair Issac Corporation (FICO). Scores of between 2001 and 2008 in the State of Florida from a panel of nearly 7 million observations of roughly 270,000 individual mortgage borrowers.

Oyedokun (2012) carried out a comprehensive study on analysis of default factors in residential mortgages of PMIs, using both descriptive and correlational research. His study revealed that, payment-to-income ratios is at 58% which is more than the stipulated 33.33% of Central Bank of Nigeria, this which is responsible for mortgage default, other factors identified by him being significant are Borrower’s sex, Educational Status. Whereas, factors including, loan-to-value ratio, loan duration, credit history, nature of employment, borrower’s age, number of borrower’s dependents, availability of guarantors, marital status, borrower’s nationality and tribe are insignificant to mortgage default.

Ahmed (2013) samples the commercial banks and PMIs in Nigeria, the findings show that borrowers are declared defaulters after missing 3 repayment and, factors credit history, net-income to repayment, loan duration, age, change in income, interest, mortgage charges and illness were identified as significant causes of default. Although this study served as a basis for the present one, the current paper differs in methodology adopted. This is because its examination was on comparison basis of the two group sampled and the use of RII as against weighted means score used by Ahmed (2013).

The factors that can be inferred from the above as factors responsible for mortgage default are Interest Rate, Loan-to-value Ratio, Charge in Income, Illness, Net-income-to –repayment Ratio, Mortgage insurance, Mortgage charges, Marital status, Age, Liquidity of housing asset, Education status, Dependant, Borrower’s sex, Loan duration and Credit history.

**ANALYTICAL FRAMEWORK**

The study focuses on mortgage issuer’s, that is, the commercial banks and PMIs. Questionnaire was used to obtain information from them as to what causes default in the Nigerian mortgage market in which they are actively involved. The 15 causes that were identified from the literature review were listed in the questionnaire alphabetical order and was also analysed in the same order.
The use of relative important index (RII) in this study for the analysis is a means of improving on the mean item score (MIS) used by Ahmed (2013). Although both look the same but RII considers the responses to each variable/factor under consideration, this makes the denominator vary for each variable, whereas in MIS the denominator is constant. In order to establish potent causes of default in the study area, the result of the RII was ranked in descending order for the two groups of issuers, the symbol ‘˄’ was used to identify causes that are greater in one group than the other and symbol ‘*’ used to establish the three most prominent causes of default in each group.

RESEARCH DESIGN AND METHOD

The main instrument employed was questionnaire which was designed to collect information on the determining of point of default and causes of mortgage default from 14 commercial banks and 21 PMIs. This represent 66.67% and 33.33% of the commercial banks and PMIs operating in Lagos respectively, as at 1st July, 2012 there are 21 commercial banks whose most of them have their headquarters in Lagos and 63 PMIs who are active in Lagos (www.cenbank.org/supervision). The importance of the Primary Mortgage Institutions (PMIs) and the Commercial Banks in Nigeria mortgage business is germen. The PMIs are statutorily empowered to provide mortgage for the contributors of the National Housing Fund and Estate Developers. The revolution in the banking sector in the earlier 2000’s of universal banking have expanded their scope of practice of commercial banks into real estate mortgage business either directly or indirectly and they are one of the main sources of real estate finance in Nigeria and many emerging economies (Atilola and Nubi, 2010). The situation in Nigeria is also similar to what the India mortgage market experience, Rais, Selvarasu and Jose (2013) submitted that “the foremost players in this sector are the finance corporation but presently the commercial banks are also starting to play an important role in the development and growth of the India mortgage market”.

The data were analyzed with descriptive statistics (Percentage table and Relevant Important Index) as used by Bello and Adewusi (2009), Oyedokun (2012) and Ahmed (2013). The researchers adopted 5 point likert scale that is (5, 4, 3, 2, 1)”Strongly Agree” Agree, “indifferent” “Disagree” and “Strongly Disagree” can be used to denote the figure in descending order.

Relative Importance Index (RII) = \[
\frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + n_1}{5(N)}
\]

Where:  
\( n_5 \) = number of responses for “Strongly Agree” 
\( n_4 \) = number of responses for “Agree”
n3= number of responses for “indifferent”
n2= number responses for “Disagree”
n1= number of responses for “Strongly Disagree”.
And N = Number of respondents to each variable/factor

The respondents were asked to tick in the questionnaire if they agree that the various variables cause default in the Nigerian mortgage market, this is calculated to obtain the relative importance index using equation 1 above. Thereafter, the RII was ranked in descending order based on the value of the RII

**Result and Discussion**
The analysis here provides answers to the two objective of the study, in the Subsequent subheadings.

**Determining Mortgage Default in Commercial Banks and PMIs**
Table 1 below shows that majority of the commercial banks will declare of borrowers’ defaulter after missing two repayments (instalment), while such declaration will be made by PMIs after missing three repayments. The findings from the PMIs is in agreement with earlier study of Oyedokun (2012) that borrowers are declared defaulters after missing 3 instalments. What can be inferred from this is that, commercial banks are proactive than the PMIs as they see lending as “business”, and did not want to give room for situation that will warrant increase in loan-to-value ratio. On the part of the PMIs, the initial savings made by the borrowers to the NHF before the loan was granted was seen as what they can fall back on, so they are not in haste in declaration of defaulters.

<table>
<thead>
<tr>
<th>Number of Instalment default</th>
<th>Commercial Banks</th>
<th>PMIs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3 (21.43)</td>
<td>1 (4.76)</td>
</tr>
<tr>
<td>2</td>
<td>4 (28.57)</td>
<td>4 (19.05)</td>
</tr>
<tr>
<td>3</td>
<td>3 (21.43)</td>
<td>12 (57.14)</td>
</tr>
<tr>
<td>4</td>
<td>1 (7.14)</td>
<td>4 (19.05)</td>
</tr>
<tr>
<td>5</td>
<td>3 (21.43)</td>
<td>0 (0.00)</td>
</tr>
<tr>
<td>Total</td>
<td>14 (100)</td>
<td>21 (100)</td>
</tr>
</tbody>
</table>

Note: The figures in brackets are percentage of respondent

**Evaluating the Determinants of Mortgage Default**
Table 2 below shows the RII and their ranking, it reveals that 6 factors representing 40% (that is 6/15) of the causes of default in commercial banks are higher than PMIs, while 9 factors representing 60% (that is 9/15) of the causes of default in PMIs are higher than the commercial banks. This is clearly displayed in figure 1 below.
Also, Table 2 shows that the first three causes based on ranking for commercial banks are net-income to repayment ration 1st; credit history 2nd and, interest rate and mortgage charges 3rd. on the part of the PMIs, mortgage charges 1st, while credit history, loan duration and net-income to repayment ratio were ranked, 2nd.

Table 2: Causes of Mortgage Default in Commercial Banks and PMIs

<table>
<thead>
<tr>
<th>Causes</th>
<th>Commercial Banks RI</th>
<th>Ranking</th>
<th>PMIs RI</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.65</td>
<td>12</td>
<td>0.82^</td>
<td>6</td>
</tr>
<tr>
<td>Borrowers Sex</td>
<td>0.35</td>
<td>15</td>
<td>0.61^</td>
<td>12</td>
</tr>
<tr>
<td>Change in Income</td>
<td>0.75</td>
<td>5</td>
<td>0.83^</td>
<td>5</td>
</tr>
<tr>
<td>Credit History</td>
<td>0.91*^</td>
<td>2</td>
<td>0.88*</td>
<td>2</td>
</tr>
<tr>
<td>Education Status</td>
<td>.60^</td>
<td>13</td>
<td>0.49</td>
<td>15</td>
</tr>
<tr>
<td>Illness</td>
<td>0.75</td>
<td>5</td>
<td>0.76^</td>
<td>8</td>
</tr>
<tr>
<td>Interest Rate</td>
<td>0.77**</td>
<td>3</td>
<td>0.73</td>
<td>10</td>
</tr>
<tr>
<td>Liquidity of the Asset</td>
<td>0.69^</td>
<td>10</td>
<td>0.65</td>
<td>11</td>
</tr>
<tr>
<td>Loan Duration</td>
<td>0.72</td>
<td>8</td>
<td>0.88**^</td>
<td>2</td>
</tr>
<tr>
<td>Loan-to-Value Ratio</td>
<td>0.68</td>
<td>11</td>
<td>0.76^</td>
<td>8</td>
</tr>
<tr>
<td>Marital Status</td>
<td>0.57</td>
<td>14</td>
<td>0.60^</td>
<td>13</td>
</tr>
<tr>
<td>Mortgage Charges</td>
<td>0.77</td>
<td>3</td>
<td>0.91*^</td>
<td>1</td>
</tr>
<tr>
<td>Mortgage Insurance</td>
<td>0.73</td>
<td>7</td>
<td>0.79^</td>
<td>7</td>
</tr>
<tr>
<td>Net-Income to Repayment Ratio</td>
<td>0.92*^</td>
<td>1</td>
<td>0.88*</td>
<td>2</td>
</tr>
<tr>
<td>Number of Dependant</td>
<td>0.71^</td>
<td>9</td>
<td>0.59</td>
<td>14</td>
</tr>
</tbody>
</table>

Source: field survey 2013.

*The first three ranked causes
^Causes in one group that is higher than the other group

Fig. 1: The RII of the commercial Banks and PMIs on causes of default.

From the analysis so far, 5 causes can be identified as major causes of defaults in Nigeria mortgage market from the perspective of the two issuers. An evaluation of these causes with previous study of the literature reveal the following:
Credit history: This is not in line with Cairns and Pryce (2005), Bandyopadhyay and Saha (2009), Mayu (2009) and Oyedokun (2012). It however agrees with the findings Li (2005), Smith (2010) and Ahmed (2013);

Interest rate: As regards to this variable as a cause of defaults, it agrees with the study of Cairns and Pryce (2005) and Ahmed (2013). But is not in agreement with Bandyopadhyay and Saha (2009) and Mayu (2009) finding of study;

Loan duration: The findings here is in line with that of Ahmen (2013), but not in agreement with that of Oyedokun (2012);

Mortgage charges: This is in agreement with submission of Nubi (2003), Cairns and Pryce (2005) and Ahmed (2013).

Net income to repayment ratio: This confirm the submission of Bandyopadhyay and Saha (2009), Oyedokun (2012) and Ahmed (2013).

Finally, there is a relationship between interest rate, loan duration, mortgage charges and net income to repayment ratio. When mortgage charges are high, with a short loan repayment period and high interest rate for a borrower with low net income to repayment ratio, then defaults is inevitable.

CONCLUSION

This study has examined the declaration of default by lender and causes of default in commercial banks and PMIs mortgage market. The study revealed that the commercial banks and PMIs declared borrowers defaulters after missing 2 and 3 repayment respectively; the prominent causes of default for the commercial banks and PMIs are credit history, interest rate, mortgage charges and net-income to repayment ratio and credit history, loan duration, mortgage charges and net-income to repayment ratio respectively and, 40% of the causes of default of commercial bank are higher than that of PMIs, while 60% of the causes of default of PMIs are higher than the commercial banks.

This study extended what past studies have done in the area of determining defaulters and causes of default in Nigeria mortgage market of commercial banks and PMIs only. However, since the study was limited to commercial banks and PMIs, another study may be conducted to cover wider set of lenders such as bank of industry, micro finance bank, cooperative society and other lenders in Nigeria.

The study concluded that there should be enactment of Credit History Bureau Act in Nigeria; long term loan period which will bring about low net-income to repayment ratio. The study will however inform the foreign investors and local investors, on default factor they should be aware of in the Nigerian mortgage market whether they will be participating directly or indirectly.
REFERENCES


FORECASTING THE DURATION FOR SMALL SPAN BRIDGE CONSTRUCTION PROJECTS USING ARTIFICIAL NEURAL NETWORK

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Department of Building Technology, KNUST, Kumasi, Ghana

Forecasting the duration for bridge construction projects represents a problem for construction professionals in Ghana. The purpose of this paper is to develop an artificial neural network model for forecasting the duration of small span bridge projects. Data for 18 completed bridge projects from the Department of Feeder Roads were collected and analyzed using the artificial neural network (ANN) and multiple regression. The data collected were quantities of work items executed in the BOQ namely site clearance, earthworks, in–situ concrete, reinforcement, formwork, approach gravelling and actual duration. The coefficient of correlation (R) as well as the mean absolute percentage error (MAPE) obtained show that construction professionals can use the developed ANN model or the multiple regression model for forecasting duration. The study shows that ANN model produces a better result (MAPE of 7.88%) than the multiple regression model (MAPE of 12.58%). The outcome of this study is to help construction professionals to fix realistic contract duration for bridge construction projects before signing of a contract. Such realistic contract duration would help reduce time overruns as well as the payment of liquidated and ascertained damages by contractors for late completion.

Keywords: artificial neural networks, artificial neural network model, bridge projects, project duration, multiple regression

INTRODUCTION

One of the factors for classifying a project as successful is the time required for its completion. This is because late completion of projects increases the cost of the works. According to Lim and Mohamed (1999), clients, users, stakeholders and the general public usually look at project success from the macro point of view of early completion. However, developing countries tend to have problems with time overrun on construction projects and the Ghanaian Construction industry is no exception.

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Although there are conventional tools (such as Gantt chart, Critical Path Method - CPM and Programme Evaluation Review Technique - PERT) for construction duration estimation, these methods have been found to have inherent problems. For instance the PERT technique is applied only to a single critical path. This assumption means that the result obtained always underestimates the duration of a project (Mawdesley et al, 1997). The PERT technique assumes that the uncertainty associated with the overall duration is approximately a normal distribution (Omar 2009).

For small projects however, there may not be enough activities defining the duration of the project to make the assumption of normal distribution of project duration valid (Mawdesley et al, 1997).

According to Williams (2008), the State Highway Agency (SHA) responsible for road construction in the United States employ a more detailed scheduling technique in duration estimation but such an estimate, according to him, is time consuming and is based on a lot of assumptions. This is because many departments of transportation simply do not have sufficient data in terms of production rates to apply computerised methods to improve the reliability of their estimates (Chong et al, 2011) and the road agencies in Ghana is no exception.

The aim of this paper is to develop an artificial neural network and multiple regression models for forecasting the duration of small span bridge construction projects

**Problem statement and purpose of study**

Studies have been carried out to determine the duration for building and road projects (Bromilow et al 1980, Ireland 1985, Kaka and Price 1991, Kumaraswamy and Chan 1995, Chan 1999, 2001, Choudhury and Rajan 2003, Love et al 2005, Ogunsemi and Jagboro 2006, Hoffman et al 2007, Mensah (2009, 2010), Le-Hoai and Lee (2009), Pewdum et al (2009) and Petruseva et al, (2013). However no research has been carried out for the determination of the duration for bridge construction projects. Forecasting the duration for bridge construction projects presents a problem for construction professionals mostly in Ghana. It is worth mentioning that the duration of bridge construction projects in Ghana is determined based on experience by construction professionals. Professionals responsible for bridges at the moment do not have a scientific method for estimating the duration of bridge projects. In fact Seshie (2009) carried out a research for public building projects in Ghana and found that construction professionals estimate durations based on experience and did not adopt any scientific method for fixing duration for building projects. The fixing of the duration by the agencies for road and bridge projects binds on potential bidders/contractors once the contract is awarded and signed. The risk is that where the duration fixed is not reasonable; the prospective contractor is likely to suffer the consequences of late completion including deduction for liquidated and ascertained damages. In addition, time overruns, increased claims and substandard performance are the consequence of unrealistic contract duration. Where the duration fixed is
however, overestimated, the employer/client loses potential revenue had the appropriate duration been fixed.

The lapses in the conventional methods identified by researchers in section 1.0 call for alternative ways for determining the duration of bridge projects by the agencies in Ghana. At the moment, the Government of Ghana, its development partners and other stakeholders for bridge projects are dissatisfied with time overrun of bridge construction projects. The purpose of this paper is to develop models for the purpose of predicting the duration of bridge projects.

UNIQUE RELEVANCE OF ANN IN DETERMINING DURATION AND RELATED LITERATURE

The artificial neural network (ANN) has proved to have successfully provided solutions to many engineering problems. The network is able to solve complex or non-linear problems and have gained popularity in construction management and engineering. ANN has been found to produce better results or has a better accuracy than regression techniques (Petruseva et al 2013, Singh and Chauhan 2009). In addition, the ANN does not make prior assumptions about the distribution of the data or the form of interactions between factors (Singh and Chauhan 2009). ANN is robust, has the ability to adapt to unknown datasets and has a good learning capability (Jha and Chockalingam, 2011).

Petruseva et al, (2013) used the linear regression and artificial neural network to develop models for the prediction of duration of building projects in Bosnia and Herzegovina. Data for 75 building projects were collected through field studies. The data collected were the contracted and real time of construction, the contracted and real price of construction as well as the year of construction. Using the back propagation feed forward artificial neural network, a model was developed using cost as the independent variable with good predictive ability (Coefficient of determination, $R^2 = 0.97$) and mean absolute percentage error of 2.5%.

Pewdum et al (2009) developed an artificial neural network to forecast the final budget and duration of highway construction projects in Thailand. Data for 51 highway construction projects between 2002 and 2007 were collected from project progress reports. After experimenting with several neural network models, they found five factors namely, work starting date, evaluating date, contract duration in days, percentage of planned completion and percentage of actual completion as major determinants for project duration. After developing the neural network model for duration, it was compared with the current method (i.e. earned value method) for duration determination in Thailand. They found that the developed ANN model (with a mean absolute percentage error of 8.51%) forecasts the duration for highway projects better than the current method (with a mean absolute percentage error of 19.90%).
Bhoka and Ogunlana (1999) also used the artificial neural network to forecast the construction duration for buildings at the pre-design stage. One hundred and thirty six (136) building projects completed during the period 1987 – 1995 in Greater Bangkok were used for training and testing the network. The best network developed for the determination of construction duration at the pre-design stage had six hidden nodes with an average error of 13.6%.

In spite of the application of the ANN in determining the duration, none of the researchers have used the executed quantities in bill of quantities (BOQ) as independent variables for forecasting the duration. This paper attempts to develop an artificial neural network and multiple regression models for predicting the duration of small span bridge construction projects using quantities executed in completed projects.

### Topology of ANN

An artificial neural network (ANN) is an intelligent system or a mathematical model which is based on biological neural networks (Singh and Chauhan 2009, Jha and Chockalingam 2011, Petruseva et al, 2013). A typical topology that was used in this study is shown in figure 1. It consists essentially of many interconnected but artificial neurons which weighs, sums and threshold incoming signals to produce an output (Taylor et al, 2007). The ANN makes use of processing units which are connected by links with the processing unit grouped into three main layers, viz input layer, hidden layer and output layers (Afrifa et al 2012). The input layer receives information from the outside world with the hidden layer serving the purpose of creating an internal representation of the problem. The output layer gives solution to the problem by offering a more accurate prediction. Further details of the topology and background of ANN, could be read in articles authored by Petruseva et al, (2013), Afrifa et al (2012), Jha and Chockalingam (2011), Singh and Chauhan(2009). However, in this study the back propagation feed forward network was used.

![Figure 1: Topology of ANN used in study](image)

\[ w_1, w_2, \ldots, w_{15} \text{ are connection weights.} \]
BRIDGE CONSTRUCTION AT THE DEPARTMENT OF FEEDER ROADS

The Department of Feeder Roads (DFR) of the Ministry of Roads and Highways is responsible for provision of safe all weather accessible Feeder Roads at optimum cost to facilitate the movement of people, goods and services and to promote socio-economic development, in particular agriculture. During the last decades, demand for small span bridges has increased drastically in Ghana. This is because rivers and streams routinely cut off access to the main roads for villages preventing the rural folks from accessing health care and transporting farm produce to the market centers. The Ministry of Roads and Highways through the Department of Feeder Roads and its development partners teamed up to provide prefabricated steel components for the construction of bridges in the country. The development partners (namely Dutch, Acrow and Spanish) mainly provided the prefabricated steel components for the bridge superstructure whilst the Ghana Government took care of the civil works.

DATA COLLECTION

Data for completed bridge projects from 2008 to 2014 were collected from the Department of Feeder Roads. Both hard and soft copies of projects completed in five (5) regions were provided. The data collected were payment bills of quantities (BOQ) for the final certificates including the final progress reports. The projects examined were constructed in five (5) regions namely Eastern, Western, Brong Ahafo, Northern and Upper West regions of the country. Eighteen (18) BOQS for different spans of bridge projects were examined and the data extracted were mainly categorized under four headings namely bridge foundations, In-situ concrete, approach roads and installation of bridge components. These categories were those indicated in the BOQS and essentially constitute the whole of the works under each project. For all the selected projects, the steel bridge components were prefabricated and installed or launched onto the reinforced concrete abutment foundations which were done in-situ. Additional information was obtained from the engineers who worked on the selected bridges. The additional information was obtained through a questionnaire. The information requested for in the questionnaire include the total bridge span (ranging from 20 – 54m), weights of the steel components and the total number of lanes of the bridge components for each of the eighteen (18) selected bridge projects. In four (4) out of the eighteen (18) projects, there were two steel bridges that were completed under each contract. For such contracts, the spans, weights and lanes of the bridge components were added together to arrive at the total span, weight and number of lanes which were then used for the analyses.

Justification for items used in model development
The duration of a project depends more on its quantities of work items rather than its cost (Horner and Zackieh, 1993). In addition, the duration of a project equals the quantity divided by its output. This means that a link between the duration and quantity can easily be established. As a result, quantities of work items executed were extracted. Table 1 shows details of the items extracted in the BOQ and used as time influencing factors or attributes for the developed models in this study. These selected items were considered to be critical in the construction of steel bridges because they were the main works and essentially constitute the whole works under steel bridge projects. Horner and Zackieh (1993) used in-situ and precast concrete, formwork, reinforcement, pavings, fabrication of parapets and imported filling around structural foundations in BOQS as quantity significant work operations for developing an integrated model for estimating and controlling reinforced concrete bridge construction cost and duration. This study however uses the items in Table 1 as input variables. In addition to the items in Table 1, the start date, intended completion date, revised and actual completion dates, contract sums and final amounts paid on completion were also extracted. Items such as gravel sub-base and stone pitching which were measured in m² in the BOQ were converted to m³. A summary of the characteristics of the selected bridge projects is also shown in Table 2.

Table 1: Time influencing quantities (factors) used for model development

<table>
<thead>
<tr>
<th>FACTOR/ITEM</th>
<th>CATEGORY</th>
<th>ITEMS IN BOQ</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Bridge foundation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>In-situ concrete</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Approach Roads</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Installation of bridge components</td>
</tr>
<tr>
<td>Input variables</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excavation of foundation including excavation from borrow pits &amp; Gravel sub-base in m³ (EW)</td>
<td>Excavation of foundation in m³</td>
<td>Concrete of all grades in m³</td>
</tr>
<tr>
<td>In-situ Concrete of all grades including stone pitching in m³ (IC)</td>
<td>Stone pitching (STP) in m² converted to m³</td>
<td>Gravel sub-base in m² converted to m³</td>
</tr>
<tr>
<td>Reinforcement in kg (R)</td>
<td>Reinforcement in kg</td>
<td>Site clearance in m²</td>
</tr>
<tr>
<td>Formwork in m² (F)</td>
<td>Formwork in m²</td>
<td>Haulage of aggregates in m³-km</td>
</tr>
<tr>
<td>Site Clearance in m² (SC)</td>
<td>Haulage of aggregates in m³-km</td>
<td></td>
</tr>
<tr>
<td>Bridge span in metres (BS)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight of steel bridge component in kg (WT)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of bridge lane</td>
<td>(BL) (single or double)</td>
<td></td>
</tr>
<tr>
<td>Haulage of aggregates in m³-km (H)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The duration of a project depends more on its quantities of work items rather than its cost (Horner and Zackieh, 1993). In addition, the duration of a project equals the quantity divided by its output. This means that a link between the duration and quantity can easily be established. As a result, quantities of work items executed were extracted. Table 1 shows details of the items extracted in the BOQ and used as time influencing factors or attributes for the developed models in this study. These selected items were considered to be critical in the construction of steel bridges because they were the main works and essentially constitute the whole works under steel bridge projects. Horner and Zackieh (1993) used in-situ and precast concrete, formwork, reinforcement, pavings, fabrication of parapets and imported filling around structural foundations in BOQS as quantity significant work operations for developing an integrated model for estimating and controlling reinforced concrete bridge construction cost and duration. This study however uses the items in Table 1 as input variables. In addition to the items in Table 1, the start date, intended completion date, revised and actual completion dates, contract sums and final amounts paid on completion were also extracted. Items such as gravel sub-base and stone pitching which were measured in m² in the BOQ were converted to m³. A summary of the characteristics of the selected bridge projects is also shown in Table 2.
Kaming et al (1997) defines time overrun (or delay) as the extension of time beyond the planned completion date. For the purpose of this study, time overrun is the difference between the estimated (or revised) completion date approved or authorized by the client and the actual date of completion.

The percentage of time overrun = \( \frac{\text{Time overrun}}{\text{Estimated (revised) completion}} \times 100 \) \( \ldots \ldots (4) \)

Estimated (revised) completion

<table>
<thead>
<tr>
<th>Table 2: Summary characteristics of selected bridge projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>CATEGORY</td>
</tr>
<tr>
<td>Location</td>
</tr>
<tr>
<td>Eastern</td>
</tr>
<tr>
<td>Northern</td>
</tr>
<tr>
<td>Upper East</td>
</tr>
<tr>
<td>Brong Ahafo</td>
</tr>
<tr>
<td>Western</td>
</tr>
<tr>
<td>Time overruns (T)</td>
</tr>
<tr>
<td>T&lt; 0</td>
</tr>
<tr>
<td>0 ≤ T ≤5%</td>
</tr>
<tr>
<td>5&lt; T ≤20%</td>
</tr>
<tr>
<td>T &gt;20%</td>
</tr>
<tr>
<td>Cost overruns (C)</td>
</tr>
<tr>
<td>C&lt; 0</td>
</tr>
<tr>
<td>0 ≤ C ≤5%</td>
</tr>
<tr>
<td>5&lt; C ≤20%</td>
</tr>
<tr>
<td>C &gt;20%</td>
</tr>
<tr>
<td>Donors / Funding Type</td>
</tr>
<tr>
<td>Acrow</td>
</tr>
<tr>
<td>Dutch</td>
</tr>
<tr>
<td>Spanish</td>
</tr>
</tbody>
</table>

RESULTS AND DISCUSSION

Figure 2 shows the trend in time overrun for the period of analysis. Years 2008 and 2009 had one project each and recorded time overrun of 102.6% and 90.25% respectively. The projects completed in year 2012 experienced a relatively high percentage mean of time overrun (74.14%). Years 2013 and 2014 had percentage means of time overrun of 55.26% and 45.82% respectively (see table 3). However, there were two projects that were completed before the estimated (or revised) completion date and for such projects the time overruns were negative. One important revelation that emerges from this analysis is that the estimated duration of bridge projects are often exceeded by contractors who execute such contracts. Nevertheless, the causes or reasons for this anomaly require further investigation which would be conducted outside the scope of this paper.
Figure 2: Trend in time overrun for selected bridge projects

Table 3: Percentage of time overrun of selected bridge projects

<table>
<thead>
<tr>
<th>YEAR OF COMPLETION</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>PERCENTAGE OF TIME OVERRUN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>102.60</td>
<td>90.25%</td>
<td>14.69%</td>
<td>-0.90%</td>
<td>121.55%</td>
<td>71.53%</td>
<td>-1.33%</td>
</tr>
<tr>
<td></td>
<td>0.35%</td>
<td>111.81%</td>
<td>27.68%</td>
<td>27.58%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>220.1</td>
<td>63.19%</td>
<td>137.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>16.50%</td>
<td></td>
<td>3.70%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>90.50%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>113.70%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MEAN</td>
<td>102.60%</td>
<td>90.25%</td>
<td>7.52%</td>
<td>-0.90%</td>
<td>74.14%</td>
<td>55.26%</td>
<td>45.82%</td>
</tr>
</tbody>
</table>

Development of multiple regression models
The most important step in developing a forecasting model is the process of selecting the independent variables (Pewdum et al, 2009). The correlation matrix was therefore carried out to ascertain the existence of any linear correlation between each pair of independent (input) variables indicated in Table 1. Using the SPSS version 17, the Pearson's correlations are as shown in table 3.

The statistics in table 3 helped to identify any correlations between the independent variables to avoid multicollinearity. Multicollinearity is a situation where the correlations among the independent variables are strong. When two variables are correlated, they essentially convey the same kind of information. Table 3 therefore is useful for preventing modelling biases in using correlated variables in the same model. The analysis was performed both at 1% and 5% level of significance using the two tailed.
The analysis indicate that the variables, ‘bridge span’ and ‘weight of prefabricated bridge components’ are strongly correlated, rho (\( p \)) = 0.819 and highly significant (\( p<0.01 \)) since \( p =0.009 \). This means that these two variables cannot be included in the same model.

A similar situation can be said about the ‘haulage of aggregates’ correlated with ‘earthworks’, rho (\( p \)) = 0.574, (\( p<0.05 \)), ‘concrete’ rho (\( p \)) = 0.60, (\( p<0.01 \)) and ‘reinforcement’ rho (\( p \)) = 0.598, (\( p<0.01 \)). Further correlation was also identified for earthworks and formwork. In developing the regression model, the correlated independent variables were removed one after the other whilst observing the coefficient of determination (\( R^2 \)) and the overall p value of the multiple regression model. This was done to minimize collinearity. The independent variables that were finally selected for analysis were site clearance, concrete works, reinforcement and bridge lane type (see table 6). Fifteen (15) of the projects were used for developing model whilst the remaining three (3) was used for validation. To prevent
biases, the statistica software which was used for the development of the ANN model was employed to randomly select the projects for validation purpose.

Table 4: Summary of model predictability

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.794</td>
<td>.631</td>
<td>.484</td>
<td>208.663</td>
</tr>
</tbody>
</table>

Predictors: (Constant), SITECLEARANCE, BRIDGELANE, CONCRETE, REINFORCEMENT

Using the unstandardized coefficients from table 6, the developed regression model can be expressed as follows:

\[ T = 943.958 - 270.812 \times BL + 0.263 \times IC + 0.010 \times RFT + 0.004 \times SC \ldots \ (5) \]

Where \( T \) is duration in days, \( BL \) is the bridge lane type (single =1, double = 2), \( IC \) is the total volume of in-situ concrete and stone pitching in m\(^3\), \( RFT \) is total reinforcement in kg and \( SC \) is site clearance in m\(^2\). Since these independent variables are known before a contract is awarded and signed, the duration for a bridge project can easily be determined before commencement.

Table 4 shows the predictive ability of the developed model in equation 5. The coefficient of determination (R\(^2\)) which determines the predictive ability was 0.631 indicating that 63.1% of the variance in bridge construction is explained by the four independent variables in equation 5.

Table 5: Analysis of variance

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>744919.211</td>
<td>4</td>
<td>186229.803</td>
<td>4.277</td>
<td>.028</td>
</tr>
<tr>
<td></td>
<td>435402.789</td>
<td>10</td>
<td>43540.279</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1180322.000</td>
<td>14</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), SITECLEARANCE, BRIDGELANE, CONCRETE, REINFORCEMENT
b. Dependent Variable: ACTUAL DURATION
The analysis of variance in table 5 indicates that the overall multiple regression model in equation 5 is significant at the 5% level, \[ F (4, 10) = 4.277, p<0.028 \]. This means that construction professionals can adopt the model in forecasting the duration of bridge projects.

### Table 6: Parameter estimates for coefficients in model

<table>
<thead>
<tr>
<th>Coefficientsa</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>B</td>
<td>Std. Error</td>
</tr>
<tr>
<td>1 (Constant)</td>
<td>943.958</td>
<td>199.988</td>
</tr>
<tr>
<td>BRIDGELANE</td>
<td>-270.812</td>
<td>180.126</td>
</tr>
<tr>
<td>CONCRETE</td>
<td>.263</td>
<td>.354</td>
</tr>
<tr>
<td>REINFORCEMENT</td>
<td>.010</td>
<td>.008</td>
</tr>
<tr>
<td>SITECLEARANCE</td>
<td>.004</td>
<td>.002</td>
</tr>
</tbody>
</table>

a. Dependent Variable: ACTUAL DURATION

### Table 7: Validation of multiple regression model

<table>
<thead>
<tr>
<th>Actual duration (Days)</th>
<th>Predicted duration (Days)</th>
<th>Percentage error (B-A)/A x 100</th>
<th>C= Accuracy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>891</td>
<td>1035</td>
<td>16.189</td>
<td>83.814</td>
</tr>
<tr>
<td>771</td>
<td>839</td>
<td>8.784</td>
<td>91.216</td>
</tr>
<tr>
<td>1137</td>
<td>1282</td>
<td>12.782</td>
<td>87.218</td>
</tr>
<tr>
<td>MAPE/AV.ACCURACY</td>
<td>12.584</td>
<td>87.416</td>
<td></td>
</tr>
</tbody>
</table>

### Development of ANN model

The four variables already determined above (i.e. the site clearance, concrete; reinforcement and bridge lane) were used as the input variables. The actual durations were selected as the target or output variable. The statistica software release 7 was used for the analysis using the back propagation feed forward network. The performance of the neural network is measured by how well it predicts data that was not used during training. One major concern is the problem of overfitting/underfitting. Overfitting happens when the ANN model is too complex, have insufficient data or noisy training data whereas underfitting occurs with models that are too simple with insufficient training data (Sodikov, 2005). To resolve this problem, the eighteen bridge projects were randomly divided into three groups, 60% for training, 20% for testing the performance of the networks while under training and the remaining 20% was used for validation of the selected model to determine how well the network
predicts "new" data that was neither used to train the model nor test its performance when being trained. The percentages indicated meant that 12 projects were used for training, 3 for testing and the remaining 3 for validation. Twenty (20) different networks were trained but the best five (5) were retained for final selection. Using the automated network search (ANS) of the software, the results of the five retained multi-layer perceptron (MLP) models are shown in Table 8.

Table 8: Summary of results for retained ANN models

<table>
<thead>
<tr>
<th>Model Architecture</th>
<th>CORRELATION COEFFICIENT(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Training performance</td>
</tr>
<tr>
<td>1. MLP 4-7-1</td>
<td>0.779953</td>
</tr>
<tr>
<td>2. MLP 4-3-1</td>
<td>0.788389</td>
</tr>
<tr>
<td>3. MLP 4-16-1</td>
<td>0.799932</td>
</tr>
<tr>
<td>4. MLP 4-19-1</td>
<td>0.777335</td>
</tr>
<tr>
<td>5. MLP 4-1-1</td>
<td>0.777121</td>
</tr>
</tbody>
</table>

The forecasting performance of the model is determined using the mean absolute percentage error or the average accuracy, defined by Elhag and Boussabaine (1998) as:

Mean absolute percentage error (MAPE) = \( \frac{\sum |X_i - \hat{X}_i| \times 100\%}{N} \)  

Where \( X_i \) = actual duration  
\( \hat{X}_i \) = predicted duration  
N = number of cases.  

Average Accuracy % = 100 – MAPE .......... (7)

Clearly, from table 9, the best of the five retained ANN model for forecasting the duration of a bridge project is one which has a lower MAPE value or a higher average accuracy. Goh (2000) opines that for a model to produce accurate forecast, the MAPE = ±10%. From table 9, MLP 4-19-1 is the best among the five with a MAPE value of 7.879% or an average accuracy of 92.12%. The MAPE value of 7.879% falls well within the acceptable limit of ±10%. MLP 4-19-1 means a multi-layer perceptron of
number of inputs of 4, number of hidden units of 19 and number of output
of 1.

Table 8 shows a summary of the results of the five retained ANN models. It is evident that the models achieved better results during testing and validation stages. This may be due to the fact that the desired outputs for the test and validation data are always unknown to the models.

Table 9: Validation of ANN model

<table>
<thead>
<tr>
<th>Model Architecture</th>
<th>Actual duration (Days) - A</th>
<th>Predicted duration (Days) - B</th>
<th>Percentage error (C=(B-A)/A \times 10)</th>
<th>MAPE (%) (VALIDATION) (D=C/3)</th>
<th>Average Accuracy (%) 100 - D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. MLP 4-7-1</td>
<td>891.000</td>
<td>1017.653</td>
<td>14.215</td>
<td>13.380</td>
<td>86.62</td>
</tr>
<tr>
<td></td>
<td>771.000</td>
<td>878.993</td>
<td>14.007</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1137.000</td>
<td>1272.524</td>
<td>11.919</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. MLP 4-3-1</td>
<td>891.000</td>
<td>986.428</td>
<td>9.377</td>
<td>9.026</td>
<td>90.97</td>
</tr>
<tr>
<td></td>
<td>771.000</td>
<td>910.648</td>
<td>15.887</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1137.000</td>
<td>1160.081</td>
<td>1.814</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. MLP 4-16-1</td>
<td>891.000</td>
<td>968.2383</td>
<td>7.835</td>
<td>7.950</td>
<td>92.05</td>
</tr>
<tr>
<td></td>
<td>771.000</td>
<td>859.773</td>
<td>9.748</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1137.000</td>
<td>1209.714</td>
<td>6.268</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. MLP 4-19-1</td>
<td>891.000</td>
<td>966.837</td>
<td>7.832</td>
<td>7.879</td>
<td>92.12</td>
</tr>
<tr>
<td></td>
<td>771.000</td>
<td>853.979</td>
<td>9.651</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1137.000</td>
<td>1211.448</td>
<td>6.154</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. MLP 4-1-1</td>
<td>891.000</td>
<td>1016.106</td>
<td>12.940</td>
<td>12.451</td>
<td>87.55</td>
</tr>
<tr>
<td></td>
<td>771.000</td>
<td>895.785</td>
<td>14.612</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1137.000</td>
<td>1255.748</td>
<td>9.802</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Comparison of ANN and multiple regression models

Table 10 compares the performance of the ANN and the multiple regression models. The ANN model produces a better result (MAPE 7.88%) than the multiple regression model (12.58%) during the validation stage. This is because of the robustness of the developed network and good learning capability. This result corroborates the findings of Petruseva et al (2013) who also found the ANN model to be superior over the regression models.

Table 10: Comparison performance of ANN and multiple regression models

<table>
<thead>
<tr>
<th>MODEL</th>
<th>MAPE (%)</th>
<th>Accuracy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANN</td>
<td>7.88</td>
<td>92.12</td>
</tr>
<tr>
<td>Multiple regression</td>
<td>12.58</td>
<td>87.42</td>
</tr>
</tbody>
</table>
LIMITATION OF STUDY
Apart from the fact that the sample size was small, the duration of a construction project is affected by several factors apart from the quantities used in the BOQ. Kumaraswamy and Chan (1995) derived a hierarchy of factors that can affect the duration of construction projects, some of which are contextual and organizational factors. This study does not incorporate the implications of other likely factors that can influence the total time required for the completion of a bridge construction projects.

CONCLUSION
This paper has developed both multiple and ANN models for forecasting the duration of bridge projects using executed quantities in BOQs. The research has shown that the developed regression and ANN models are useful for predicting the duration for bridge projects by construction professionals. The models provide an alternative means for construction professionals at the department to estimate construction project duration to supplement those based on an individual quantity surveyor’s or engineer’s experience. The study has also shown that ANN model is superior to multiple regression models. It is expected that construction professionals in Ghana would utilize the developed model in fixing the duration of bridge projects. The application of the model would help reduce time overruns as well as the payment of liquidated and ascertained damages by contractors for late completion.

The developed network is saved in the statistica software and can be deployed when construction professionals need to apply the developed network to new data in order to forecast duration of a bridge project. However, they would need to be conversant with the use of the statistica software.

REFERENCES


Singh Y. and Chauhan A.S (2009), Neural Networks in Data Mining. Journal of Theoretical and Applied Information Technology pp 34 -42.


FRAMEWORK FOR ASSESSING THE EFFECTIVENESS OF COMPETITIVE TENDERING PROCESS FOR WORKS PROCUREMENT AT PRE-CONTRACT STAGE IN CHAD REPUBLIC

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Department of Building, KNUST, Kumasi, Ghana

The paper presents a developed framework for assessing the overall effectiveness of Competitive Tendering Process in the award of public works contract in Chad. The adopted method is quantitative strategy using questionnaire. Respondents were asked to pair-wise compare phases, criteria and indicators established by previous studies using a simplified Analytic Hierarchy Process scale of 5 points. Then, relative and composite weights of all identified variables were computed. Based on these findings, a framework is developed following an adapted AHP methodology involving nine steps including a scoring system. The assessment process begins with the assessment of elementary effectiveness at each phase level and end at the overall effectiveness assessment of the whole competitive tendering process. After its validation by an expert group, the developed framework is an appropriate management tool that helps public contracting authorities to assess the effectiveness of every project at pre-contract phase. Its implementation will generate a substantial improvement of the performance of Competitive Tendering Process elsewhere. In addition, the study demonstrated the practical application of AHP in the evaluation of the overall performance in public works procurement. Authors believed that this framework will be adopted by the construction projects managers and recommend its computerization for easy usage.

Keywords: Analytical Hierarchy Process, Chad, competitive tendering process, effectiveness assessment framework, works procurement

INTRODUCTION

In Chad as well as in the majority of developing countries, Design-Bid-Build (DBB) method using Competitive Tendering (CT) is predominately used for public works procurement in compliance with the Public Procurement Act 2003 (Act 503). But, many contracts fail to meet

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government expectations (abandoned sites or doubtful works quality) due to poor performance of tendering procedures (CCSRP, 2009). As a result, more than 70% of loose of time and cost during construction phase were attributed to <biased> award of contracts (CCSRP, 2009). In addition, when analysing the causes of delay in construction project delivery through Open Competitive Tendering in Chad, Patrice (2008) identified up to 49 steps prescribed by the Act 503 and related regulations and procedures. It appears then clear that such very long process is responsible of excessive delays in contract award, hence project delivery. Furthermore, massive use of negotiations than competition (52%), award of many contracts (3 to 8 a year) to incapable contractors or to a single contractor, projects’ overprices (40%), are constantly reported as poor results of CT implementation in Chad (OCMP, 2008; CSCRP, 2006 to 2009). Consequently, the ineffectiveness of CT is identified as one of main concerns in public works procurement in Chad (Patrice, 2008).

However, as states Richard (2006), effectiveness assessment provides decision makers feedback on the impact of deliberate actions and affect critical issues such as allocation of scarce resources, as well as whether to maintain or change existing strategy. Besides, effectiveness assessment of the achievements of CT process prior to the approval of contract will certainly mitigate negative effects and abuses mentioned above. Not only that, US National Performance Review (2007), claims that the effectiveness of tendering process impacts directly on the value for money and also, the implementation of performance evaluation stimulates the systemic documentation of every stage of the process. Again, the evaluation of the tendering process effectiveness is identified as one of success factors in public procurement in Chad by Patrice (2008). At last, according to Patrick (2011), there is still a knowledge gap on how the procurement process can contribute to improved performance of the procurement function in developing countries.

From the foregoing and owing to various advantages offered by CT method, any improvement in effective implementation of CT Process (CTP) is therefore welcomed in developing countries. In addition, developing a tool that helps public contracting authorities to assess the effectiveness of every project at pre-contract phase will result in a substantial improvement of the performance of CTP. Thus, the local construction industry will further benefit from it. In an attempt to make progress in this regard, the following objectives were set: (1) To appraise Major Challenges facing the implementation of CT Method; (2) To define a Baseline of Standard Practices for an effective CTP; (3) To identify Relevant Criteria that influence the Effectiveness of CTP; (4) To establish Key Measureable Indicators for assessing the Effectiveness of CTP; (5) To determine the Contributions of critical phases of CTP at the pre-contract stage; and (6) To develop a Framework for Assessing the Effectiveness of CTP in Chad. However, the specific objective of the paper is to present the developed framework.
BACKGROUND

In developing economies, it is clearly established that the contribution of Public Procurement (PP) to GDP is very important and varies between 15 to 25% (Tano, 2009; OECD, 2010). And the most important and broadly accepted principle underlying any PP system is open competition (UNDP, 2004). Consequently, CT is widely recognized as an attractive procurement mechanism and is commonly advocated by international organizations like World Bank (WB), European Union (EU), African Development Bank (AfBD), and the Organization for Economic Co-operation and Development (OECD). As a result, the majority of developing countries prescribed CT as the prime method of public procurement due to its widespread benefits. These include promoting competition and hampering corruption (Steven and Patrick, 2006), reducing cost by broadly 20% (Simon et al., 2005) and providing the enabling environment for effective utilization of scarce resources in the economy (Dikko, 2000). Furthermore, an effective system is characterized by the degree to which its output conforms to the predetermined requirements. Richard (2006) added that a Measure of Effectiveness (MOE) concerns how well a system tracks against its purpose or normative behavior. Though effectiveness reflects the quality of the actual result compared to the expected one (CINTERFOR/ILO, 2007), it also determines if the right things are being done and can be considered invariant to means of achievement (Richard, 2006). Besides, Oladapo (2000) among others asserted that an effective CTP has to be open, transparent, fair, timely and cost effective and comply with rules, regulations and procedures. So, if these effectiveness attributes are assessed earlier prior to the award of contract, the results can help the final decision making in mitigating the risk associated.

Although CT appears to be the most acceptable method of selecting contractors in the world (Akubueze, 2000) and the most beneficial to local construction industries (Oladapo, 2000), its implementation has been the most difficult in developing countries (Dikko, 2000). Despite the profound reforms of the Public Procurement Policies, Acts, Regulations and Procedures, effected at the beginning of 2000s in many developing countries with the aid and support of WB and OECD, public procurement practices remain still questionable (OECD, 2010). In fact, CT does not benefit fully to developing countries as expected (WB, 2010) due to following challenges: excessive delay, massive violation of laws and regulations, weak institutions and structures, poor performance of personnel, generalized fraud and corruption practices, and above all the lack of good performance management (Douh, 2013; Collins et al, 2011; Patrice, 2008). Therefore, developing a framework for assessing the effectiveness of Competitive Tendering Process (CTP) may be a starting point of the improvement of public procurement performance in any developing country.

To develop the intended framework, a conceptual framework grounded on a multi-criteria effectiveness assessment approach is adopted. According to this concept, assessing the effectiveness requires the definition of a baseline of standard practices as reference plan, the determination of
relevant criteria and subsequent key measurable indicators, the setting of corresponding target values, and then, the collection of data to generate measures which will be compared to target values to get the actual effectiveness; the resulting aggregate value indicates the level of effectiveness. Indeed, the quantification of the performance expression can be viewed as a procedure which, in a first step quantifies the elementary performances, the second step then consists in their synthesis in an overall performance thanks to aggregation operator (Berrah et al., 2004 and Clivillé, 2004). When elementary effectiveness as well the overall effectiveness are high, the process is effective whereas when they are low, remedy actions have to be taken for improvement and the process restarts. Based on this theoretical framework, literature review has revealed that competitive tendering process comprises five following critical phases: tender planning, tender documentation, tender solicitation, tender evaluation and pre-award. Along with these phases, a reference plan or baseline including 38 standard common practices of CTP in developing countries is defined. Then, previous studies of the author (Douh, 2014) have established seven relevant criteria and 13 Key Measurable Indicators (KMI). These criteria are Fairness & Equity, Competitiveness, Compliance to laws and regulations and Conformity to rules & procedures, Transparency & public Accountability, Ethics (Integrity and Confidentiality), Time Effectiveness, and Cost Effectiveness are identified. And indicators are as follows in order of importance: Time for tender preparation, Time for tender preparation, Time for tender preparation, Applied Rate of Margin of Preference, Number & Nationalities of Bidders, Degree of Competitiveness, Advertisement total duration, Publicity frequency, Publicity extent, Time Performance Index, Cost Estimate Accuracy, Approvals Compliance Rate, Documentation Compliance Rate, Capacity Qualification Ratio, and Number of complaints or requests generated. Lastly, the table in appendix 1 describes these key indicators and their relative target values that will be used in assessing the effectiveness.

**METHOD**

The study adopted quantitative approach with questionnaire as data collection instrument. The questionnaire was designed using Analytic Hierarchy Process (AHP) approach (Saaty 1990) and was pre-tested and reviewed before final data collection. Respondents are asked to pair-wise compare the identified variables using the following simplified AHP scale of 5 points: 1 = Equal importance, 3 = Moderate importance, 5 = Strong importance, 7 = Very strong, and 9 = Extreme Importance. The targeted population comprises 60 structures including public procurement entities, consulting firms, contractors, and sponsors. The total population was considered as sample. Of the 60 questionnaires administered, 38 valid completed questionnaires were returned representing 63.32%. The majority of respondents (60.52%) are construction professionals holding
either Bachelor in Science degree (15.80%) or Master degree (84.20%). This means that the results represent the opinion of high qualified construction professionals. Not only that, respondents with more than 10 years of experience in the public works procurement practices have scored 71.05 %, indicating that the results represent the point of view of experienced construction professionals. Moreover, the Consistency Ratios (CR) varying from 0.00 to 0.055 (< to 0.10) are indicating that respondents were very consistent with their rating and results can be considered valid. Finally, the developed framework was validated by an expert group with 75% of respondents strongly agree on the relevance of the framework.

DEVELOPED FRAMEWORK

In short, the development of the framework went through nine following steps: Establishment of specific goal & objectives as well as the baseline (Step-1), Identification of relevant criteria and key related measurable indicators and corresponding target values (Step-2), Construction of AHP Hierarchies (Step-3), Collection of pair-wise comparisons from experts and Verification of the Consistency of respondents (Step-4), Computation of Geometric Means of the consistent ratings and construction of a single pair-wise comparison matrix (Step-5), Computation of weights of Phases, Criteria & Indicators, and also Lambda max, Consistency Index (CI) and Consistency Ratio (CR) for results testing (Step-6), Computation of Composite Weights and Ranking of Key Indicators (Step-7), Calculation of Elementary Effectiveness at each phase (Step-8), and Calculation of the Overall effectiveness of the whole CTP for the contract award (Step-9). As a result, a graphical representation is proposed in Figure 1 in the next page to facilitate the understanding.

As illustrated, the developed framework is divided into six main components: Five components corresponding to the five phases including each of the following elements: input and expected output, critical points and issues to look at, standard practices to follow, useful data and documents to provide, specific key indicators to use; and finally the table of assessment of Elementary Effectiveness (ei). The last sheet summarises the overall effectiveness assessment including the final decision of the contracting authority.

The Assessment process involves eight following activities: Examine the quality of the input under assessment, Find out if the critical points and issues are properly addressed, Check the conformity of performed practices to standard practices required, Get the actual measures through analysis of collected documents & data on the process, Compare actual measures to target values and use the differences to score the performance of each indicator using the scoring system below. Get the actual weighted effectiveness value by multiplying the performance value by the weight of the indicator, Get the elementary effectiveness (ei) by summing up the individual indicators weighted values and divide it by the sum of their
weights, and Get the Overall Effectiveness \((E)\) by summing up the five elementary effectiveness values.

\[
E = \text{OVERALL EFFECTIVENESS}
\]

The adopted scoring system uses the AHP scale of 0 to 9 corresponding to the following qualitative appreciations in Table 1 below. It is important to note that figures in the above table are an indication and therefore must be handled with flexibility. For example, when the actual measure of the indicator equals to or better than the target value, the score is 9. When the actual measure is less than the target value, the proportionate scale or ‘pro rata’ needs to be applied to achieve the mark. Ultimately, latitude is given to the assessor to appreciate and mark according to his conviction.

Table 1: Indication of scoring or marking system

<table>
<thead>
<tr>
<th>Qualitative appreciation</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perfect</td>
<td>8.0 – 9.0</td>
</tr>
<tr>
<td>Excellent</td>
<td>7.0 – 7.9</td>
</tr>
<tr>
<td>Very good</td>
<td>6.0 – 6.9</td>
</tr>
<tr>
<td>Good or acceptable</td>
<td>5.0 – 5.9</td>
</tr>
<tr>
<td>Fair</td>
<td>4.5 – 4.9</td>
</tr>
<tr>
<td>Not acceptable</td>
<td>2.5 – 4.4</td>
</tr>
<tr>
<td>Nil or worthless</td>
<td>0.0 – 2.4</td>
</tr>
</tbody>
</table>
The value nine (9) may be considered as target value that has to be attained by every project through an effective tendering process. Indeed, target values are most often provided in laws and regulations of every country. As such, they may vary strongly with the nature and objectives and the surrounding context in which the project is planned. Some target values are explicit (e.g. time) whereas others are implicit or interpreted or simply inferred (e.g. % of savings). Values displayed in Appendix 1 are extracted from Chadian context. In effect, from Table 1 above, the figure 6 corresponds to very good; that is why, when elementary effectiveness (ei) is < 6, the process has to be re-done. if ei ≥ 6, the process continues to the next phase. When overall effectiveness E is < 6, the whole CTP process is to be cancelled; if E ≥ 6 the contract is awarded to the winner. Lastly, when data are not available or missed or even unreliable, the assessor has to judge and score based on his experience.

The elementary effectiveness assessment follows 3 steps. First, compare collected data to target value and score the actual measure of the Indicator accordingly. Second, the actual measure of an indicator is multiply by its weight to get a weighted value of considered indicator. Third, the sum of weighted values is divided by the sum of indicator’s weights to give the score of the elementary effectiveness. The assessment of the overall effectiveness (E) follows also 2 steps. First, the actual measure of elementary effectiveness is multiply by its weight to get a weighted value of the considered phase. Second, the sum of the weighted ei values gives the Overall Effectiveness. To back up the description of the developed framework, an example is given in appendix 2 to demonstrate its practical application.

RESULTS AND DISCUSSION

According to Patrick (2010), procurement performance in construction sector has been attracting great attention from practitioners, academicians and researchers since 1930. As a result, many instruments were developed including Prior-approval or Non-objection mechanisms, Internal control, Independent or External audit, Pre-award risk analysis, Pre-award survey, Pre-contract Effectiveness Audit, Public Procurement Model of Excellence (PPME), and Country Procurement Assessment Report (CPAR) etc. (Adjei, 2012; Agbesi, 2009; UNICITRAL, 2004). In this paper, only three groups of them are briefly discussed.

First, the Construction Industry Development Board – CIDB (2006), describes Pre-award risks analysis as a means of assessing all risks involved in awarding the contract to a particular bid winner; and then, conclusions are inserted in the evaluation report to inform the final decision. Whereas, Pre-award survey is required only when information on hand or readily available to the contracting authority including information from commercial sources, is not sufficient to make a beneficial decision or when a contract administration office becomes aware of a prospective award to a contractor about which unfavorable information
exists or when the prospective contractor is debarred, suspended, or ineligible (US/GAO, 1987; RPPA, 2010). Pre-award survey is also used casually as a verification means whose output can disgrace or credit a contractor alone and fails to assess the procurement institutions and processes. Another means for evaluating a prospective contractor’s proposed rates and related internal cost structure before actually agreeing and signing the subsequent contract is the **Pre-contract Effectiveness Audit** (Moro, 2011; US/GAO, 2009; Matthew, 2012; CCCA, 2012). Its implementation in USA and Ghana has saved about 20% of initial bid price (Moro, 2011; Agbesi, 2009). But, like an audit, it is solely focused on cost criterion and the output may disgrace or credit a contractor alone. Also, pre-contract effectiveness audit fails to assess the procurement institutions and processes. Therefore, it does not fit for assessing the effectiveness as proposed by the present study as well as the pre-award risk analysis and pre-award survey.

Secondly, **Public Procurement Model of Excellence (PPME)** is a software tool developed by OECD since 2002 to facilitate the collection of data in order to measure the quality of procurement system at the level of procurement entity. Its objectives are: (i) to help in the implementation of a change process to improve procurement at entity, regional & national levels; (ii) to provide objective information for assessing the conformity of the procurement process to the requirements; (iii) to evaluate performance of procurement at various levels and provide recommendations to improve the process; (iv) to lead to the certification of the procurement entities within the country. PPME uses 80 key performance criteria and provides two reports: an assessment report on the performance of a particular entity and a comparative assessment results reports Adjei, (2005). According to Agbesi (2009), the software was piloted in Ghana in 2006 and has been used to assess more than 200 entities. And so far, results show significant progress in the performance of public procurement as well as the impact of the Act 663 admitted Adjei, (2010) and Frimpong et al., (2013). Besides that, it has the merits of achieving the assigned objectives by providing managers at all levels with both an analytical tool to compare results and a list of recommendations to improve performance asserted Adjei, (2010). Though PPME exhibits features that comply with the concept of performance measurement system and even covers tendering processes at pre and post-contract stage, it however fails to tell the level of Effectiveness attained by a particular contract even if it is effectively processed. Another weakness is that PPME uses results measures and therefore lagging indicators. Not only that, it is goal centred (focus on entities) rather than process centred. Therefore, it is significantly different from the developed framework.

Thirdly, **Country Procurement Assessment Report (CPAR)** is an analytical tool designed under the auspices of WB, OECD and UNICITRAL in 1990s and is used to diagnose a particular country’s procurement system in order to generate a dialogue with the government. The CPAR stands on four pillars: legal framework, institutional
framework and capacity, procurement operations and practices, and integrity of the procurement system (OECD, 2004). It uses 12 indicators and 54 sub-indicators distributed into two main components: Base-Line Indicators (BLIs) and Compliance & Performance Indicators (CPIs). The outputs of CPAR are essentially two tables and the adopted scoring system uses a scale of 0 to 3. With times, CPAR has become an important requirement before committing to lending and it has the merits of being worldwide accepted and applied (Rogati et al., 2004). Its methodology is regularly reviewed and complies perfectly with the performance measurement concept and principles. However, as there are no agreed International Procurement Performance System that can be applied equally to all countries, the CPAR is limited to a short term objective that is to find out the degree to which the country procurement system is following its own regulations. Besides, the perception of compliance (especially where the indicator cannot be measured quantitatively) differs from one country to another as demonstrated by Sanchez et al. (2009), who also assert that indicators alone cannot give a full picture of a whole procurement system that is by its nature complex. Indeed, some indicators are not amenable to hard measurement in terms of facts and figures and assessing their performance is better accomplished through surveys or interviews with participants in the systems such as professional associations, civil society representatives, independent experts, and government officials (Sanchez et al., 2009). Another issue is that reliable data may not be available in public administrations to the extent asked for in order to satisfy all the 54 compliance & performance indicators. Again, after data collection, validating the results to arrive at the “right score” remains another challenge to face. Not only that, the implementation of a CPAR demands a lot of financial and human resources and more often, it is undertaken with exterior financial and capacity supports. Lastly, recommendations made are rarely implemented and always every CPAR implementation is like a re-starting exercise. Therefore, CPAR is once again different from the proposed framework and does not fit for the overall effectiveness assessment.

In short, the review above has shown that governments are using various but sectorial assessment tools with more or less satisfactory results. Although, it has been proven that some tools are yielding financial benefits despite some weaknesses or limitations; yet some shortcomings have been identified. In addition, the plethoric number of indicators and sub-indicators does not facilitate their understanding and adoption in the field. Furthermore, there is still a constant need for more effective control instruments, reporting mechanisms, investigation methods and best practices as far as PP is concerned argued Patrick, (2010) and Cornela et al., (2011). Of course, none of these tools is formally adopted for assessing systematically the overall Effectiveness of tendering operations at every procuring entity level for every individual construction project. Certainly, the developed framework is a management tool for evaluating the overall effectiveness of CTP that informs Contracting authorities to decide
objectively when awarding contract; and it can be implemented in Chad and other developing countries.

CONCLUSION
The literature review has shown that governments are using various means with more or less satisfactory results. Although some are yielding financial benefits despite their weaknesses and limitations, none of them is formally adopted for assessing systematically the overall Effectiveness of tendering operations at every procuring entity level for every individual construction project. Therefore, the developed framework has filled that gap and has the merit of using multiple criteria in assessing the overall effectiveness. The demonstrative application example shows its successful implementation as well as its utility. Not only that, the developed framework bridged a knowledge gap revealed by the literature review. For further research, the study made the following recommendations: (1) its implementation in the real world for validation; (2) its computerization for easy usage, (3) development of usage manuals for End users, Assessors and Contracting Authorities.

REFERENCES


OCMP (Organe Chargé des Marchés Publics), 2008, Rapport annuel des Activités, N'Djaména, Tchad


Republic of Ghana, 2003, Public Procurement Act - Act 663, Ghana


### APPENDIX 1:

**Table 2: Key Measurable Indicators with Target values**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Indicator’s designation</th>
<th>Brief description of Indicator</th>
<th>Formula / Expression</th>
<th>Unit</th>
<th>Target values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Time for tender preparation</td>
<td>Is the actual time the last tenderer get for bid preparation</td>
<td>(Date of bids submission – Date of last tender documents sold) ; In days</td>
<td>≥ 45 days</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Advertisement total duration</td>
<td>Actual duration of the tender announcements</td>
<td>(Date of last announcement – Date of first announcement); In days</td>
<td>≥ 15 days</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Number &amp; Nationalities of Bidders</td>
<td>Combined Number of national bidders and Foreign bidders</td>
<td>(National Bidders + Foreign Bidders) / 2 ; Numerical number</td>
<td>≥ 5</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Publicity frequency</td>
<td>Frequency of advert diffusions/publication in a week</td>
<td>How many times the advert was published in a week; Numerical number</td>
<td>≥ 2 times</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Time Performance Index</td>
<td>Is the actual ratio of the time performance and time allocated for the phase</td>
<td>(Time performed / Time allocated) ; Numerical number</td>
<td>≤ 1</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Number of complaints or requests generated</td>
<td>Expresses a sort of bidders’ satisfaction</td>
<td>Number of formal complaints or requests for clarification registered; Numerical number</td>
<td>= 0</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Cost Estimate Accuracy</td>
<td>Is the actual variations of estimates as compared to initial budget</td>
<td>[(Initial Budget – Actual Estimate)/Initial budget]x100; In percentage</td>
<td>&gt; 0 and &lt; 15%</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Publicity extent</td>
<td>Number of different media used for advertisement</td>
<td>Number of News-paper, radio, TV, Internet, Numerical number</td>
<td>≥ 3 media</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Approvals Compliance Rate</td>
<td>Is the actual ratio of required approvals and performed approvals along the process</td>
<td>(Approvals performed / Approvals required) x 100; In percentage</td>
<td>= 100%</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Degree of Competitiveness</td>
<td>Expresses variations among of bids’ prices</td>
<td>[(High bid - Low bid) / Winner Bid] x 100); In Percentage</td>
<td>≤ 10%</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Documentation Compliance Rate</td>
<td>Is the actual ratio of the total number of documents required &amp; recorded and provided along the process</td>
<td>(Recorded Proceedings provided / proceedings required) x 100 ; In Percentage</td>
<td>= 100%</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Applied Rate of Margin of Preference</td>
<td>Actual rate used for that particular project as compared to the prescribed Margin of Preference</td>
<td>Applied fraction of the prescribed Margin of Preference; In Percentage</td>
<td>≤ 10 %</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Capacity Qualification Ratio</td>
<td>The level of Capacity qualification (appropriate profiles via CVs)</td>
<td>(Qualified members / Non-qualified members) ; Numerical number</td>
<td>≥ 1</td>
<td></td>
</tr>
</tbody>
</table>
### APPENDIX 2: EXAMPLE OF APPLICATION

#### Tender Planning

<table>
<thead>
<tr>
<th>Measurable Indicators</th>
<th>Target Values</th>
<th>Actual measures</th>
<th>Assess. Score(X)</th>
<th>Weight (Ki)</th>
<th>Actual Values (X*Ki)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Time Performance Index</td>
<td>≤ 100%</td>
<td>120%</td>
<td>5</td>
<td>0.077</td>
<td>0.385</td>
</tr>
<tr>
<td>2. Cost Estimate Accuracy</td>
<td>≤ 100%</td>
<td>90%</td>
<td>8</td>
<td>0.065</td>
<td>0.520</td>
</tr>
<tr>
<td>3. Publicity extent</td>
<td>≥ 3</td>
<td>2</td>
<td>7</td>
<td>0.059</td>
<td>0.413</td>
</tr>
<tr>
<td>4. Number of approvals and controls performed</td>
<td>= 100%</td>
<td>100%</td>
<td>9</td>
<td>0.051</td>
<td>0.459</td>
</tr>
<tr>
<td>5. Documentation Rate</td>
<td>= 100%</td>
<td>50%</td>
<td>4</td>
<td>0.037</td>
<td>0.148</td>
</tr>
<tr>
<td>6. Capacity Qualification ratio (Project team)</td>
<td>= 100%</td>
<td>30%</td>
<td>3</td>
<td>0.013</td>
<td>0.039</td>
</tr>
<tr>
<td>Sum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.302 1.964</td>
</tr>
</tbody>
</table>

Elementary Effectiveness at phase 1 (e1) = 1.964 / 0.302 = 6.503

#### Tender Documents

<table>
<thead>
<tr>
<th>Measurable Indicators</th>
<th>Target Values</th>
<th>Actual measures</th>
<th>Assess. Score (X)</th>
<th>Weight (Ki)</th>
<th>Actual Values (X*Ki)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Time Performance Index</td>
<td>≤ 100%</td>
<td>90%</td>
<td>9</td>
<td>0.077</td>
<td>0.693</td>
</tr>
<tr>
<td>2. Cost Estimate Accuracy</td>
<td>≤ 100%</td>
<td>80%</td>
<td>6</td>
<td>0.065</td>
<td>0.390</td>
</tr>
<tr>
<td>3. Number of approvals and controls performed</td>
<td>= 100%</td>
<td>100%</td>
<td>9</td>
<td>0.051</td>
<td>0.459</td>
</tr>
<tr>
<td>4. Documentation Rate</td>
<td>= 100%</td>
<td>80%</td>
<td>7</td>
<td>0.037</td>
<td>0.259</td>
</tr>
<tr>
<td>5. Capacity Qualification ratio (Tender commit.)</td>
<td>= 100%</td>
<td>25%</td>
<td>3</td>
<td>0.013</td>
<td>0.039</td>
</tr>
<tr>
<td>Sum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.243 1.840</td>
</tr>
</tbody>
</table>

Elementary Effectiveness at phase 2 (e2) = 1.840 / 0.243 = 7.572

#### Tender Solicitation

<table>
<thead>
<tr>
<th>Measurable Indicators</th>
<th>Target Values</th>
<th>Actual measures</th>
<th>Assess. Score (X)</th>
<th>Weight (Ki)</th>
<th>Actual Values (X*Ki)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Time Performance Index</td>
<td>≤ 100%</td>
<td>115%</td>
<td>6</td>
<td>0.077</td>
<td>0.462</td>
</tr>
<tr>
<td>2. Advertisement total duration</td>
<td>≥ 21 days</td>
<td>22 days</td>
<td>9</td>
<td>0.148</td>
<td>1.332</td>
</tr>
<tr>
<td>3. Publicity Extent</td>
<td>≥ 3</td>
<td>4</td>
<td>9</td>
<td>0.059</td>
<td>0.531</td>
</tr>
<tr>
<td>4. Publicity frequency</td>
<td>≥ 3</td>
<td>2</td>
<td>7</td>
<td>0.085</td>
<td>0.595</td>
</tr>
<tr>
<td>5. Number of requests of clarifications</td>
<td>= 0</td>
<td>2</td>
<td>7.5</td>
<td>0.073</td>
<td>0.548</td>
</tr>
<tr>
<td>6. Time allocated for tender preparation</td>
<td>≥ 60 days</td>
<td>75 days</td>
<td>9</td>
<td>0.169</td>
<td>1.521</td>
</tr>
<tr>
<td>Sum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.611 3.468</td>
</tr>
</tbody>
</table>

Elementary Effectiveness at phase 3 (e3) = 3.468 / 0.611 = 8.165
# Tender Evaluation

<table>
<thead>
<tr>
<th>Measurable Indicators</th>
<th>Target Values</th>
<th>Actual measures</th>
<th>Assess. Score (X)</th>
<th>Weights (Ki)</th>
<th>Actual Values (X*Ki)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Number and Nationalities of Bidders</td>
<td>≥ 5</td>
<td>4</td>
<td>8</td>
<td>0.145</td>
<td>1.160</td>
</tr>
<tr>
<td>2. Time Performance Index</td>
<td>≤ 100%</td>
<td>75%</td>
<td>9</td>
<td>0.077</td>
<td>0.693</td>
</tr>
<tr>
<td>3. Cost Estimate Accuracy</td>
<td>≤ 100%</td>
<td>95%</td>
<td>8.5</td>
<td>0.065</td>
<td>0.552</td>
</tr>
<tr>
<td>4. Degree of Competitiveness</td>
<td>≥ 100%</td>
<td>96%</td>
<td>8</td>
<td>0.044</td>
<td>0.352</td>
</tr>
<tr>
<td>5. Applied Rate of Margin of Preference</td>
<td>≤ 10%</td>
<td>0%</td>
<td>9</td>
<td>0.034</td>
<td>0.306</td>
</tr>
<tr>
<td>6. Capacity Qualification Ratio</td>
<td>≥ 100%</td>
<td>15%</td>
<td>2</td>
<td>0.013</td>
<td>0.026</td>
</tr>
<tr>
<td>7. Documentation Rate</td>
<td>≥ 100%</td>
<td>100%</td>
<td>9</td>
<td>0.037</td>
<td>0.333</td>
</tr>
<tr>
<td><strong>Sum</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>0.415</strong></td>
<td>3.422</td>
</tr>
<tr>
<td>Elementary Effectiveness at phase 4 (e4)</td>
<td>= 3.422 / 0.415 =</td>
<td></td>
<td></td>
<td><strong>8.246</strong></td>
<td></td>
</tr>
</tbody>
</table>

# Tender Pre-Award

<table>
<thead>
<tr>
<th>Measurable Indicators</th>
<th>Target Value</th>
<th>Actual measures</th>
<th>Assess. Score (X)</th>
<th>Weights (Ki)</th>
<th>Actual Values (X*Ki)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Time Performance Index</td>
<td>≤ 100%</td>
<td>98%</td>
<td>7.5</td>
<td>0.077</td>
<td>0.578</td>
</tr>
<tr>
<td>2. Number of complaints or litigations generated</td>
<td>= 0</td>
<td>2</td>
<td>7.5</td>
<td>0.073</td>
<td>0.548</td>
</tr>
<tr>
<td>3. Cost Estimate Accuracy</td>
<td>≤ 100%</td>
<td>90%</td>
<td>8</td>
<td>0.065</td>
<td>0.520</td>
</tr>
<tr>
<td>4. Publicity extent</td>
<td>≥ 3</td>
<td>2</td>
<td>7.5</td>
<td>0.059</td>
<td>0.442</td>
</tr>
<tr>
<td>5. Approvals Compliance Rate</td>
<td>≥ 100%</td>
<td>75%</td>
<td>7</td>
<td>0.051</td>
<td>0.357</td>
</tr>
<tr>
<td>6. Documentation Compliance Rate</td>
<td>≥ 100%</td>
<td>75%</td>
<td>6</td>
<td>0.037</td>
<td>0.222</td>
</tr>
<tr>
<td>7. Capacity Qualification Ratio (Award commi.)</td>
<td>≥ 100%</td>
<td>50%</td>
<td>6</td>
<td>0.013</td>
<td>0.078</td>
</tr>
<tr>
<td><strong>Sum</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>0.316</strong></td>
<td>2.745</td>
</tr>
<tr>
<td>Elementary Effectiveness at phase 5 (e5)</td>
<td>= 2.745 / 0.316 =</td>
<td></td>
<td></td>
<td><strong>8.687</strong></td>
<td></td>
</tr>
</tbody>
</table>

# Overall Effectiveness Assessment

<table>
<thead>
<tr>
<th>Main Phases</th>
<th>Elementary Effectivenesses (X)</th>
<th>Weights (Kp)</th>
<th>Actual Values (X*Kp)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Tender Planning</td>
<td>6.503</td>
<td>0.363</td>
<td>2.360</td>
</tr>
<tr>
<td>2. Tender Documentation</td>
<td>7.572</td>
<td>0.261</td>
<td>1.976</td>
</tr>
<tr>
<td>3. Tender Solicitation</td>
<td>8.165</td>
<td>0.161</td>
<td>1.314</td>
</tr>
<tr>
<td>4. Tender Evaluation</td>
<td>8.246</td>
<td>0.137</td>
<td>1.130</td>
</tr>
<tr>
<td>5. Tender Pre-Award</td>
<td>8.687</td>
<td>0.079</td>
<td>0.686</td>
</tr>
<tr>
<td><strong>Sum</strong></td>
<td></td>
<td>1.000</td>
<td>7.466</td>
</tr>
<tr>
<td>Overall Effectiveness E = 7.466 / 1.000 =</td>
<td>7.466</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Briefly, according to our scoring system, all the calculated eis are over 6 hence are very good and $E$ is 7.466 meaning that the Effectiveness level is $7.466 / 9 = 0.823$ or 82.3 % which is Excellent. So, the contract is awarded to the recommended winner.
FREECAD: EFFICACY OF ARCH MODULE FOR AUTHORING ARCHITECTURAL CONTENT IN A BIM PROCESS USING OPEN-SOURCE SOFTWARE

Onyeibo Oku¹ and Augustine Nwagbara²
¹,²Department of Architecture, Faculty of Environmental Sciences, Enugu State University of Science and Technology, Enugu, Nigeria

Young firms in the Architecture, Engineering and Construction (AEC) business have had to contend with stringent licensing policies and challenging financial commitments when acquiring software tools. Architects in emerging economies may be able to circumvent these restrictions by using open-source alternatives that implement open industry standards. In recent years, increasing numbers of architects prefer design tools that can integrate seamlessly into a Building Information Modelling (BIM) process to traditional CAD applications. The Arch Module in FreeCAD aims to be a plausible BIM tool for architects. It is free (gratis), and its source is available under the GNU Lesser General Public License (LGPL). This study sought to forecast the quality of this promise given the current direction of its development. The study employed normative case study methodology, in qualitative research design, to deduce qualities of BIM software that are deemed to be desirable. Deductions were made from the comparative analysis of a conservative number of selected proprietary like-products – the combination of exemplars – from which hypotheses were developed towards the resolution of the research aim. The resultant postulations should inspire further studies and refinements for improving the case product (Arch Module).

Keywords: Arch Module, BIM, FreeCAD, IFC, open-source

INTRODUCTION

FreeCAD is turning out to be to be the most appropriate open-source tools for architects wishing to participate in a BIM process while working on machines running the Linux OS. Like Blender³, FreeCAD is a cross-platform application with a robust C++/Python Application Programming Interface (API). However, it is more of a parametric modeller than a complex mesh object and multimedia editor. Its ability to generate and regenerate geometry using user-adjustable vector attributes (or base projects) is the preferred behaviour for BIM tools. The FreeCAD software takes the form of a pluggable framework. It ships with some plug-in

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modules which customise its appearance and extend its functionality for
different design purposes; users may also further extend its capabilities
with their custom-written modules. Without these modules, FreeCAD
defaults to a generic 3D modeller. (Oku 2014). Arch Module in FreeCAD
aims to provide BIM functionality for Architects wishing to use open-
source tools.

ANALYTICAL FRAMEWORK

The study examines the issue of whether or not the Arch Module in
FreeCAD will become an acceptable architectural BIM content authoring
tool considering the current direction in its development. It also probes
concepts that could ultimately attract the desired performance. Objectives
laid out towards resolving the subject were:

1. to sample a select number of similar products;
2. to determine features of the products that are considered desirable;
3. to compare the characteristics and implementations with those in the
   Arch Module;
4. to deduce performances from comparative analysis;
5. to formulate hypotheses towards the advancement of Arch Module

This text also envisages a scenario wherein participants in an
Architecture, Engineering, and Construction (AEC) project opt for open-
source software. This scenario is not contrived, considering the benefits of
open-source solutions (Pankaja et al., 2013) more so, for growing economies
(Karaganis, 2011). Given that prevailing proprietary software in the
industry is fraught with challenging licensing schemes and frequent
administration – each of which may have unattractive financial
implications – young AEC firms are more likely to consider liberating and
robust alternatives (Andrews et al., 2007).
The global increase in the number of open-source software products targeted at different disciplines, including some in the building and construction business, is indicative of their significance (Pogson, 2015; Black Duck Software, 2015). It is therefore intriguing that architects have been experiencing a “drought” in the supply of open-source BIM tools (Oku, 2012). This trend motivates further enquiry into the progress of isolated efforts in that area. Figure 1 illustrates the current distribution of BIM tools in the proprietary and open-source worlds. The list of software shown is not exhaustive. Nevertheless, the number of proprietary software tools in existence is significantly greater than those of their open-source alternatives.

Open-source projects also have the advantage of bridging the gap between the end-users and the developers of the product because of the transparent nature of the development process. This openness affords the end-users the opportunity to contribute directly towards the engineering of their tools. As a result, the final product is fashioned after their real needs and the tools compliment their techniques. The involvement of architects in open-source projects has yielded remarkable products in the past. Arch Module is a recent example.4

**RESEARCH DESIGN AND METHODOLOGY**

This research applies descriptive analysis with a normative dimension. It follows a qualitative methodological approach. Qualitative Research is primarily exploratory research. It is used to gain an understanding of underlying reasons, opinions, and motivations. It provides insights into the problem or helps to develop ideas or hypotheses for potential quantitative research (Wyse, 2011). Thus, this research involved a combination of literature review, comparative case studies and  

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4 It is the brainchild of Yorik Van Havre, a Belgian architect practising in Brazil (http://yorik.uncreated.net/)
intermittent interviews with the developer of the Arch Module (the case).

According to Routio (2007), case study is a usual approach in descriptive research projects, but it can easily be amplified with a normative aspect in order to give grounds for later improvements in the object of study, be it an existing circumstance, product, or work routine. The difference between descriptive and normative styles of comparison is that in normative analysis one of the principal criteria is evaluative (such as "satisfaction", "usefulness"), and the aim of the study is to point out the best (in this respect) among the alternatives that are being studied. Sometimes the final aim is not only to find the best, but also to improve it or similar objects later on, and comparative analysis is expected to provide grounds for the planning of improvements to existing circumstances or products (Routio, 2007).

The methodology involved a parallel study of similar proprietary products – the “combination of exemplars” – to extract valuable features for comparative analysis. These products were

1. Revit®,
2. AutoCAD® Architecture
3. ArchiCAD®.

The inclusion of AutoCAD® Architecture may raise concerns since it derives from a traditional CAD technology (AutoCAD®). At the time of writing Autodesk, the vendor maintained silence⁵ over its BIM capabilities while promoting Revit as a BIM tool. Some authors (Lewis, 2008; Maiers, 2015) identified it as a plausible BIM product, while others were sceptical about its performance in the BIM arena. Nevertheless, the study provided a secondary opportunity to authenticate or discredit either of these perspectives irrespective of vendor marketing policies.

**BIM software expectations**

The definition of BIM – Building Information Modelling – has been the subject of many debates in recent years. Aranda-Mena et al. (2008) identified three schools of thought:

1. It is a software application;
2. It is a process for designing and documenting building information;
3. It is a whole new approach to practice and advancing the profession that requires the implementation of new policies, contracts and relationships amongst project stakeholders.

More recent texts integrate the three perspectives in the definition of BIM (Azhar et al., 2012). Hence, BIM is a process that is characterized by the use of specialized software tools towards the realization of the effective

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⁵ Autodesk dubbed AutoCAD® Architecture merely as “an architectural drafting tool to help you design and document more efficiently” (Autodesk, 2015) while defining Revit® as a “building design software is specifically built for Building Information Modelling (BIM), including features for architectural design, MEP and structural engineering, and construction.” (Autodesk, 2015)
design, documentation, and implementation of the intents of all stakeholders in an AEC project. This text is concerned with the software aspects of BIM tools and their usage, primarily, in the design phase of a building project. Secondary consideration is given to their involvement in the collaboration phase vis-à-vis their interoperability.

In the discourse for universal definition, software vendors agree that:

- Architectural BIM applications should be able to create virtual three-dimensional (3D) objects identical to those in the AEC industry.
- The virtual objects created should possess industry-standard properties that designers can modify to create variants of themselves. Therefore, they should be parametric.

Alterations in the virtual object should inform corresponding changes or updates in objects in their hierarchy. The objects should maintain an intelligent relationship. Child objects should translate with parent or host objects. For example, holes in wall objects should reposition with windows that require them or disappear when the relationship ceases to exist (perhaps in the event that the window is deleted or removed from the wall). Likewise, the alteration of a window's height property should trigger intelligible readjustments in sub-objects of its class – i.e. mullions, frames, and glazing should update accordingly.

- Architectural BIM applications should provide the medium for documentation, conceptualization, and visualization.
- BIM applications should be able to translate their native file structures into a format that is universal to facilitate interoperability with other software tools that may participate in a BIM process. This translation should transpire without significant losses to promote collaboration among professionals in the process.

These mutual expectations formed the basis for evaluating our case subject (Vectorworks, 2003; Autodesk, 2002; Cyon, 2003).

**Test case scenario**
The exemplars were subjected to a test project and observed. The experimental case study was delimited in scope by the magnitude of a test project designed to capture scalable aspects of fundamental architectural BIM content (see Figure 2 below).
For the purpose of this research, the study focused on the subjects' handling of levels, walls, slabs (by extension, columns), roofs, railings, and openings (i.e. arches, doors and windows). These objects are fundamental to architectural design.

All the exemplars were released in 2014. Tests involving the proprietary reference products were performed on 64-bit PCs running Microsoft Windows® 8 while FreeCAD was installed and observed on a 64-bit PC running Fedora® Linux (release 22)\(^6\).

**RESULTS**

Visually speaking, only two things distinguished the model created in FreeCAD from those of the exemplars: (1) The absence of railings and (2) the treatment of the four extreme exterior corners of the building. Except

\(^6\) FreeCAD was compiled from source. Both source and compiled (installation-ready) snapshots were preserved and are available at [http://schemefusion.com/research/freecad/efficacy-of-arch-module/sources/](http://schemefusion.com/research/freecad/efficacy-of-arch-module/sources/). Compilation was done off-tree in a folder called “cmade”. Running “make install” on a terminal, with that folder as the present working directory, will install FreeCAD, provided all dependencies are satisfied. The user should attempt installation only as a system administrator (root). Arch Module relies on IfcOpenShell for exchange with other BIM software. The relevant snapshot of IfcOpenShell is available likewise.
those, one could say that their interpretations of the test project were alike. Now this inference is by mere visual assessment (see Figure 3, below). The applications showed some variance in the modelling process. A detailed treatment of these differences follows below.

![Images of models created with different software](image)

**Figure 3:** Screenshots from the exemplars and the case (Arch Module) showing their treatment of the Test Project.

*Source: The Authors*

**Handling of Levels**

Arch Module’s level objects maintained an intelligent relationship with dependent objects. A translation (movement) of the former (the level) triggered a corresponding movement of the latter (i.e. objects on the level). As expected, this influence was not bidirectional -- hence, child objects could translate independently. The exemplars exhibited similar behaviour. Contrary to the reference applications, Arch Module did not assign hierarchical links automatically. This behaviour meant that, despite the prior selection of the target level, new objects were placed at a default level (zero). In the exemplars, placing a new object in the virtual world (scene) while a particular level was active assigned the new object to the active level. This automatic assignment is desirable as it is logical and time-saving. Arch Module expected a manual assignment before establishing a relationship. This order often required the corrective manual translation of the new object to the appropriate altitude since it was placed at zero-level before the assignment.
Handling of Walls
Walls in Revit® and ArchiCAD® displayed a higher level of intelligence over those in AutoCAD® Architecture and FreeCAD. Their ability to derive their heights from bounding levels is desirable. It is also logical since walls often span levels. Revit® and ArchiCAD® also provided a convenient way to override this behaviour so that certain walls terminate below or above a level as desired. Arch Module (FreeCAD) and AutoCAD® Architecture left height adjustments wholly to the user. Arch Module grouped walls together in a manner that impedes the manipulation of member walls. For example, after modelling a space enclosed by four walls, clicking or selecting any one of the walls also selected the rest in the chain. One would expect only the highlighted wall to be available for editing. However, independent tweaking was possible via the hierarchy panel (Navigator). Digging through the hierarchy list in search of desired walls proved less efficient (time-consuming). Furthermore, Arch Module did not offer any intuitive way of adjusting the wall lengths in real-time after their creation.

Handling of Slabs
All the tested applications approached the creation of slabs in the same manner. Each one expected the user to define the profile of the slab using a two-dimensional tool before generating a 3D slab object. ArchiCAD® and Revit® offered other advanced methods. The thickness of the slab remained adjustable after creation. However, while the exemplars handled the creation in one process, Arch Module expected predefined profiles that the user must create in a separate process; otherwise, Arch Module creates a default structural element. Investigating further beyond the scope of test project, the authors found no dedicated way of creating slab holes in Arch module. Holes required for stairwells or multilevel voids would need to be created by Boolean operations. Users would need to create secondary objects for the Boolean subtractions. The exemplars made provisions for slab holes. Arch Module allowed its users to define the role of its structural objects (whether they function as slabs, beams, or columns) whereas the exemplars assigned roles explicitly. This unique approach is plausible since all the products based most structural objects on profiles. It is, therefore, logical to approach them in generic terms then define their roles afterwards. The approach addressed different structural objects with one tool. Other products dealt with them separately, although their modelling process was similar.

Handling of Openings
As with slabs, Arch Module offered no dedicated away of creating archways or empty openings. The developer recommended Boolean subtractions in the absence of an automated method. Unlike the exemplars, doors and windows in FreeCAD depended heavily on sketcher objects. Sketcher objects are 2D shapes that can be constrained via
FreeCAD’s Sketcher module. The constraints on the 2D shapes were hooked up to the User-Interface (UI) from where users could change their values. A change of value meant a corresponding update in the shape -- it was interactive. Arch Module then added thickness to the shape to create the 3D geometry of the opening. (Figure 4 illustrates this process).

When the user initiates the creation process, the module presents a list of pre-sets (window or door types that are already constrained as described above). One apparent problem with this approach is that it does not adequately represent openings with components that have irregular cross-sections or profiles. It can only handle components with rectangular profiles or mimic more complex ones by juxtaposing rectangular shapes. This approach does not adequately represent reality.

Handling of Railings
The developer had not implemented parametric railings at the time of this study. They were therefore not tested.

Handling of Roofs
All the software products satisfactorily modelled the roof in the test project using different algorithms. Each product used the values provided for the pitch (slope), overhang and boundaries to derive the roof geometry. The
processes were largely parametric. Arch Module differed from the exemplars, in that it derived the roof geometry only from a 2D shape object (representing the area to be roofed). The exemplars offered additional methods -- they could deduce the roof geometry from specified supporting walls objects.

Handling of Stairs
All the exemplars were meritorious in dealing with the specifics of stair-formation. They appeared to have considered rules guiding stairs, irrespective of their type (whether they are U-shaped or dog-legged, straight, L-shaped, or having multi-landings). Their stair geometries remained flexible to adjustments after their creation. This flexibility is desirable. Arch Module also delivered an impressive straight stair for a product tagged 'experimental'. Its staircase was, by far, the most parametric in its collection. However, further adjustments to the stair were limited to the properties (User-Interface) panel. Users were not given any graphical way of adjusting the flow and extents of existing stair geometries. Only straight stairs had been implemented in Arch Module as at the time of testing.

Handling of Exchange
The authors exchanged models of the test project between the software products to test their level of interoperability. The exchange standard used for the experiment was the IFC file format (specifically the IFC2x3 version also known as Coordination View 2.0)\(^7\). The study sought to ascertain the extent to which the basic building objects from one product reintegrated into the native environments of the others. A desirable outcome would be a situation where a product identifies the foreign objects and can use its native tools to manipulate them intelligibly. An example is a case where Arch Module (FreeCAD) correctly categorizes a wall object from ArchiCAD\(^\circ\) as a "wall object", and can alter its height, width, or length parametrically. Table 1 summarizes the outcome of this investigation. Objects tagged "parametric" were those that were fairly reintegrated into another software environment. Those tagged "static" were those that the new host identified but it could make no further adjustments to them. Those tagged "generic" were objects that the new host software received but it could neither classify nor modify them. Objects that did not show up within a new software environment were tagged as "lost". The test also examined each products' ability to interpret and reintegrate their exported data.

\(^7\) http://www.buildingsmart-tech.org/specifications/ifc-view-definition/coordination-view-v2.0/summary
Each of the products exhibited some difficulty in communicating with others via the IFC format. Other observers have attributed this to the nature of the exchange format (Bentley, 2007; Pniewski, 2011). The IFC format is an evolving open standard aimed at encouraging collaboration between the stakeholders of a building project irrespective of their preferred software tools. The format is yet to capture all the definitive aspects of AEC objects. That notwithstanding, Arch Module showed the lowest level of interoperability. Other products understood its exports the least, whereas it could interpret theirs relatively better than its export.

**GENERAL OBSERVATIONS**

Arch Module took a minimalistic approach in its provision of AEC objects. The objects in general were either lacking defining industry components or rules guiding their class. The output of AutoCAD® Architecture was proof that it is a viable product for BIM oriented projects.
HYPOTHESIS AND PROPOSALS

From the experimental case studies, one can deduce that the software products that offered more intelligent virtual AEC objects satisfied the expectations of a BIM design tool and, therefore, were more desirable. Hence, the more the AEC objects could adapt intelligibly to design activity, the more desirable the design experience was. The above observation lends weight to a hypothesis:

(1) *Arch Module will become a plausible BIM tool when it features AEC objects that adjust intelligibly to common design procedures.*

One common design routine is the addition of walls onto levels (also called floors or stories in different software applications). In such regular activities, a designer may momentarily reflect on the following questions:

"If I activate a level object, will the tool be intelligent enough to add my latest (or subsequent) walls onto it?"

"If I remove a window object from a wall object, will the later be smart enough to close up the associated hole?"

Similarly:

"If I no longer require a casement window, does the tool provide means to swap it with another type or opening?"

Plausibility then becomes a factor of the number of such routines that the product anticipated and automated. However, considering that Arch Module is a product of a solo effort and that, indeed, intelligent AEC objects are evolving within, albeit, at a relatively slow pace, one could conjecture that:

(2) *Arch Module will become a plausible BIM tool if development accelerates in the current direction*

In other words, the project could benefit from more like-minded developers that are committed to a regular release cycle. Yorik van Havre works on Arch Module in his spare time using a relaxed schedule. Given that the product evolved to support IFC exchange in less than three years, a lot would have been achieved by three or more dedicated developers within that time-frame (van Havre, 2014). Judging from another perspective, Arch Module's treatment of the basic parametric AEC objects were too sketchy to justify widespread adoption into intense or fast-paced BIM work-flows. Therefore, the critical challenge towards achieving plausibility may not be in the need to hasten development, or increase the number of intelligent AEC objects, but in the quality of implementation. One can postulate that:

(3) *Arch Module will become a plausible BIM tool when it exhibits strong evidence of delivering tools and AEC objects that are inherently elaborate and stable.*

A detailed approach implies the enhancement of existing implementations to include missing components. For instance, wall objects in FreeCAD did
not show evidence of prior consideration to accommodate composite members. The same was true about the roof and slab objects. In reality, these objects sometimes include components in their composition (e.g. layers comprising of brickwork, insulation, concrete works, finishing, fascia and soffits). It is possible to reinforce the promise of plausibility with one lavishly executed AEC object that will serve as a proof-of-concept. Implementations of virtual AEC objects guided by the in-depth studies of their real-world versions will produce better results even when execution is rudimentary. A holistic approach makes it easier to improve on the objects later.

For instance, one could consider a different (proposed) approach to window objects. A holistic concept would accommodate the possible aspects of a window that a designer may wish to feature in his work. The designer may also anticipate freedom to refine or redefine the window geometry even to the smallest component. One way to satisfy these conditions is to treat the window as a system of reusable and scalable profiles. The modularized window structure would be defined and stored in a human-readable configuration file format (a plain text file). Variants could evolve from instancing and modifying existing window definitions. Table 2 shows the contents and syntax of a sample configuration.

Table 8: Contents of a sample configuration file

<table>
<thead>
<tr>
<th>1</th>
<th># configuration version 0.1 (proposed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td># KEY</td>
</tr>
<tr>
<td>3</td>
<td># ---------------------</td>
</tr>
<tr>
<td>4</td>
<td># justification =</td>
</tr>
<tr>
<td>5</td>
<td># along length of host object (left/right/centre)</td>
</tr>
<tr>
<td>6</td>
<td># along width of host object (left/right/centre)</td>
</tr>
<tr>
<td>7</td>
<td># sill =</td>
</tr>
<tr>
<td>8</td>
<td># enable/disable (boolean) ; profile to extrude with ; overshoot value (ends)</td>
</tr>
<tr>
<td>9</td>
<td># frame =</td>
</tr>
<tr>
<td>10</td>
<td># extrude path ; profile to extrude with ;</td>
</tr>
<tr>
<td>11</td>
<td># openings =</td>
</tr>
<tr>
<td>12</td>
<td># what occupies this opening? ;</td>
</tr>
<tr>
<td>13</td>
<td># index of affected wall-component (* means all) ; path to use:</td>
</tr>
<tr>
<td>14</td>
<td># transom =</td>
</tr>
<tr>
<td>15</td>
<td># ID of transom ; points defining extrude path (line/arc) ;</td>
</tr>
<tr>
<td>16</td>
<td># profile to extrude with ; bounding object (offset) ;</td>
</tr>
<tr>
<td>17</td>
<td># repeat interval ; instances</td>
</tr>
<tr>
<td>18</td>
<td># mullion and panels share same parameter structure as transom.</td>
</tr>
<tr>
<td>19</td>
<td># Multiplying GUI attribute-values with dimensions of corresponding</td>
</tr>
<tr>
<td>20</td>
<td># paths/profiles yields the final dimensions used at creation time.</td>
</tr>
<tr>
<td>21</td>
<td># definition of shapes and paths depends on the way part-module handles geometry</td>
</tr>
<tr>
<td>22</td>
<td># definitions below only convey a concept. They’re not final</td>
</tr>
<tr>
<td>23</td>
<td># CONFIGURATION</td>
</tr>
</tbody>
</table>

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```xml
# -------------
<shapes>
  # normalized shapes are used as extrude-paths and profiles.
  Default = line | 0,0 | 0,1 | 1,1 | 1,0 | close
  arch = line | 0,0 | 0,0.85 | arc | 0.5,1 | 1,0.85 | line | 1,0 | close
  one-chamfered-corner = line | 0,0 | 0,1 | 0.5,1 | 1,0.5 | 1,0 | close
</shapes>

<window>
  style = default
  justification = centre:centre
  sill = 0;;
  frame = default:default
  openings = frame:all:default
  panel = A:default:default:frame | frame | frame | frame;;
</window>

<window>
  style = arched-transomed
  justification = left | 600:centre
  sill = 1:one-chamfered-corner:150
  frame = archtop-default:default
  openings = frame | * | default:sill | 1 | default
  transom = A:line | 0,0.75 | 1,0.75:default:frame;;
  mullion = A:line | 0.33,0 | 0.33,0.75:default:transom,A:0.33:1
  panel = A:frame | transom,A | mullion,A | frame:0.33:2
</window>
```

Source: The First Author

![Graphical representation of the concept exemplified in the configuration file](image)

Figure 5: Graphical representation of the concept exemplified in the configuration file

Source: The First Author
In Table 2, the profiles for creating component geometries (such as mullions, and transom) are described in terms of normalized coordinates. The final dimensions would be determined by multiplying the normalized dimensions with corresponding values provided at Arch Modules' properties panel (user-interface). The concept of scalable normalized shapes covers sills and architraves (Oku, 2014).

**CONCLUSIONS**

Arch Module is not ready for use in a production environment. The developer of Arch Module is explicit about its experimental status. However, this study does not set out to measure preparedness but to evaluate the tool's design and implementation, forecast performance, and propose improvements. The comparative analysis affirms the existence of positive design intent and promising direction, although some implementations may require reconsideration. The development of the Arch Module should focus on delivering AEC objects guided by concepts that are broad in their consideration. Otherwise, the product will be of limited use to designers that require fast methods for generating very detailed models. The mission before the developer of Arch Module is huge. The project begs for more involvement from potential beneficiaries at its current stage. Its open-source licensing provides the opportunity for...
researchers in BIM to formulate and test concepts, especially those with scripting or programming skills.

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