Book of abstracts for the Waber 2021 conference 9th-11th August 2021 Accra, Ghana

Book

Published Version

WABER 2021 Conference, Book Of Abstract

BOOK OF ABSTRACTS

WABER 2021 CONFERENCE

WEST AFRICA BUILT ENVIRONMENT RESEARCH CONFERENCE

9-11 AUGUST
Labadi Beach Hotel
Accra, Ghana

WWW.WABERCONFERENCE.COM

KNOWLEDGE, INTERACTION, PEOPLE & LEADERSHIP

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EDITORS: S. LARYEA AND E. ESSAH

WEST AFRICA BUILT ENVIRONMENT RESEARCH (WABER) CONFERENCE
Knowledge, Interaction, People & Leadership

BOOK OF ABSTRACTS FOR THE WABER 2021 CONFERENCE

9th-11th August 2021

Accra, Ghana

EDITORS

Sam Laryea
Wits University, South Africa

Emmanuel Adu Essah
University of Reading, United Kingdom

Proceedings of the West Africa Built Environment Research (WABER) Conference 2021

9th – 11th August 2021

Labadi Beach Hotel, Accra, Ghana

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Sam Laryea, Wits University, South Africa
Emmanuel Adu Essah, University of Reading, United Kingdom

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Declaration

All papers in this publication have been through a 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 to ensure quality of content.

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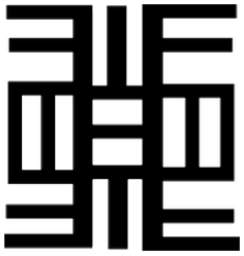

NEA ONNIM NO SUA A, OHU

"*He who does not know can know from learning*"

This is the Adinkra symbol of knowledge, life-long education and continued quest for knowledge. The Akan people in West Africa believe that the search for knowledge is a life-long process. This is evident from the Akan saying "Nea onnim sua a, ohu; nea odwen se onim dodo no, se ogyae sua a, ketewa no koraa a onim no firi ne nsa" which translates into "He who does not know can become knowledgeable from learning; he who thinks he knows and ceases to continue to learn will stagnate".

FOREWORD

I would like to welcome each participant to the WABER 2021 Conference. Since its inception in 2009, the WABER Conference series has done a great deal to nurture and support researchers, initially in West Africa, also, in other parts of Africa and elsewhere. I would like to thank all delegates for your participation which enables us to keep this Conference going.

The WABER Conference enjoys a positive international reputation and has continued to grow from strength to strength over the past 13 years. For this, I would like to thank our team, keynote speakers and participants over the years for every contribution you have made to the success of this Conference. This year's Conference has an excellent programme, line up of speakers and authors.

I would like to thank and commend the authors of all 72 papers in this Conference proceedings. If the research paper writing process was compared to a marathon, the authors of the 72 papers in this publication would be adjudged as the ones who have endured and finished the race.

We opened the call for papers for this Conference in December 2020 and over 100 abstracts were submitted by authors. However, it is one thing to propose to write a paper, and it is quite another thing to actually write the paper. Therefore, I would like to thank and congratulate all authors who succeeded in completing the process of getting published in this conference proceedings.

It is befitting that we have an excellent range of interesting topics in the 72 papers to be discussed at this conference.

We are honoured to welcome Professor Charles Egbu, Vice Chancellor of Leeds Trinity University, to give us a special opening address.

In the three days of this conference, we will have various plenary presentations by experienced international academics and I would like to thank and welcome each of them below.

Professor Albert Chan
Richard Lorch
Professor Taibat Lawanson
Professor Dato' Sri Ar Dr Asiah Abdul Rahim
Professor George Ofori

In addition to these speakers, we have other interesting sessions on the programme including a special session for doctoral students and supervisors several other experienced speakers addressing various topics that should be of interest to many of us.

I would like to thank all members of the organising team particularly Associate Professor Emmanuel Essah, Dr Yakubu Aminu Dodo and Dr Sam Moveh for their efforts which has helped to organise this Conference successfully. I would also like to thank all of our reviewers particularly Associate Professor Emmanuel Essah and Dr Haruna Moda for the considerable time and effort spent reviewing and checking all papers to ensure a high standard of quality.

The WABER Conference Team always plays an excellent role in the success of our events and I would like to thank and appreciate the contributions of Florence, Sam Boakye, Victor Ayitey and his team, Kwesi Kwofie and Issah Abdul Rahman to the success of this Conference.

I hope you enjoy our first hybrid conference and engage with our exciting speakers on the diverse topics that will be covered over the three days of this Conference.

Sam Laryea
University of the Witwatersrand, Johannesburg, South Africa
Chairman of WABER Conference
August 2021

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PEER REVIEW AND SCIENTIFIC PUBLISHING STATEMENT

9th August 2021

TO WHOM IT MAY CONCERN

The scientific information published in peer-reviewed outlets carries special status, and confers unique responsibilities on editors and authors. We must protect the integrity of the scientific process by publishing only manuscripts that have been properly peer-reviewed by scientific reviewers and confirmed by editors to be of sufficient quality.

I confirm that all papers in the WABER 2021 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 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 peer review process involving examination by at least two referees who are knowledgeable on the subject. A paper is only accepted for publication in the conference proceedings based on the recommendation of the reviewers and decision of the editors.

The names and affiliation of members of the Scientific Committee & Review Panel for WABER 2021 Conference are published in the Conference Proceedings and on our website www.waberconference.com

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

Yours Sincerely,

Sam Laryea, PhD
Chairman of WABER Conference

PEER REVIEW PANEL

WABER Conference is very grateful to each the following persons for your contribution to the peer review process. Thank you so much.

Associate Professor Samuel Laryea, Wits University, South Africa
Associate Professor Emmanuel A. Essah, University of Reading, UK
Prof Carmel Margaret Lindkvist , Norwegian University of Science and Technology, Norway
Associate Professor Ian Ewart, University of Reading, UK
Associate Professor Joy Maina, Ahmadu Bello University, Nigeria
Associate Professor Obinna Ozumba, University of the Witwatersrand, South Africa
Dr Adwoa Serwaa Ofori, Trinity College Dublin, Ireland
Dr Afolabi Dania, University of Westminster, UK
Dr Amna Shibeika, United Arab Emirates University
Dr Amos Darko, The Hong Kong Polytechnic University, Hong Kong
Dr Bruno Lot Tanko, University of Reading Malaysia, Malaysia
Dr Chiahemba J. Nor, Department of Parks and Recreational, Nigeria
Dr. Ing. Collins Ameyaw, Kumasi Technical University, Ghana
Dr Cynthia Adeokun, O. N. A. Architects Ltd, UK
Dr Dave Collins, Norwegian University of Science and Technology, Norway
Dr Erekpitan Ola-Adisa, University of Jos, Nigeria
Dr Faizah Bashir, University of Hail, Saudi Arabia
Dr Folake Ekundayo, Architect at Berkshire Healthcare NHS Foundation Trust, UK
Dr Gabriel Nani, Kwame Nkrumah University of Science and Technology, Ghana
Dr Hafizah Latif, Universiti Teknologi MARA (Perak), Malaysia
Dr Haruna Moda, Manchester Metropolitan University, UK
Dr Humphrey Danso, Akenten Appiah-Menka University of Skills Training & Entrepreneurial Development, Ghana
Dr Immanuel Darkwa, Trinity College Dublin, Ireland
Dr Kwadwo Oti-Sarpong, University of Cambridge, UK
Dr Eng L. Ofetotse, Kingston University, UK
Dr Lawrence Mbugua, University of Reading, UK
Dr Mehdi Shahrestani, University of Reading, UK
Dr Naa Adjeley Ashiboe-Mensah Doamekpor, University of Professional Studies, Accra
Dr Nimlyat S. Pontip, University of Jos, Nigeria
Dr Ogunbode Ezekiel Babatunde, Federal University of Technology Minna, Nigeria
Dr Philippa Boyd, University of Reading, UK
Dr Prince Senyo, University of Southampton, UK
Dr Ron Watermeyer, Infrastructure Options (Pty),Ltd, South Africa
Dr Ronan Champion, University of Reading, UK
Dr Sarfo Mensah, Kumasi Technical University, Ghana
Dr Selorm Adukpo, Oxford Brookes University, UK
Dr Seyi Odeyale, University of Ibadan, Nigeria
Dr Sherif Razak, University of Salford, UK
Dr Sitsabo Dlamini, Wits University, South Africa
Dr Wallace Imoudu Enegbuma, Victoria University of Wellington, New Zealand
Dr. Yakubu Aminu Dodo, Istanbul Gelisim University, Turkey

PRIZES TO BE AWARDED AT THE WABER 2021 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 Oral Presentation**

This prize is awarded to recognise 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 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.

9-11 AUGUST 2021

Labadi Beach Hotel
Accra, Ghana and Online

TIME

08:45am to 16:00pm GMT/UTC

Please note your local time zone may be different

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Meeting ID: 894 6050 4735

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PROGRAMME

WEST AFRICA BUILT ENVIRONMENT RESEARCH CONFERENCE

W W W . W A B E R C O N F E R E N C E . C O M

KNOWLEDGE, INTERACTION, PEOPLE & LEADERSHIP

SPECIAL OPENING ADDRESS ON THE THEME OF

ACADEMIC ASPIRATION AND EXCELLENCE

By Professor Charles Egbu, Vice Chancellor Leeds Trinity University, UK

Keynote presentations by experienced international academics

Professor Charles Egbu
Vice Chancellor
Leeds Trinity University, UK

Professor Albert Chan
Department of Building and Real Estate
Hong Kong Polytechnic University, Hong Kong

Professor Taibat Lawanson
Department of Urban and Regional Planning
University of Lagos, Nigeria

Professor Asiah Abdul Rahim
Department of Architecture,
International Islamic University Malaysia

Professor George Ofori
Dean of School of the Built Environment and Architecture
London South Bank University, UK

Richard Lorch
Editor-in-chief
of Buildings and Cities,
former editor-in-chief of Building Research and Information

DAY 1

MONDAY 9th AUGUST 2021

zoom

WABER 2021 CONFERENCE

08:45-09:00	**WELCOME REMARKS AND INTRODUCTION OF GUEST OF HONOUR BY PROFESSOR SAM LARYEA - CHAIRMAN OF WABER CONFERENCE**		
09:00-10:00	OPENING ADDRESS BY PROFESSOR CHARLES EGBU, VICE CHANCELLOR, LEEDS TRINITY UNIVERSITY, UK Theme: Academic aspiration and excellence		
10:00-10:30	**BREAK**		
10:30-11:15	KEYNOTE ADDRESS BY PROFESSOR ALBERT CHAN, HONG KONG POLYTECHNIC UNIVERSITY, HONG KONG Topic: Current trends and future directions of built environment research		
11:15-11:30	**BREAK**		
11:30-12:40	**PAPER PRESENTATIONS**		
	PARALLEL SESSION 1	**PARALLEL SESSION 2**	**PARALLEL SESSION 3**
11:30-11:35	Session Chair remarks Dr Humphrey Danso, AAMUSTED, Ghana	Session Chair remarks Prof Kulomri Adogbo, Ahmadu Bello University, Nigeria	Session Chair remarks Dr Cynthia Adeokun, O.N.A Architects London
11:35-11:45	Stress-coping strategies among construction personnel: an integrative review - Janet Mayowa Nwaogu and Albert P. C. Chan	Impact of risk factors on construction projects' quality in Nigeria - Ziyadul Hassan Ishaq, Mu'awiya Abubakar, Shehu Muhammad, Yarima Sallau Lawal and Ibrahim Isah	Automated recognition of construction workers' physical fatigue based on foot plantar patterns captured from a wearable insole pressure system - Maxwell Fordjour Antwi-Afari, Heng Li, David John Webb, Shahnawaz Anwer, JoonOh Seo, Kenneth Sungho Park and Alex Torku
11:45-11:55	The relationship between self-efficacy beliefs and career choices of undergraduate built environment students - Mariam Akinlolu and Theo C. Haupt	Awareness and perceptions of construction professionals on environmental risks in construction project delivery in Lagos and Ondo States, Nigeria - Deborah Abosede Ogungbemi and Ayokunle Olubunmi Olanipekun	Socio-psychological motivational needs of unskilled women working in Nigeria's construction industry - Seun Micheal Oloruntoba and Ayokunle Olubunmi Olanipekun
11:55-12:05	**Q&A**		
12:05-12:15	Factors affecting the delivery of building construction projects funded by district assemblies common fund (dacf): the case of selected regions in Ghana - Aborah-Osei Castro and Humphrey Danso	Review of risk management studies: towards a frame of reference for large projects - Rilwan Shuaib Abdulrahman, Ahmed Doko Ibrahim, Baba Adama Kolo and Hassan Adaviriku Ahmadu	Covid-19 pandemic and co-working environment: analysis of shared office space in Federal Capital Territory (FCT), Abuja, Nigeria - Tosin B. Fateye, Abiodun K. Sodiya, Victoria O. Odunfa, Ayodele A. Ibuoye and Adewale R. Adedokun
12:15-12:25	Assessment of residents' perception of infrastructure delivery in Nigeria: the tale of Osogbo - Olatunji Solomon Ayodeji and Olowoporoku Oluwaseun Ayodele	Urban morphology and crime patterns in urban areas: a review of the literature - Idris Isah Iliyasu, Aldrin Abdullah and Massoomeh Hedayati Marzbali	The potential role of green infrastructure on mental health and well-being: the covid-19 pandemic experience - Adedo-tun Ayodele Dipeolu and Akintunde Olaniyi Onamade
12:25-12:35	**Q&A**		
12:35-12:40	Session Chair remarks Dr Humphrey Danso, AAMUSTED, Ghana	Session Chair remarks Prof Kulomri Adogbo, Ahmadu Bello University, Nigeria	Session Chair remarks Dr Cynthia Adeokun, O.N.A Architects London
12:40-13:30	**BREAK**		

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WABER 2021 CONFERENCE

MONDAY 9th AUGUST 2021

DAY 1

13:30-14:40	PAPER PRESENTATIONS		
	PARALLEL SESSION 1	PARALLEL SESSION 2	PARALLEL SESSION 3
13:30-13:35	Session Chair remarks Dr Humphrey Danso, AAMUSTED, Ghana	Session Chair remarks Prof Kulomri Adogbo, Amadu Bello University, Nigeria	Session Chair remarks Dr Cynthia Adeokun, O.N.A Architects London
13:35-13:45	Assessing the causes of material wastage as it affects various building materials on Nigerian construction sites - A. A. Salihu, S. Gambo, M. M. Sa'ad, F. M. Oyeleke and J. Usman	Performance–based EPC contracting: a preliminary study of the challenges of engineering procurement and construction projects in Nigeria Aluko-Olokun Bukola Adenike, Baba Adama Kolo,Mustapha Abdulrazaq and Peter C. Gangas	BIM utilization in facilities management practice: a status study in South Africa - Faith Dowelani and Aghaegbuna O. U. Ozumba
13:45-13:55	Determination of factors that influence labour output on construction sites in Ghana - Joseph Henry Acquah, Humphrey Danso and Emmanuel Bamfo-Agyei	Enablers of mutual satisfaction in transnational public infrastructure development: the case of Sino- Ghana - Bridget Tawiah Badu Eshun, Albert P.C. Chan and Frank D.K. Fugar	The benefits of building information modeling in architectural education in Nigeria - Elimisiemon Monday Chris, Poopola J. O. and Salisu A. S.
13:55-14:05	Q&A		
14:05-14:15	Examination of energy consumption reduction measures for residential buildings in tropical climate (A Case Study of Birnin Kebbi, Nigeria) - Nkeleme Emmanuel Ifeanyichukwu, Sani Abdulrahman Tolani, Winston Shakantu and Mbamali Ikemefuna	Towards a research agenda for smart contract adoption in less technologically enabled construction environments: a systematic literature review - Ekweani Chioma Precious, Kolo Baba Adama, Adogbo Kulomri Jaule and Mohammed Abdullahi	BIM education ontology: towards a research agenda for non-industrialized economies - Abdulazeez Abdulmumin, B. A. Kolo, Y. G. Musa-Haddary and P. G.Chindo
14:15-14:25	An investigation into the use of building information modelling and its impact on construction performance within Ghanaian constructionindustry - Frederick Kwasi Wirekoh and Humphrey Danso	Key factors for electronic procurement systems in the promotion of sustainable procurement in construction projects - Sitsofe Kwame Yevu, Ann Tit Wan Yu, Amos Darko and Mershack Opoku Tetteh	Advancements in computer-aided design and the challenges for architectural education in Nigeria – feedback from the students' industrial work experience scheme - Sunday A. Bobadoye, Dorcas A. Ayeni, Saidat D. Olanrewaju andAjenifujah-Aminat O. Ajenifujah-Abubakar
14:25-14:35	Q&A		
14:35-14:40	Session Chair remarks Dr Humphrey Danso, AAMUSTED, Ghana	Session Chair remarks Prof Kulomri Adogbo, Amadu Bello University, Nigeria	Session Chair remarks Dr Cynthia Adeokun, O.N.A Architects London
14:40-15:00	BREAK		
15:00-15:45	KEYNOTE ADDRESS BY PROFESSOR GEORGE OFORI, LONDON SOUTH BANK UNIVERSITY, UK Topic: Construction in developing countries: need for new concepts and theorising of contextual specificities to the global corpus of knowledge		
15:45-16:00	WRAP UP AND CLOSE - SAM LARYEA, WITS UNIVERSITY, SOUTH AFRICA		

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DAY 2

TUESDAY 10th AUGUST 2021

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WABER 2021 CONFERENCE

08:45-09:00	**CHECK-IN AND OVERVIEW OF WHAT WE WILL COVER FOR THE DAY** **EMMANUEL ESSAH, UNIVERSITY OF READING, UK**		
09:00-10:00	SESSION FOR DOCTORAL STUDENTS AND SUPERVISORS - BY PROFESSOR ALBERT CHAN AND PROFESSOR GEORGE OFORI Topic: Experiential tips for doing and supervising doctoral research successfully		
10:00-10:15	**BREAK**		
10:15-11:15	EDITOR'S FORUM PRESENTATION BY RICHARD LORCH (EDITOR-IN-CHIEF OF BUILDINGS AND CITIES and FORMER EDITOR-IN-CHIEF OF BUILDING RESEARCH AND INFORMATION) FOLLOWED BY 15 MINS Q&A Topic: Elements of a good research article and what the editors and reviewers of top journals look for in modern scientific research articles		
11:15-11:30	**BREAK**		
11:30-12:40	**PAPER PRESENTATIONS**		
	PARALLEL SESSION 1	**PARALLEL SESSION 2**	**PARALLEL SESSION 3**
11:30-11:35	Session Chair remarks Dr Haruna Moda, Manchester Metropolitan University, UK	Session Chair remarks Prof Kola Akinsomi, Wits University, South Africa	Session Chair remarks Dr Amina Batagarawa, Baze University, Nigeria
11:35-11:45	Application of Information and Communication Technology on the implementation of health and safety measures by construction firms in Abuja, Nigeria - Abdullateef Adewale Shittu, Anita Dzikwi Adamu, Abel John Tsado, Lois Adedamola Arowolo and Shakirat Remilekun Abdulazeez	Challenges to sustainable affordable housing using frugal innovation David Mbabil Dok-Yen, Duah Daniel Yaw Addai and Michael Nii Addy	Analytical nexus of urban liveability, liveable communities and place-making in African cities - Samuel Medayese, Hangwelani Magidimisha-Chipungu, Ayobami Popoola and Lovemore Chipungu
11:45-11:55	Assessment of the challenges and solutions to implementation of safety measures by small and medium sized construction firms in Abuja, Nigeria - Jibril Adamu Muhammad, Abdullateef Adewale Shittu, Yakubu Danasabe Mohammed, John Ebhohimen Idiake and Zannah Alhaji Ali	Development of social housing agenda to solve housing deficit in sub-Sahara Africa: a case for Ogun State, Nigeria - Babatunde Adekoyejo Jolaoso and Olusegun Olaopin Olanrele	Users' assessment of the relationship between housing quality and the conditions of residential outdoor spaces in Ilesa, Nigeria - Yussuf Shakirat Oladayo, Jiboye Adesoji David, Agbabiaka Hafeez Idowu, Adeyemi Toyin Ebenezer and Oke Oluyemi Ebenezer
11:55-12:05	**Q&A**		
12:05-12:15	An Investigation into the safety performance of public buildings in relation to compliance of fire safety regulations: a case study of Ashanti and Greater Accra Regions of Ghana - Samuel Asumadu Roberts and Humphrey Danso	Housing affordability in Osogbo Osun State Nigeria - Akinremi Adenike R., Adedayo Adeyanju G., Saheed Jelili, Yussuf Shakirat O. and Ojo Omotayo 'Mubo	Awareness and acceptance of smart security system among occupants of selected public buildings in central business district (FCT-Abuja) Nigeria - Fatima Baba Ciroma, Musa Lawal Sagada and Joy Joshua Maina
12:15-12:25	Evaluation of health and safety compliance of construction projects in south east Nigeria - Chidinma Amarachukwu Emma-Ochu, Kevin C. Okolie and Ikem Mbamali	Factors influencing perceived value of residential properties in Free State Province, South Africa - Kahilu Kaji-mo-Shakantu, Barend Groenewald and Timothy O. Ayodele	Awareness of green infrastructure and its socio-demographic predictors among residents of Lagos metropolis, Nigeria - Adedotun Ayodele Dipeolu, Eziyi Offia Ibem, Joseph Akinlabi Fadamiro, Gabriel Fadairo, Joseph Adeniran Adedeji and Akintunde Olaniyi Onamade
12:25-12:35	**Q&A**		
12:35-12:40	Session Chair remarks Dr Haruna Moda, Manchester Metropolitan University, UK	Session Chair remarks Prof Kola Akinsomi, Wits University, South Africa	Session Chair remarks Dr Amina Batagarawa, Baze University, Nigeria
12:40-13:30	**BREAK**		

WABER 2021 CONFERENCE

TUESDAY 10th AUGUST 2021

DAY 2

13:30-14:40	PAPER PRESENTATIONS		
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13:30-13:35	Session Chair remarks Dr Samuel Moveh, Universiti Teknologi Malaysia, Malaysia	Session Chair remarks Prof Kola Akinsomi, Wits University, South Africa	Session Chair remarks Dr Yakubu Aminu Dodo, Istanbul Gelisim University, Turkey
13:35-13:45	A study on interpersonal skills of Nigerian built environment professionals for the successful delivery of mass housing programmes - Mansir Dodo, Muhammad M. Gambo, Kabir Bala and Badamasi Abdulmalik	Micro-climatic benefits of Green infrastructure (trees) in a Housing Estate in Abuja, Nigeria - Tobi Eniolu Morakinyo, Olumuyiwa Bayode Adegun, Morisade O Adegbie and Olawale Oreoluwa Olusoga	Spatial accessibility to urban infrastructure services among hotels in the small city of Wa, Ghana Elvis Attakora-Amaniampong, Appau Williams Miller and Emmanuel K. Derbile
13:45-13:55	Adoption of technology in human resource management - a new normal - Kuforiji, A. Aramide	Investigating the effect of covid-19 driven inflation on commercial property hedging capacity in Lagos, Nigeria - Muktar Babatunde Wahab, Wasiu Ayobami Durosinmi, Matthew Mamman, Yetunde Christianah Charles-Afolabi and Dodo Usman Zakari	Modeling of future land use/land cover change dynamics in Lagos, Nigeria using cellular automata and Markov chain (Ca-Markov) - Auwalu Faisal Koko, Wu Yue, Muhammed Bello and Ghali Abdullahi Abubakar
13:55-14:05	**Q&A**		
14:05-14:15	Assessing the level of awareness on the concept of Design for Safety (DfS) amongst design professionals in the construction industry in Nigeria - Mu'awiya Abubakar, Bello Mahmud Zailani and Abdulgafar Adamu	Students' perceptions about training on property valuation techniques in selected tertiary institutions in Nigeria - Augustina Chiwuzie, Daniel Ibrahim Dabara, Edith Mbagwu Prince, Sayo Tolani Olawuyi and Sayo Tolani Olawuyi	Assessment of factors responsible for outsourcing of facilities management services in public hospitals within Kaduna metropolis - Aliyu Suleiman Shika, Mohammed Mustapha Saad and Abdullahi Getso Ibrahim
14:15-14:25	An exploration of spatial layout and communication patterns in tertiary hospital design: an innovative approach to sustainable hospital design - Ejeh David Ekoja, Sagada Musa Lawal, Oluigbo Stephen Nwabunwanne, Maina Joy Joshua and Sufiyan Mu'awiyyah Babale	Predictors of academic attainment in a Nigerian polytechnic: perceptions of estate management students - Augustina Chiwuzie	An innovative approach for the evaluation of expansion option in buildings - Yarima Sallau Lawal, Aliyu Makarfi Ibrahim, Mu'awiya Abubakar and Ziyadul Hassan Ishaq
14:25-14:35	**Q&A**		
14:35-14:40	Session Chair remarks Dr Samuel Moveh, Universiti Teknologi Malaysia, Malaysia	Session Chair remarks Prof Kola Akinsomi, Wits University, South Africa	Session Chair remarks Dr Yakubu Aminu Dodo, Istanbul Gelisim University, Turkey
14:40-15:00	**BREAK**		
15:00-15:45	KEYNOTE ADDRESS BY PROFESSOR TAIBAT LAWANSON, UNIVERSITY OF LAGOS, NIGERIA Topic: Rethinking current approaches to urban development in Africa		
15:45-16:00	**WRAP UP AND CLOSE - EMMANUEL ESSAH, UNIVERSITY OF READING, UK**		

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DAY 3

WEDNESDAY
11th AUGUST
2021

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WABER 2021 CONFERENCE

08:45-09:00	**CHECK-IN AND OVERVIEW OF WHAT WE WILL COVER FOR THE DAY PROFESSOR SAM LARYEA, WITS UNIVERSITY, SOUTH AFRICA**		
09:00-10:00	KEYNOTE ADDRESS BY PROF ASIAH ABDUL RAHIM, INTERNATIONAL ISLAMIC UNIVERSITY, MALAYSIA Topic: Current trends and future directions in the inclusive, sustainable and tropical design of built facilities		
10:00-10:30	**BREAK**		
10:30-11:15	KEYNOTE ADDRESS BY PROF ALBERT CHAN, HONG KONG POLYTECHNIC UNIVERSITY, HONG KONG Topic: Insights for developing individual and institutional research areas and strategies in construction and real estate		
11:15-11:30	**BREAK**		
11:30-12:40	**PAPER PRESENTATIONS**		
	PARALLEL SESSION 1	**PARALLEL SESSION 2**	**PARALLEL SESSION 3**
11:30-11:35	Session Chair remarks Dr Maxwell Fordjour Antwi-Afari, Aston University, UK	Session Chair remarks Dr Humphrey Danso, AAMUSTED, Ghana	Session Chair remarks Dr Sarfo Mensah, Kumasi Technical University, Ghana
11:35-11:45	Conceptual framework for whole-life cost data transformation and model selection - Ibrahim, A., M. , Bala, K. , Ibrahim, A. D. , Zubairu, I. K.	Water absorption quality of clay bricks made by emerging manufacturers in SouthAfrica Bonga PraiseGod Khuzwayo	Comparative analysis of soundness and setting time of Portland cement of three companies in Nigeria - Angulu Haruna, Abba Musa, Samaila Hamza, Galadima Muhammad and Odesanmi, Atinuke
11:45-11:55	The impact of project contributory factors on the cost performance of building projects - V. H. Jiya, A. D. Ibrahim, D. Kado and K. Bala	Effects of sand on the properties of cement-laterite interlocking blocks - Sampson Assiamah and Humphrey Danso	Effect of cereal flours on the properties of concrete - Alfa Nasirudeen Musa and Adeleke Babatunde Kazeem
11:55-12:05	**Q&A**		
12:05-12:15	Developing a framework for public private partnership project governance in Nigeria - Atoyebi Kayode Emmanuel and Ojo Stephen Okunlola	Effect of petroleum contamination on some selected properties of compressed stabilized earth brick (CSEB) K. A. N. Sackey, M. M. Garba, O. G. Okoli and D. D. Dahiru	Effect of palm kernel shell as coarse aggregate on the properties of concrete A.G. Ibrahim, A. Yahya, M.M. Gambo, S. Gambo and J. Usman
12:15-12:25	Contractors' selection and its effects on water infrastructure delivery Mkasi P., Ogbeifun E. and Pretorius J. H. C.	Suction of clayey soil treated with quarry dust base geopolymer cement for sustainable pavement subgrade construction - Ezenwa Chinenye Amanamba and Kennedy Chibuzor Onyelowe	Effects of maximum aggregate sizes on flexural strength of recycle iron and steel slag (RIIS) concrete - Oluwaleke Adekunle Olowu, Akeem Ayinde Raheem, Abiodun Yesiru Akinsanya and Victor Ikechukwu Opara
12:25-12:35	**Q&A**		
12:35-12:40	Session Chair remarks Dr Maxwell Fordjour Antwi-Afari, Aston University, UK	Session Chair remarks Dr Humphrey Danso, AAMUSTED, Ghana	Session Chair remarks Dr Sarfo Mensah, Kumasi Technical University, Ghana
12:40-13:30	**BREAK**		

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WABER 2021 CONFERENCE

WEDNESDAY 11th AUGUST 2021

DAY 3

13:30-14:40	PAPER PRESENTATIONS		
	PARALLEL SESSION 1	PARALLEL SESSION 2	PARALLEL SESSION 3
13:30-13:35	Dr Afolabi Dania, University of Westminster, UK	A/Prof Emmanuel Essah, University of Reading, UK	Session Chair remarks Dr Sarfo Mensah, Kumasi Technical University, Ghana
13:35-13:45	Responsible material sourcing: Assessment of factors influencing construction material sustainability - Nana Benyi Ansah , Emmanuel Adinyira , Kofi Agyekum and Isaac Aidoo	Modelling optimal unconfined compressive strength of geotextile reinforced soil for flexible foundation construction - Daniel E. Aju and Kennedy C. Onyelowe	Investigating the effect of curing methods on the strength properties of concrete - Francis Kwesi Nsakwa Gabriel-Wettey and Humphrey Danso
13:45-13:55	Social procurement and sustainability in the Nigerian construction industry - Francis O. Okeke and Rosemary C. Nnaemeka-Okeke	ANFIS model of the UCS of modified soil for construction purposes - Udeala, R. C., Onyelowe, K. C., Uranta, J. D. C., Keke, E. O. and Alaneme, G. U.	Assessment of seasonal flood impact and management strategies in Okitipupa, Ondo State, Nigeria - Olorunlana, Folasade Aderonke
13:55-14:05	Q&A		
14:05-14:15	The relationship of attitude and perceived behavioral control on behavioral intention to practice surveying - Ayodele Oduwole	Households' exposure to indoor air pollution from fossil fuel electric generator use in Minna Nigeria - C. B. Ohadugha, Y. A. Sanusi, A. O. Sulyman, B. N. Santali, M. Mohammed and S. O. Medayese	Session Chair remarks Dr Sarfo Mensah, Kumasi Technical University, Ghana
14:15-14:25	The role of safety attitude in changing safety behaviour and hazard recognition capability of construction workers - Bello Mahmud Zailani, Mu'awiya Abubakar and, Yahaya Makarfi Ibrahim	Diurnal temperature changes and physiological experience: case study analysis of indoor condition in a school environment in Nigeria - Eludoyin Oyenike Mary	Join Session 1 or Sesison 2
14:25-14:35	Q&A		
14:35-14:40	Dr Afolabi Dania, University of Westminster, UK	A/Prof Emmanuel Essah, University of Reading, UK	
14:40-15:00	BREAK		
15:00-15:45	KEYNOTE ADDRESS BY PROFESSOR GEORGE OFORI, LONDON SOUTH BANK UNIVERSITY, UK Topic: What African built environment academics and departments need to know and strategise in the march forward into the future		
15:45-16:00	CONFERENCE SUMMARY, PRESENTATION OF CERTIFICATES/PRIZES, VOTE OF THANKS PROFESSOR SAM LARYEA, CHAIRMAN OF WABER CONFERENCE		

PRIZES TO BE AWARDED AT THE WABER 2021 CONFERENCE

BEST RESEARCH PAPER AWARD

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 PRESENTATION AWARD

This prize is awarded to recognise 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.

GIBRINE ADAM PROMISING YOUNG SCHOLAR AWARD

This prize is awarded to recognize and encourage 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.

Professor Charles Egbu
Vice Chancellor
Leeds Trinity University, UK

WABER 2021 CONFERENCE
SPECIAL OPENING ADDRESS

Professor Charles Egbu joined Leeds Trinity University as Vice-Chancellor on 1 November 2020. He leads the University on all strategic matters; ensuring financial sustainability to allow the delivery of the University's Strategic Plan, including the overall vision and values of the University. He represents the University externally at various groups including Universities UK (UUK), Million Plus and the Cathedral's Group. He works closely with industry and professional bodies, especially in the Built Environment sector, and with local communities.

Professor Egbu's research interests focus on project management, construction management and sustainable development; subjects about which he has written 12 books and contributed to more than 350 publications in various international journals and conferences. He has supervised over 25 PhD students and examined over 100 PhD candidates world-wide. In addition, he has acted as an external examiner to many undergraduate and postgraduate programmes in universities all over the world

Richard Lorch
Editor-in-chief
of Buildings and Cities,
former editor-in-chief of Building
Research and Information
and executive editor
of Climate Policy

WABER 2021 CONFERENCE
INVITED SPEAKER FOR THE EDITOR'S FORUM ON TUESDAY 10TH AUGUST

Richard Lorch is an architect, researcher, writer and editor-in-chief of Buildings & Cities. He was the former editor-in-chief of Building Research and Information and executive editor of Climate Policy.

He is a visiting professor at University College London and Politecnico di Milano and on the advisory board of the Dresden Leibniz Graduate School. He works on organisational / policy responses to climate change - mitigation and adaptation paths - and the environmental impacts of the built environment and building performance at different scales from the individual building to neighbourhood to city.

As editor, his key concerns are fair, robust peer review assessment and feedback processes, author support and the diffusion and take-up of research and new knowledge by 'end users' - promoting two-way dialogue and co-production between stakeholders, practitioners, policy makers and the academic community.

WABER 2021 CONFERENCE
KEYNOTE SPEAKER

Professor Albert Chan
Department of Building
and Real Estate
Hong Kong Polytechnic University,
Hong Kong

Professor Albert Chan is Associate Director of RISUD and Able Professor in Construction Health and Safety and Chair Professor of Construction Engineering and Management, Hong Kong Polytechnic University, Hong Kong.

A Chartered Construction Manager, Engineer, Project Manager, and Surveyor by profession, Prof. Chan has worked in a number of tertiary institutions both in Hong Kong and overseas. He was a Senior Lecturer and Deputy Head of the School of Building and Planning at the University of South Australia.

Professor Chan joined the Department of Building and Real Estate of the Hong Kong Polytechnic University in 1996 and was Associate Head (Teaching) from 2005 to 2011; Associate Dean and Interim Dean of the Faculty of Construction and Environment from 2011 to 2013, and from 2013 to 2014 respectively.

His outstanding research performance has resulted in the appointment of Able Professor in Construction Health and Safety in August 2019. He has produced over 1,000 research outputs in refereed journal papers, international refereed conference papers, consultancy reports, and other articles. He has won numerous prestigious research paper and innovation awards since 1995. Professor Chan served as an expert member in the Built Environment Panel of FORMAS, Swedish Research Grants Council. He was also an expert member to assess the research performance of the Faculty of Architectural and the Built Environment, TU Delft, the Netherlands. Professor Chan is currently an expert member of the Engineering Panel of the Research Grants Council, HKSAR.

Professor Chan holds an MSc in Construction Management and Economics from the University of Aston in Birmingham, and a PhD in Project Management from the University of South Australia. He has been an Adjunct Professor in a number of universities. Professor Chan was also a Founding Director of Construction Industry Institute, Hong Kong, which was a joint research institution developed by industry and the academia.

Professor Taibat Lawanson
Department of Urban and
Regional Planning
University of Lagos, Nigeria

WABER 2021 CONFERENCE
KEYNOTE SPEAKER

Professor Taibat Lawanson is a Professor in the Department of Urban and Regional Planning at the University of Lagos, Nigeria, where she leads the Pro-poor Development and Urban Management Research Cluster. She is also co-director at the University of Lagos Centre for Housing and Sustainable Development. She holds a PhD in Urban and Regional Planning from the Federal University of Technology, Akure, Nigeria.

She has conducted extensive research on issues relating to urban informality, livability,environmental justice and pro-poor development. She is interested in how formal and informal systems can synthesize in the emerging African city, and written or co-authored over 60 articles in peer-reviewed journals, books and conference proceedings and enjoyed funding support for her work from UKAid, USAID, Cambridge Alborada Research Fund, GCRF, British Academy and University of Beyreuth 'Africa Multiple' among others. She is a member of the editorial advisory board of Area Development and Policy Journal of the Regional Studies Association and International Corresponding Editor at Urban Studies Journal.

She is also a member of the advisory committee of UNHABITAT fl agship 'State of the World's Cities Report'. She is a registered town planner and a member of the Hunan Capacity Development Association,Urban Aff airs Association and International Society of City and Regional Planners among others.Taibat is a proud alumnus of the prestigious Rockefeller Foundation Bellagio Academic Residency and is a 2013 World Social Science Fellow of the International Social Science Council.

Professor Asiah Abdul Rahim
Department of Architecture,
International Islamic
University Malaysia

WABER 2021 CONFERENCE
KEYNOTE SPEAKER

Professor Dato' Sri Ar Dr Asiah Abdul Rahim, is a Professor at the Department of Architecture in Kulliyyah of Architecture and Environmental Design (KAED), International Islamic University Malaysia (IIUM), apart from being a Professional Architect, she used to managed her own Architectural Firm, DASAR Architect, she is also a renowned architect in Designing and managing construction for various building typologies. She is also Universal Design Expert and an Access Audit Consultant.

She obtained her PhD from Oxford Brookes University in Oxford, United Kingdom with her previous degree of B. Arch from Deakin University in Australia and a Diploma in Architecture from our local University of Technology Malaysia (UTM). She was among the pioneer lecturers in establishing Kulliyyah of Architecture & Environmental Design (KAED) of International Islamic University Malaysia (IIUM) about 22 years ago.

WABER 2021 CONFERENCE
KEYNOTE SPEAKER

Professor George Ofori
Dean of School of the Built Environment and Architecture
London South Bank University, UK

Professor George Ofori specialises in Construction Management and Economics, at the project, company and industry levels. His main subject of research is the improvement of the capacity and capability of the construction industry, especially in developing countries. Professor Ofori was educated at the University of Science and Technology in Kumasi, Ghana where he obtained a BSc (Building Technology in Quantity Surveying) (First Class Honours). He worked briefl y in that university as a Teaching Assistant before proceeding to the UK to study for an MSc (Building Economics and Management) (Distinction) degree at University College London, from where he also obtained a Ph.D. degree in 1981.

He was subsequently awarded a DSc degree by the University of London in 1998. Professor Ofori is a Fellow of the Ghana Academy of Arts and Sciences. Professor Ofori worked with G.A. Takyi and Partners in Accra, Ghana, as a Senior Quantity Surveyor for two years.

From 1983 to 2017, he was employed by the National University of Singapore, where he was promoted to Full Professor in 1999, and was the Head of the Department of Building for fi ve years. He has been a consultant to many governments and international agencies on construction industry development.

We would like to sincerely thank
all our distinguished speakers
for accepting to be part of this year's

WABER 2021 CONFERENCE

CONFERENCE PAPERS

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West Africa Built Environment Research (WABER) Conference
WABER 2021 Conference, 9-11 August 2021, Accra, Ghana
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A STUDY ON INTERPERSONAL SKILLS OF NIGERIAN BUILT ENVIRONMENT PROFESSIONALS FOR THE SUCCESSFUL DELIVERY OF MASS HOUSING PROGRAMMES

Mansir Dodo[1], Muhammad M. Gambo[2], Kabir Bala[3] and Badamasi Abdulmalik[4]
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The Nigerian Economic Sustainability Plan (NESP) 2021 is the most current national plan in Nigeria. It aims to alleviate the economic emergency caused by the COVID-19 pandemic, as well as bridge the housing deficit in the country. The Mass Housing Programme of the NESP is predicted to provide 300,000 houses in 12 months. Also, the project is expected to produce 1.8 million jobs and help Nigeria reach Goal 11 of the Sustainable Development Goals (SDG). However, the capacity of relevant built environment specialists has affected the successful delivery of previous mass housing programmes in Nigeria, which poses a possible hurdle to the successful delivery of the planned Mass Housing Programme in the NESP. This research aims to study the interpersonal skill of the built environment professionals towards successful delivery of mass housing projects. The data was acquired using an online survey with the aid of a structured questionnaire. A total of 137 professionals participated in the survey. Data were analyzed descriptively and inferentially. Study discovered that none of the factors studied is deemed to be of essential priority. Likewise, the following interpersonal skills are opined to be of higher priority: decision making; leadership; communication; team building; motivation; trust-building; influencing, and conflict management. However, more attention must be given to the interpersonal factors coaching, negotiation, and political and cultural awareness. The implication of this study may imply that, to successfully deliver mass housing projects like the Mass Housing Programme proposed in the NESP, academic institutions, construction firms, and professional bodies must invest more in education and training programs supporting and facilitating coaching, negotiation, and, most importantly, political and cultural awareness.

Keywords: built environment professionals, interpersonal skills, mass housing programme, Nigerian economic sustainability plan

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ADOPTION OF TECHNOLOGY IN HUMAN RESOURCE MANAGEMENT - A NEW NORMAL

Kuforiji, A. Aramide[1], Eze, B. Daniel[2] and Fajana, Sola[3]
[1]*Industrial Relations and Personnel Management, Olabisi Onabanjo University, Nigeria*
[2]*Business Administration, Christopher University, Nigeria*
[3]*Employment Relations and Human Resources Management, University of Lagos, Nigeria*

The COVID-19 pandemic has disrupted socio-economic activities globally.In the same vein, police brutality, Black life matters in the US and ENDSARS protest in Nigeria re-emphasized the importance of technological advances in business activities. Before this period, businesses in Nigeria have been skeptical in using technology to run businesses, as employees have to resume work by 8:00am and leave after 8 hours of work. However, with the advent of COVID19 and ENDSARS protests, working from home with flexible work hours that are being practiced in technologically advanced economies is now becoming the new normal in Nigeria. This study examines the effect of technology adoption on human resource practices in selected manufacturing firms in Lagos and Ogun States, Nigeria. The study employed survey research design, through the administration of structured questionnaire on selected members of staff of the selected manufacturing firms. The findings reveal that e-hr implementation has a positive significant effect on HR practices with a coefficient of 0.5612(p-value <0.05). However, the findings further reveal that technology adoption has a negative significant effect on employees' collaboration and bonding. It can therefore be concluded that while e-hr has positively affected HR practices, technology adoption has negatively affected employees' collaboration and bonding. It is recommended that engagement strategies should be adopted by management to facilitate collaboration and bonding among employees while implementing e-HR in the organization.

Keywords: collaboration, COVID-19 pandemic, e-HR, emotional intelligence (EI), workplace

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ADVANCEMENTS IN COMPUTER-AIDED DESIGN AND THE CHALLENGES FOR ARCHITECTURAL EDUCATION IN NIGERIA – FEEDBACK FROM THE STUDENTS' INDUSTRIAL WORK EXPERIENCE SCHEME

Sunday A. Bobadoye[1], Dorcas A. Ayeni[2], Saidat D. Olanrewaju[3] and Ajenifujah-Aminat O. Ajenifujah-Abubakar[4]
[1,2,3,4]*Department of Architecture, Federal University of Technology Akure, Nigeria*

The paper examines the challenges that revolutionary advancements in Computer-Aided Design (CAD) pose to architectural education against the background of widespread applications of computers to architectural practice in twenty-first Century Nigeria. Architectural education as universities in Nigeria are offering it has not adequately responded to the challenge of equipping students to cope with computer applications to architecture and construction. On the other hand, design and modelling operations in architecture and construction establishments are mostly done in CAD. Using a structured questionnaire as research instrument, this paper seeks to answer some questions: 1. What CAD knowledge does the architecture school provide? 2. What CAD competency do students possess, and how were they acquired? 3. Was CAD competency required to secure internship placements? Feedback from the mandatory Student's Industrial Work Experience (SIWES) program undertaken by fourth-year students of the Department of Architecture, Federal University of Technology Akure, Nigeria (FUTA), was used to gauge students' preparation and expectations from architecture and construction establishments. The questionnaire administered on sixty randomly selected students was used in eliciting data and serves as feedback on which this study was anchored. Content analysis was used to analyse the data obtained. Results from the survey revealed that the current curriculum does not provide the students with adequate CAD competency to meet architectural workplaces' challenges. However, CAD competency was significant in securing SIWES placements, and self-help measures were the primary means to acquire CAD competency. The study suggests the collaborative design of a Twenty-first Century relevant CAD curriculum, establishment and maintenance of functional CAD laboratories, re-skilling and up-skilling of educators to equip architecture students for the profession's CAD realities.

Keywords: architectural education, CAD, curriculum, students 'industrial work experience scheme

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AN EXPLORATION OF SPATIAL LAYOUT AND COMMUNICATION PATTERNS IN TERTIARY HOSPITAL DESIGN: AN INNOVATIVE APPROACH TO SUSTAINABLE HOSPITAL DESIGN

Ejeh David Ekoja[1], Sagada Musa Lawal[2], Oluigbo Stephen Nwabunwanne[3], Maina Joy Joshua[4] and Sufiyan Mu'awiyyah Babale[5]
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Hospitals are designed to provide healthcare. This is the goal of any healthcare institution. From previous studies, 36% of the mortality rates in Tertiary Hospitals in Nigeria have been attributed to communication errors between and among healthcare professionals and patients. While it is obvious that there is a complex communication pattern in the Hospital environment, this study sought to investigate how the spatial layout is related to how the users of the hospital's spatial layout communicate. Thus, this study sought to probe specific ways the spatial layout is related to communication patterns in the Hospital environment. To achieve this, this study developed a conceptual framework that interpreted the spatial layouts in Hospitals based on the Space Syntax theory and communication patterns on the concept of organisational culture and social interactions. Based on the framework, a sequential transformative research design was used to guide the gathering, analysis and interpretation of data. Using DepthmapX and hospital design sketches, this study assessed the spatial characteristics of hospital design based on three spatial Depth and Shape of the Spatial layout. Closed Circuit Televisions (CCTVs) were used to monitor users' social networks in these spatial categories. In a bid to explore the relationship between spatial layout and communication patterns in Tertiary Hospital design, results revealed, among other findings, that the shape, size, and depth, of the Spatial layout contribute significantly to the predominant communication pattern in the Treatment and Diagnostics Areas (Vertical Communication patterns). This study concludes through an Evidenced-based Design framework that the spatial layout of the hospital is strongly related and influences the patterns of communication among healthcare professionals and between healthcare professionals and patients. It is, however, recommended that further comparative studies be conducted to validate findings in this study, as this study (a case study) was conducted to develop theory in this regard.

Keywords: communication patterns, organisational culture, social interactions, space syntax, spatial layout

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AN INNOVATIVE APPROACH FOR THE EVALUATION OF EXPANSION OPTION IN BUILDINGS

Yarima Sallau Lawal[1], Aliyu Makarfi Ibrahim[2], Mu'awiya Abubakar[3] and Ziyadul Hassan Ishaq[4]
[1,2,3,4]*Department of Building, Ahmadu Bello University, Zaria, Nigeria.*

Expansion option (EO) in buildings is more valuable when it is easier to achieve. Creating EO in initial building designs facilitate future expansion. However, this requires additional investment and the future is unknown whether or not the option would ever be exercised. This paper proposes an innovative approach for the evaluation of EO in buildings to avoid under or over-investment. Mathematical equations and algorithms were first developed based on the binomial method (BM) of real options analysis which were then implemented on a computer system. An algorithm was also developed for Monte Carlo simulation (MCS) and integrated with the binomial model. To illustrate its applicability, a real-life project was used to test the model. Sensitivity analysis was conducted to explore the influence of input variables on expansion option value (EOV). The result shows that inflation rate (i), borrowing rate (b), and rental value (Ri) are the most sensitive variables for EOV. An increase in i and Ri by just 5% causes a corresponding increase in EOV by 16.26% and 10.60% respectively. While an increase in b by just 5% causes a corresponding decrease in EOV by 14.61%. However, the least sensitive variables appear to be the discount rate (r) and volatility (δ). An increase in r by 5% causes a decrease in EOV by 6.9% while an increase in δ by 5% causes an increase in option value by 5.85%. Also, the result shows that creating EO in the initial design adds over 10% value to a building. More so, by integrating the BM with the MSC method, EOV increases by 190%. The model builds upon a previously developed model for evaluating building development option (DOV) which was found to have a result accuracy of 80.77%. It was recommended that building investment decision-makers should combine both BM and MCS to obtain more reliable and sustainable results.

Keywords: binomial method, building investment, expansion option, Monte Carlo simulation, sustainable building development

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AN INVESTIGATION INTO THE SAFETY PERFORMANCE OF PUBLIC BUILDINGS IN RELATION TO COMPLIANCE OF FIRE SAFETY REGULATIONS: A CASE STUDY OF ASHANTI AND GREATER ACCRA REGIONS OF GHANA

Samuel Asumadu Roberts[1] and Humphrey Danso[2]
[1]*Department of Building and Construction, Cape Coast Technical Institute, P.O Box Dl155, Cape Coast, Ghana.*
[2]*Department of Construction and Wood Technology Education, Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development, P. O. Box 1277, Kumasi, Ghana*

Ghana has experienced various forms of fire outbreaks emanating from domestic buildings, public buildings, industrial activities, and forests. It has become almost impossible to end a year in Ghana without recording incident of fire outbreaks that result in the deaths of individuals and loss of property. This study therefore aims at investigating the safety performance of public buildings concerning compliance with fire safety regulations in the Ashanti and Greater Accra regions of Ghana. A descriptive survey research design was adopted. The targeted population consisted of housemasters in public Senior High Schools and fueling station managers in Accra and Kumasi. Convenient and purposive sampling techniques were employed in selecting 72 housemasters and 384 filling station managers, and a questionnaire was used as a data collection instrument. The study found that the occupants of public buildings in Ashanti and the Greater Accra Region do not comply with safety regulations. It was also revealed that fire has caused many negative effects in Ghana from an economic perspective, population, safety, and security. A positive and significant relationship was found between compliance with fire safety regulation and safety performance of the public building ($F=127.293$, $df=308$, $p<0.01$). It was recommended that building owners should ensure that their buildings are well equipped with active and passive firefighting equipment. Also, training on fire safety, first aid, use of firefighting equipment, and evacuation procedure should be made compulsory for all building occupants and at regular intervals. This implies that compulsory compliance of fire safety regulation will give a positive effect on public building structures in performing their required purposes.

Keywords: compliance, fire outbreak, public building, safety performance

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Asumadu and Danso (2021) An investigation into the safety performance of public buildings in relation to compliance of fire safety regulations: a case study of Ashanti and Greater Accra regions of Ghana In: Laryea, S. and Essah, E. (Eds) Procs West Africa Built Environment Research (WABER) Conference, 9-11 August 2021, Accra, Ghana, 99-114

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AN INVESTIGATION INTO THE USE OF BUILDING INFORMATION MODELLING AND ITS IMPACT ON CONSTRUCTION PERFORMANCE WITHIN GHANAIAN CONSTRUCTION INDUSTRY

Frederick Kwasi Wirekoh[1] and Humphrey Danso[2]
[1,2]Department of Construction and Wood Technology Education, Aketen Appiah-Menka University of Skills Training & Entrepreneurial Development, Kumasi-Ghana

Building Information Modelling (BIM) is a key computer aided technology that can facilitate construction productivity enhancements through the removal of numerous construction inefficiencies. This study investigates the use of BIM and its impact on construction project performance in Ghanaian architecture, engineering and construction industry. A cross-sectional survey design was adopted for the study. Self-administered questionnaires were used for data collection from architects, structural and civil engineers, project managers, quantity surveyors, contractors and general foremen in Greater Accra, Ashanti and Western Regions. Purposive sampling technique was used to elicit information from 300 participants. Data was analysed through the use of multiple response analysis, relative importance index (RII), principal component analysis and descriptively analysis. The results indicated that experts in the construction industry obviously agreed that the use of BIM has a great impact on construction project performance. Increase productivity, improve product quality and create customer value, help in removing barriers and constraints, reduce time of project design and shop drawings, improve communication effectiveness, provide accurate cost estimation and take off materials, reduce conflicts and number of claims, reduce defects in the construction phase, increase collaboration in project design were considered by the respondents as the most important factors for project performance improvement. It is recommended that experts and stakeholders should encourage the use of BIM technology in Ghanaian construction industry to improve construction project performance to meet customer satisfaction and also boost the infrastructural development.

Keywords: building information modelling (BIM), construction performance, Ghana

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ANALYTICAL NEXUS OF URBAN LIVEABILITY, LIVEABLE COMMUNITIES AND PLACE-MAKING IN AFRICAN CITIES

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Literature suggests that there are sets of standard variables that can explain urban liveability differentials. These variables used to examine liveable city spaces are and contribute to the constructs for urban development. Therefore, the purpose of this paper is to analyse empirical linkages within urban liveability, place-making, and Liveable communities in Africa using a partial least squares path analytic method. This study examines the interrelationship within three important constructs using a questionnaire survey to obtain data from 390 residents across twelve (12) country capitals in the four major geographical zones in African. Using a path analytic approach, the paper examines the relationship between the constructs discussed in the study. The data analysis findings show that place-making influences Liveable communities and urban liveability. Therefore, the results indicate that cities that prioritise place-making have better liveable community spaces over those that do not. The study findings have implications for liveable communities, as it could help city development planners acknowledge the influence of place-making on urban liveability and liveable communities. The study contributes to the current debate on measuring urban liveability within the African City Space.

Keywords: Africa, liveable communities, place-making, quality of life, urban liveability

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ANFIS MODEL OF THE UCS OF MODIFIED SOIL FOR CONSTRUCTION PURPOSES

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Adaptive neuro-fuzzy inference system (ANFIS), which integrates both Takagi-Sugeno fuzzy logic and neural network principles and also captures their benefits in a single framework was deployed for the modelling of the unconfined compressive strength (UCS) of expansive clayey soil treated with hybrid binder (HB). The compaction properties, consistency limits and the HB were the predictors while UCS was the target in the evolutionary model. The advantages of artificial intelligence techniques deployment in geotechnical research is to deal with the complex challenges associated with effectiveness in the utilization of construction materials so as to achieve optimal assessment of geotechnical materials 'behaviour and sustainable engineering design. ANFIS model development was carried out with 35 data sets derived from the experimental responses with respect to varying proportions of HB treatment from 0% to 12%. 10 and 25 datasets were used for training and testing the network respectively. The UCS was the target response while the HB replacement ratio, compaction and consistency limits properties were the input variables of the developed model. The model evaluation results obtained using statistical tools showed mean absolute error (MAE) of 0.7196, root mean square error (RMSE) of 0.9004, mean square error (MSE) of 0.811, and coefficient of determination (CoD) value of 0.9992 for UCS response parameters. The results obtained indicate a very good performance in terms of prediction accuracy. This shows that ANFIS provides the flexibility in achieving sustainable geotechnical materials integration in the built environment.

Keywords: adaptive neuro fuzzy inference system(ANFIS), hybrid binder, soft computing, soil stabilization, unconfined compressive strength (UCS)

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APPLICATION OF INFORMATION AND COMMUNICATION TECHNOLOGY FOR THE IMPLEMENTATION OF HEALTH AND SAFETY MEASURES BY CONSTRUCTION FIRMS IN ABUJA, NIGERIA

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The Nigerian construction industry contributes 12% of Gross Domestic Product (GDP) to the nation's economy. In spite of this, studies have shown that health and safety (H&S) measures are poorly implemented by construction firms in Nigeria. Therefore, this study assessed the application of Information and Communication Technology (ICT) on the implementation of H&S measures by construction firms in Abuja, Nigeria. The study employed the use of quantitative research approach with the aid of questionnaire survey to obtain data from 25 construction firms in Abuja that are registered with Federation of Construction Industry (FOCI). Analysis of data was undertaken using Mean Item Score (MIS) and Relative Index (RII). Findings from the study show that H&S measures mostly requiring the use of ICT tools for proper implementation on construction sites which are Creating safety and health regulation and hazard identification, prevention and control (RII = 0.99). Site surveillance technologies (CCTV) is the ICT tools mostly required for monitoring the level of compliance to H&S measures on construction sites (RII = 0.98). The impact of ICT tools on the level of compliance to H&S measures on construction sites is significant (MIS = 4.46). Contractors 'compliance with safety regulation is the most effective strategy for enhancing the safety performance of construction firms on construction sites with the use of ICT tools (MIS = 4.44). It was concluded that use of ICT tools has significant impact on the level of implementation of H&S measures by construction firms. It was recommended that construction firms should set up workable mechanism for effectively implementing the strategies required to enhance the H&S performance of construction firms through the use of ICT tools.

Keywords: construction firms, health and safety measures, information and communication technology

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ASSESSING THE CAUSES OF MATERIAL WASTAGE AS IT AFFECTS VARIOUS BUILDING MATERIALS ON NIGERIAN CONSTRUCTION SITES

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There is an increase in quantity of waste being generated by construction activities and this has caused major concern for the construction industry. An ineffective planning and control of materials on site could lead to poor performance and undesirable project outcomes which in turn affects the overall cost of a project. Previous researchers have tried to study the most wasteful material on building construction site and also established general causes of material wastage. However, no attempt has been made to bring a synergy between the causes of waste and the type of materials been wasted. Hence, this paper aimed at studying the causes of material wastage as it affects each building construction material used on site with a view to having an effective cost control. A quantitative approach involving the use of a structured questionnaire was used to collect data on a five (5) point Likert scale of 1- strongly disagree to 5- strongly agree. Responses from the administered questionnaire were collated, interpreted and analyzed using descriptive statistics and results presented in tables. Results indicated that poor handling of materials is the major factor resulting to materials wasted during timber formwork, concrete works and ceramic/vitrified tiling works with mean value of 4.46, 3.74 and 3.64 respectively. Furthermore, poor supervision of operatives is the major factor causing material wastage in POP works and mortar for rendering with mean value of 3.87 and 3.85 respectively. Poor handling of materials, poor supervision of operatives and misuse of materials are the major causes of waste on construction sites irrespective of the building materials involved. These factors could result to cost overrun and undesirable project outcomes. Therefore, proper material handling and high level of supervision should be given consideration when using timber, concrete, ceramic tiles, plaster of paris (POP) and mortar in construction sites. The study has affirmed the need for studies to focus on developing viable strategies/techniques that would bring about improvements in material handling when using timber, concrete and ceramic tiles in construction sites.

Keywords: building materials, construction sites, plaster of Paris (POP), project, wastage

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ASSESSING THE LEVEL OF AWARENESS ON THE CONCEPT OF DESIGN FOR SAFETY (DFS) AMONGST DESIGN PROFESSIONALS IN THE CONSTRUCTION INDUSTRY IN NIGERIA

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Designing for construction safety entails safety considerations of construction workers and end users in the design of a project with a view to improve safety performance in construction project delivery. Despite the apparent potential benefits of Design for Safety (DfS) in curbing the persistent safety hazards and accidents faced in the conduct of construction activities, little or no effort has been made in most developing countries including Nigeria to ensure its wide adoption and implementation. This has been argued to be largely due to the dogmatic attitude of such developing industries towards conventional safety support systems and mechanisms. Thus, with a view to put the argument into clearer perspective, and also set the scene for effective DfS implementation in Nigeria, this study aimed to assess the level of awareness and readiness of professionals towards accepting the concept of DfS, and the possible changes that need to be made in the industry to facilitate its implementation. A quantitative research approach was adopted using a structured questionnaire to elicit data from randomly sampled professionals often involved in design for construction projects in the Nigerian construction industry. Data collected was analyzed using descriptive statistical methods. Findings of the study showed a relatively low level of awareness on the concept of DfS amongst industry professionals, and the need to constitute safety training programs which will go a long way in changing the perception of the design professionals towards safety. This will provide them with deeper insight on the contemporary trends in safety management tools and techniques for an improved safety performance.

Keywords: awareness, construction industry, design for safety (DfS), Nigeria, professionals

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ASSESSMENT OF FACTORS RESPONSIBLE FOR OUTSOURCING OF FACILITIES MANAGEMENT SERVICES IN THE PUBLIC HOSPITALS WITHIN KADUNA METROPOLIS

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Outsourcing is an increasingly popular strategy that healthcare organizations can use to control the rising costs of providing services. With outsourcing, an external contractor assumes responsibility for managing one or more of a healthcare organization's business, clinical, or hospitality services. Nigeria's public hospitals are not adequately equipped with the necessary best practice mechanisms to guide them in making right decisions regarding outsourcing of services while taking into consideration the likely risks that may be associated with such outsourcing transactions. This study assesses the factors responsible for outsourcing of Facilities Management Services in Public Hospitals within Kaduna Metropolis. The research was designed to assess the non-core facility management services outsourced in the selected hospitals. The population of the study were public hospitals within Kaduna metropolis. Convenience sampling technique was used in selecting the hospitals assessed. Data was collected using a well-structured questionnaires distributed to respondents. Descriptive statistics were utilized and data obtained was analysed with the aid of SPSS version 16. Results obtained from the analysis shows that though facility management services are outsourced in the assessed hospitals but it is as low as 29.63% while 62.965% of the services are being provided in-house and 7.41% are not rendered. Kaduna State Ministry of Health is encouraged to outsource more of the non-core services provided in-house in order to enable the state owned public hospitals focus more on their core services thereby improving their performance standard.

Keywords: assessment, facilities management services, hospitals, outsourcing, performance

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ASSESSMENT OF RESIDENTS' PERCEPTION OF INFRASTRUCTURE DELIVERY IN NIGERIA: THE TALE OF OSOGBO

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Peoples 'perception of the delivery of infrastructure is important in urban planning. This is because urban planning is a public activity hence information from people who are the recipient of planning activities assist stakeholders either to reverse deteriorating conditions or enhance existing successful programs. This paper assessed residents 'perception of infrastructure delivery across the identified different residential zones of Osogbo, Nigeria. This was with a view to identify the factors influencing residents 'perception of infrastructure delivery in the study area. The study area was stratified into three identified residential zones (traditional, transition and sub-urban). Using systematic sampling technique a total of 390 residents were selected for survey. Findings from the study revealed that residents ' socio-economic characteristics varied significantly with different residential zones.The study established that variation existed in the condition of environmental infrastructure across the study area. Also, the importance and satisfaction that residents derived from available infrastructure varied across residential differentials. Regression analysis revealed that residents perception of infrastructure delivery are significantly influenced by age with Beta value (β = -.253; p<.005), income (β = -0.197; p<.005), length of stay (β = 0.297; p<.005), and educational status (β = 0.281; p<.005). The study concluded that residents ' perception of infrastructure delivery differ significantly across the identified residential zones as reflected by residents socio-economic characteristics. The study recommends adequate provision of infrastructure needed by each category of people in the city.

Keywords: delivery, infrastructure, Nigeria, perception, urban planning

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ASSESSMENT OF SEASONAL FLOOD IMPACT AND MANAGEMENT STRATEGIES IN OKITIPUPA, ONDO STATE, NIGERIA

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Flood is becoming the most environmental challenge menacing Okitipupa in Ondo State. Many parts of the metropolis experience flood regularly most especially during and after rains. This study assesses how Okitipupa have been affected by flood menace incidences as it takes a look at the devastating impacts, remedial and management strategies at curbing flooding in Okitipupa which has almost become a yearly occurrence. Data were collected through the use of structured questionnaire from the respondents. A total of two hundred (200) questionnaires were administered to the respondents in the study area. The questionnaires were distributed using the systematic random technique at interval of ten housing units. Data collected were analyzed through the use of descriptive statistical analysis and presented using pie chart. The study reveals that the major cause of flood in the study area was high intensity of rainfall (21.5%) followed by dumping of waste materials and refuse into drainage (21%). Also, blockage of natural and artificial waterways (18.5%) and building on floodplain (16.5%) have contributed to the regular occurrence of flood in the area. Poor drainage system (14%) and improper planning and poor land use (8.5%) also contributed to flood in the area. Flood remedial and management strategies adopted by respondents include proper use of drainage system, proper refuse disposal, construction of drainage where there is none, proper land use planning, use of sandbags and river channelization. The study recommends enforcement of environmental laws that will restrict dumping of waste into the water body and sponsoring of public awareness and educative programs on how man's activities has contributed to flood occurrence.

Keywords: causes, floods, impacts, remedial and management strategies

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ASSESSMENT OF THE CHALLENGES AND SOLUTIONS TO IMPLEMENTATION OF SAFETY MEASURES BY SMALL AND MEDIUM SIZED CONSTRUCTION FIRMS IN ABUJA, NIGERIA

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Studies have revealed that construction firms lack proper implementation of safety measures on construction projects in Abuja, Nigeria. Construction works all over the world therefore pose serious threat to workers and non-workers in most of the developing countries such as Nigeria. This paper assessed the level of implementation of safety measures by small and medium sized construction firms (construction SMEs) in Abuja with a view to improving the safety performance of construction firms. This was achieved through: identification of the effective safety measures required on construction sites; examination of the challenges affecting the implementation of safety measures on construction sites; and suggesting strategies for improving the level of implementation of safety measures by construction SMEs. Data were obtained from selected construction SMEs in Abuja using structured questionnaire distributed to 50 randomly selected SMEs with a response rate of 92%. Relative Importance Index (RII) and Mean Item Score (MIS) were employed for data analysis. It was revealed that the use of personal protective clothing (MIS = 4.54) is the most effective safety measure required on construction sites. It was also found that ineffective management commitment (MIS = 4.63) is the most severe challenge affecting the implementation of safety measures by construction SMEs. The study also found that provision of personal protective equipment (RII = 0.94) is the most effective strategy for improving the level of implementation of safety measures on construction sites. It was however concluded that the level implementing safety measures by construction SMEs in Abuja is low. Therefore, this research recommends that construction stakeholders should encourage, ensure, and promote the proper implementation of safety measures in construction SMEs. This will assist to curb the challenges inhibiting safety measures implementation so as to improve the safety performance of construction SMEs.

Keywords: construction firms, construction SMEs, safety measures

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AUTOMATED RECOGNITION OF CONSTRUCTION WORKERS' PHYSICAL FATIGUE BASED ON FOOT PLANTAR PATTERNS CAPTURED FROM A WEARABLE INSOLE PRESSURE SYSTEM

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Construction workers are exposed to numerous non-fatal occupational injuries (e.g., fall accidents, work-related musculoskeletal disorders) due to physically demanding activities such as repetitive lifting tasks. One of the key preventive measures to mitigate these occupational injuries among construction workers is by recognizing workers ' physical fatigue. However, previous approaches for recognizing workers 'fatigue are subjective, time-consuming, and based on localized muscle fatigue. Therefore, the objective of this study is to develop a non-invasive approach to recognize workers ' physical fatigue by capturing foot plantar patterns measured by a wearable insole pressure system after a fatiguing repetitive lifting task. The experimental protocol was designed to recruit construction workers to participate in this study by collecting their foot plantar patterns during normal gait and after a fatiguing repetitive lifting task. The performance accuracy was evaluated by adopting five types of supervised machine learning classifiers and different window sizes. The results showed that the Random Forest classifier obtained the best classification performance with an accuracy of 95.8% and sensitivity of 97.8% using a sliding window of 2.56s. The findings indicate that the proposed approach would provide useful ergonomic intervention guidelines for early detection of workers 'physical fatigue, and thus enable safety managers to mitigate non-fatal occupational injuries among construction workers.

Keywords: construction workers, physical fatigue, repetitive lifting task, supervised machine learning classifiers, wearable insole pressure system, work-related musculoskeletal disorders

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AWARENESS AND ACCEPTANCE OF SMART SECURITY SYSTEM AMONG OCCUPANTS OF SELECTED PUBLIC BUILDINGS IN CENTRAL BUSINESS DISTRICT (FCT-ABUJA) NIGERIA

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Considering the persistence increase of burglary and fire incidences, coupled with lack of effective security systems (lock-and-key) in public buildings in Nigeria, there has been a clamor for an innovative and creative system like Smart Security Systems that can be deployed against all forms of intruders and related security challenges. This paper investigated the awareness, and acceptance of smart security system among occupants of selected public buildings in Nigeria with the Central Business District (CBD) FCT-Abuja as the area of study. Also, a gap exists in literature on a formal scientific approach to the analysis and evaluation of behavioral changes that will occur in public buildings in Nigeria in the context of smart security systems. To address this gap and present a formal analysis, this study adopted a cross-sectional survey research design with a quantitative approach to data collection using the study's population of 253 occupants of selected public buildings within the Central Business District (CBD) FCT-Abuja; out of which 153 occupants were randomly selected. The validated Smart Security System Questionnaire (SSSQ) was used as data collection instrument. 132 representing out of 153 copies of SSSQ were analyzed using frequency, percentage, mean, standard deviation in tabulation format; these values were subjected to ANOVA evaluation in order to determine the strong and weak data components. These statistics which were scientifically computed with the aid of Statistical Packages for Social Sciences (SPSS) at 0.05 (p-value) is a true test of statistical significance. Findings from the study reveal that while the occupants of public buildings believe that a smart security system will make their offices more secure, the expected level of acceptance to the operation of their workplace as a result of changes that will occur due to the incorporation of a smart security system has not been observed. It was also found that the management and occupants of selected public buildings in Central Business District (CBD) FCT-Abuja are quite aware of Smart Security System as security mechanism; they showed an appreciable level to accept, deploy and implement the system in their building architecture. The one-way ANOVA test performed revealed significant statistical difference between group means for readiness level and perceived usefulness for smart security systems.

Keywords: acceptance, awareness, knowledge, perceived usefulness, smart security system

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AWARENESS AND PERCEPTIONS OF CONSTRUCTION PROFESSIONALS ON ENVIRONMENTAL RISKS IN CONSTRUCTION PROJECT DELIVERY IN LAGOS AND ONDO STATES, NIGERIA

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Conventional construction project delivery is very destructive and leads to high environmental risks. Meanwhile, a risk management approach can be employed to manage the environmental risks and prevent destructive project delivery. However, this requires proper identification and evaluation of the environmental risks, but it is yet to be investigated in the research. Therefore, this study assessed the awareness and perceptions of construction professionals on environmental risks in construction project delivery in Lagos and Ondo States, Nigeria. More also, evaluation of the likelihood of occurrence and severity from the perspectives of 100 construction professionals working in environmentally vulnerable areas in Lagos and Ondo States, Nigeria. The survey was presented online using Google forms for the administration of questionnaires to the sampled construction professionals. It comprises two sections. The first section comprises a qualification question about respondents 'involvement in a construction project delivery in environmentally vulnerable areas such as the Lagos Island in Lagos State or the Ondo State South Senatorial District in Ondo State. A 'YES 'response will enable them to complete the survey, whereas a 'NO 'response will automatically terminate their participation in the survey. The second section comprises questions that cast as multiple-choice variables and rated by respondents on a five- point Likert scale about environmental risks and their likelihood of occurrence and severity.Data obtained from the questionnaire survey was analyzed using percentage frequency distribution and mean score. Of the five common environmental risks identified in the literature, the findings reveal that the risk of air pollution is the commonest, most likely to occur and when it does occur it is the most severe. The other environmental risks such as the risks of land degradation and noise and vibration, have high scores which suggest that they are more common, more likely to occur and more severe when they occur. Furthermore, the risk to flora and fauna has the least score in terms of commonness, likelihood to occur and severity. This study concludes that identifying and evaluating environmental risks in terms of commonness, likelihood to occur and severity can be employed for environmental risk management in construction project delivery. The risk of air pollution and the risk to flora and fauna should be accord the highest and least priorities in environmentally vulnerable areas in Lagos and Ondo States in Nigeria. This suggestion is applicable to other environmentally vulnerable areas in Nigeria and other countries where construction professionals have strong environmental vulnerability perceptions.

Keywords: construction project delivery, environmental risks

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AWARENESS OF GREEN INFRASTRUCTURE AND ITS SOCIO-DEMOGRAPHIC PREDICTORS AMONG RESIDENTS OF LAGOS METROPOLIS, NIGERIA

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Green Infrastructure (GI) is being promoted as a strategy to mitigate the adverse effects of environmental sustainability challenges. However, the extent to which residents are aware of the different types of GI in order to show stewardship and also enjoy the benefits provided by these facilities remains unclear, especially in the global South. This study examined residents' level of awareness of GI and its socio-demographic predictors in selected neigbhourhoods in Lagos Metropolis, Nigeria. Totally, 1560 residents completed a semi-structured questionnaire using multi-stage sampling technique. Descriptive and multiple regression analysis were performed. Results show that 22 types of GI existed in the study area but a high proportion of the respondents were only aware of green gardens, parks, grasses, street trees, and sport fields. Marital status, education, income among others, emerged as significant predictors of GI awareness among respondents. City managers and policy makers should focus more on these identified factors in their attempts to improve the quantity and quality of GI and in creating more awareness among residents in Lagos Metropolis and other cities in sub-Saharan Africa.

Keywords: awareness, conservation, environmental sustainability, green infrastructure (GI), urban centre

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BIM EDUCATION ONTOLOGY: TOWARDS A RESEARCH AGENDA FOR NON-INDUSTRIALISED ECONOMIES

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BIM education is the cornerstone in addressing the shortage of BIM knowledgeable practitioners, currently experienced by the construction industry. To address this shortage, most industrialised economies are at the least, fine-tuning the incorporation of BIM education into higher education. BIM education ontology, though similar in nature, applies differently across the industrialised and non-industrialised economies, thus demanding differing approaches toward managing research gaps. While several studies on BIM education have been carried out in the non-industrialised economies, there is a lack of common frame of reference for managing research gaps in BIM education within these economies. By undertaking critical literature review, this paper explores the main themes within BIM education field of research. Relying on the theoretical research gap framework proposed by Miles (2018) to espouse the main considerations (in terms of concepts and properties) in BIM education research and their interdependencies, a conceptual model for BIM Education ontology is proposed. Based on the conceptual model, global considerations in BIM education centres around three main themes: curriculum, integration and implementation. Research gaps within curriculum are largely focused on insufficient curriculum, lack of unified method of assessment/evaluation, and lack of specific teaching methods; those within integration are inadequate collaboration between academia and industry; while those within implementation concentrates on lack of strategies on BIM implementation and competency deficits. Drawing upon the differentials between the industrialised and non-industrialised economies, the paper concludes by providing insights to newer research directions particularly targeted at addressing the challenges of incorporating BIM education into Higher Education in non-industrialised economies.

Keywords: BIM education, conceptual model, higher education, non-industrialised economy, ontology

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BIM UTILIZATION IN FACILITIES MANAGEMENT PRACTICE: A STATUS STUDY IN SOUTH AFRICA

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Facilities Management is the most extended phase in the life cycle of a facility. To effectively manage facilities' electronic information is needed. An integrated information management system such as Building Information Modelling (BIM) can be utilised to support data at any given phase of a building life cycle. Literature review shows that there are benefits to using BIM in Facilities Management. However, there is insufficient research regarding the use of BIM in Facilities Management in South Africa. The purpose of this research was to investigate the extent to which BIM is utilised in the South African Facilities Management sector. The findings reveal that majority of Facilities Management practitioners are not utilising BIM, due to factors relating to cost and week support organisations. Those who use BIM believe that the model does not have enough information to carry out all Facilities Management activities.

Keywords: BIM, buildings, facilities, ICT, management

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CHALLENGES TO SUSTAINABLE AFFORDABLE HOUSING USING FRUGAL INNOVATION

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Across the globe, and especially in the developed world, housing remains one of the crucial challenges of growth due to the immense difference between housing supply and demand. Broadly speaking, the housing crisis is primarily a matter of demand for housing, outstripping supply and/or the price of housing above the average worker's income. The global COVID 19 pandemic has shown how important it is to reduce the global housing crisis by ensuring sustainable, affordable, and healthy housing for all. However, in terms, of financial and limited natural resources, one idea currently gaining traction is frugal innovation. The aim of this research is to establish the challenges to sustainable affordable housing using frugal innovation. Frugal innovation is simple, a low-cost innovation (LCI) developed to serve customers at the bottom of the pyramid (BOP) of the unserved mass market. A comprehensive literature review was conducted using a deductive approach. The structured survey questionnaire was used as an instrument for collecting data, using a non-probability purposive sampling technique, and the data was analysed using descriptive statistics. The seven (7) most significant challenges to sustainable affordable housing using frugal innovation in Ghana are; difficulty in significantly lowering costs while retaining functions, perceived low benefit or profit return on investment, lack of research and design, lack of demand, ineffective local partners, difficulty establishing key functional elements, and low confidentiality. This research will build an immense contribution to improving the access for all adequate, safe and affordable housing and basic services and upgrade the slums of the sustainable development goal target of the 2030. Future research should focus on how to use frugal innovation to effectively establish the core functional elements of a sustainable, affordable housing system, and how to apply frugal innovation to other construction sectors, especially in developing countries.

Keywords: affordable housing, frugal innovation, sustainability

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COMPARATIVE ANALYSIS OF SOUNDNESS AND SETTING TIME OF PORTLAND CEMENT OF THREE COMPANIES IN NIGERIA

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This study was designed to compare and analyze the soundness and setting time of Ashaka, BUA and Dangote portland cements in Nigeria. For quite some times in Nigeria, the news of collapsed building has been forming the headlines of Nigerian newspapers, some of the reasons for the collapsed buildings were attributed to the quality of materials used, the workmanship, as well as the integrity of professionals that handled the projects. To carry out this study, Explanatory Sequential Mixed Method Research Design was employed for this study. In the first instance, laboratory experiments were carried out using Le chatelier apparatus to carry out the soundness test, while Vicat apparatus was used to analyze the setting time of the cement samples from the three companies. The samples from the three companies were used and the results were presented in tables and charts format. The results of the study revealed that: Dangote is sounder with its expansion of 0.1mm, followed by Ashaka Portland cement with the expansion of 0.2mm and lastly BUA Portland cement with the expansion of 0.3mm. In terms of setting time, Dangote cement took longer time to finally set than Ashaka and BUA Portland cements. All the cement samples tested adhere to the required standard as specified by the British standard Institute (BS, 4550, 1978) which states that the individual cement expansion should not exceed 10mm. Based on the results of the study, it was recommended that: the three cement companies 'products are good for construction of any building in Nigeria and the world over, hence, the quality of production by the three companies meet the required standard as spelt out in the BS.

Keywords: Portland cement, setting time test, soundness test

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CONCEPTUAL FRAMEWORK FOR WHOLE-LIFE COST DATA TRANSFORMATION AND MODEL SELECTION IN THE BUILDING SECTOR

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Data for Whole Life Costing (WLC) is obtained from multiple sources in different formats. This inhibits data sharing between built-environment costs professionals thereby adding to data related problems often associated with WLC. This paper presents a proposed framework for mapping WLC data to models, as well as transforming data into a variety of formats. Framework components, variables and processes were identified from literature and synthesized into a conceptual framework. Also, a matrix of transformation logic was produced to compliment the model selection process. Seven data related scenarios and possible decisions/ courses of actions were derived from the framework. Additionally, seven useful data types and fourteen data formats were identified. Of the fourteen formats random statistical data, probability density functions and fuzzy membership functions were found to be the most important in terms of transformability ranking. The framework provides strategic decision guide for cost professionals during the preparation of WLC data and the selection of a suitable model, while the transformation processes provides a procedural guide for converting data into different formats. The findings set the stage for the development of transformation and integration algorithms to support computer coding, and the design and implementation of a database that would facilitate the storage and retrieval of data in multiple formats.

Keywords: data integration, data sharing, data transformation, whole life cost data, whole life cost models

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CONSTRUCTION IN DEVELOPING COUNTRIES: NEED FOR NEW CONCEPTS AND THEORISING OF CONTEXTUAL SPECIFICITIES TO THE GLOBAL CORPUS OF KNOWLEDGE

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Studies on construction industries in developing countries have resulted in a distinct field of knowledge. The aim of this study is to contribute to the debate on whether new perspectives and concepts of the body of knowledge of construction in developing countries must be found because of the requirements and contexts of developing countries. The study is based on a review of the literature on the body of knowledge of construction in developing countries. It is found that developing countries need high volumes of constructed items, but the capacity of the construction industries in these countries, and their performance require major improvement. Research should contribute to improving the industry's capability and performance. However, progress in the development of the body of construction in developing countries has stalled. Subjects on which further research is most needed are outlined. It is concluded that the construction industry in developing countries requires more sophisticated approaches and analyses than their industrialised countries counterparts. It is necessary to reconsider construction in developing countries to enable research on the subject to contribute to practice in improving the performance of the industries in those countries.

Keywords: body of knowledge, capacity and capability, construction in developing countries, research new perspectives

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CONTRACTORS' SELECTION AND ITS EFFECTS ON WATER INFRASTRUCTURE DELIVERY

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Recognising the impact of the dearth of water infrastructure on the economy and social wellbeing of the citizens, the government of South Africa has continued to invest in the development of suitable water infrastructure. Unfortunately, the current pace of water infrastructure delivery is not complementary to the investment made, due to an ineffective procurement system that fails to produce quality performing contractors. The work quality of contractors influences the successful execution of infrastructure delivery. Therefore, it is imperative to evaluate the current procurement system. In this research, the single site case study method of qualitative research was adopted. Semi-structured questionnaires, complemented by interviews, were used as instruments for data collection. The participants were drawn from the supply chain management functions unit, the bid adjudication committee, technical team, consultants, and contractors. The findings revealed that the combined effects of the use of an ineffective procurement system and low capacity of professionals in the in-house team of the client have contributed to the delays in procuring the services of the specialist sub-contractors required for the execution of the rehabilitation scheme of the Clanwilliam Dam project. Therefore, this research recommends the adoption of contractors 'pre-qualification to facilitate the selection of quality contractors as well as to increase of the capacity of the in-house professionals.

Keywords: Clanwilliam dam, contractors 'pre-qualification, selection of quality contractor, procurement process, water infrastructure delivery

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COVID-19 PANDEMIC AND CO-WORKING ENVIRONMENT: ANALYSIS OF SHARED OFFICE SPACE IN FEDERAL CAPITAL TERRITORY (FCT), ABUJA, NIGERIA

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The study examined the impact on Covid-19 pandemic of shared office spaces business in FCT, Abuja. The host (managers) and the customers (users) of shared office spaces constitute the study population. A total of 16 shared office spaces selected participated in the survey exercise. The choice of selection was based on location i.e. those operating within Central Business District, Abuja and showed interest to participate. All the 16 managers (host) and 58 customers (users) that gave attention to participate were administered with questionnaire. The study employed descriptive statistical tools such as frequency distribution, percentage and weighted mean score (WMS) to analyse the data. The study found that majority of the managers i.e. 56.27% were female, 43.75% were of age bracket 31-40years and 81.75% were HND/B.Sc. school certificate holders. The users were more of male gender (63.79%) with dominance age group of 21-50years representing 89.64% and about 79.31% were holders of HND/B.Sc. certificate. Professions in the real estate industry accounted for 55.75% of the managers ' professional background. The start-up/entrepreneurs and freelancer were the major users of the shared office facilities. The reasons for high rate of patronage by the users (WMS) were affordability (4.069), concentration (3.879) and flexibility of time/price plan (3.793). The managers ranked challenges (WMS) such as low patronage/demand (4.688), passive economic activities (4.063) and users 'psychological effects (4.000) as the prominent ones faced during the pandemic period. Meanwhile, the COVID-19 safety measures that exhibited prominent impact on the business activities were stay-at-home order and social/physical distancing with respective WMS of 4.438 and 4.125. The study concluded that the negative effects on property market and by extension shared office spaces businesses suggests the need for sustainable policy framework that will protect the economy and by extension real estate sector from the future occurrences of any outbreak of global pandemic

Keywords: challenges, co-working, covid-19, health, shared office

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DESIGN TRENDS AND FUTURE PLANNING FOR INCLUSIVE DEVELOPMENT IN TROPICAL BUILT ENVIRONMENT

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A brief history of the introduction of Universal Design and Accessibility in Malaysia where it has been established since 1990 of three Malaysian Standards regarding design for access to buildings. Coping with the demands of providing accessibility for Persons with Disabilities (PwDs) and the elderly has been a challenge for these past three decades. The intention is to distinguish current Universal Design trends and the level of public and professional awareness of inclusive development. Furthermore, an exploration of integrating inclusive development within the tropical built environment and our social construct of Asian culture and lifestyle. As a summary, to cater design for diverse age and ability is esteemed in providing recommendations or innovation design solutions to accommodate access design that complements in creating an accessible built environment.

Keyword: accessibility, access design solution, inclusive development, universal design

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DETERMINATION OF FACTORS THAT INFLUENCE LABOUR OUTPUT ON CONSTRUCTION SITES IN GHANA

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Labour output affects construction performance in most developing countries. This study aimed at determining the factors that influence labour output on construction sites in Ghana. The research design adopted for the study was a descriptive survey. The study focused on site-level operatives in active operation at their various construction sites. A sample size of 220 site-level operatives was considered. A questionnaire was used as data collection instrument. The study revealed that payment delay, inspection delay, rework, poor communication, unavailability of needed tools, lack of labour supervision and shortage of materials are the major factors that affect labour output in construction sites. The study concludes that labour output of construction workers in Ghana is affected by several factors. It is recommended that construction managers regularly inspect and pay attention to the quality of construction materials and tools used in projects to eliminate inspection delay and unavailability of needed tools.

Keywords: construction sites, inspection delay, labour output, payment delay, labour productivity

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DEVELOPING A FRAMEWORK FOR PUBLIC PRIVATE PARTNERSHIP PROJECT GOVERNANCE IN NIGERIA

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The widening gap in infrastructural deficit especially in the developing world has forced governments to explore innovative financing methods where private sector investments are attracted through a mutually beneficial arrangement called Public Private Partnership (PPP). However, PPPs are not solutions to all infrastructural problems due to variation in project type and settings. Despite the various benefits of application of PPP in project management, there has not been a unified structure/framework for successful implementation of PPP arrangement in project governance in Nigeria. This study therefore attempts to develop a framework for implementing PPP projects with a view to enhancing the service delivery performance of PPP in project governance in Nigeria. Conceptually, the studied reviewed critical factors affecting PPP in project governance, project governance, Critical Success Criteria (CSCs) and Critical Success Factors (CSFs) for PPP in project governance. Using examples from both developed and developing world, the study established the inter-connectivity between elements of PPP structure, Critical Success Factors (CSFs) and Critical Success Factors (CSFs) in the development of the framework to enhance service delivery performance of PPP in Project Governance in Nigeria. It was concluded that the success of PPP project governance in Nigeria fundamentally depends on the adoption of an integrated framework.

Keywords: framework, governance, infrastructure, Nigeria, public private partnership

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DEVELOPMENT OF SOCIAL HOUSING AGENDA TO SOLVE HOUSING DEFICIT IN SUB-SAHARA AFRICA: A CASE FOR OGUN STATE, NIGERIA

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The cumulating housing deficit and its consequences in most Africa nations has called for a review of housing policies and initiatives across the sub-Sahara Africa. Scholars have advocated integrative social housing (SH) strategy as possible solutions for adequate supply of housing to the citizenry. The paper reviewed the State's policy initiatives to solving housing provision challenges in Ogun State, Nigeria. The aim is to showcase the efficacy of social housing programme as a sustainable option to providing housing that meets the need of low-medium income group of the population in terms of accessibility and affordability. The study adopts qualitative research approach, using content analysis of reviewed literature and a Focus Group Discussion (FGD) of 10 professionals in the built environment from the academia. The study found that there is neither a specific policy/programme for social housing nor development models in Ogun State. The paper suggests policy reforms incorporating SH initiatives within the notion of affordability in the open-market economy. This study in its contribution to solving housing problem, viewed social housing with the involvement of the Private Sector as a possible solution to eradicate housing supply deficit in Sub-Sahara Africa.

Keywords: development models, housing supply, intervention, policy, social housing

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DIURNAL TEMPERATURE CHANGES AND PHYSIOLOGICAL EXPERIENCE: CASE STUDY ANALYSIS OF INDOOR CONDITION IN A SCHOOL ENVIRONMENT IN NIGERIA

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Studies have shown that school residence and hostels thermal environments could impact on thermal comfort and learning performance. Majority of current researches on the school indoor thermal environment have been focusing on urban areas, but notably little research has been conducted on rural and medium-size urban schools. The present study characterized the daytime thermal condition (in terms of the ambient air temperature change) in a University campus in southwest Nigeria, and examined the perception of students in the halls of residence on thermal condition and their strategies for coping with extreme thermal cases. Ninety-eight (98) copies of a set of structured questionnaire were administered, and the weight and body temperature of the respondents were measured alongside with the ambient temperature and relative humidity at morning and afternoon sessions, making a total of 196 sessions. Diurnal thermal range varied between 32.4°C and 35°C in the morning and between 26.5°C and 30.9°C in the evening. Thirty-five (35%) percent of the subjects (young male and female students, aged 18 – 45 years) associated thermal discomfort with restlessness and profuse sweating but 13% did not feel any significant thermal stress within the study period. Also, effects of thermal stress varied diurnally; whereas 65% of the subjects experienced heat rashes and headache in the evening and afternoon, respectively, about 10% experienced profuse sweat and chest constriction in the morning. Lastly, perception of thermal stress varied with room temperature, subjects 'body weight, period of the day and ventilation. The study concluded that thermal discomfort in the area is influenced by indoor and outdoor atmospheric conditions as well as subjects 'physical and physiological characteristics.

Keywords: indoor characteristics, perception, physiology, temperature, thermal stress

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EFFECT OF CEREAL FLOURS ON THE PROPERTIES OF CONCRETE

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In hot weather in order to overcome accelerating effect of high temperature retarding admixture are added to concrete to slow down the initial hydration so that concrete remain plastic and workable for longer period of time which will gives room to high volume placements. The research is aim at investigating the effect of cereal flours made from maize and sorghum on the properties of concrete; this is with a view to establishing the results of the selected cereals as retarder in concrete. The mix used for the research was calculated using the BRE method and the water cement ratio of 0.6 was used. The mix ratio of 1:1.13:3.40 was used. Trial test was conducted with maize, sorghum, wheat and millet. The cereal was ground, sieved and added in various percentages by weight to the cement, mix and cast in a cube of 100 by 100 by100mm mould left in the mould for 24 hours then demould and immersed in water for seven days. After seven days it was tested for compressive strength, the sorghum and maize gave the highest and higher values of compressive strength respectively and therefore used for the main work. The same procedure was used for the main work the samples used were produced in three different batches. The first sets of batches were the control samples which also served as source of comparison. The second and the third batches had various percentages of maize and sorghum flour added respectively. The curing was done by complete immersion for 1, 3, 7, 28 and 56 days for all the samples. It was observed that the maize flour has higher starch content, PH and solubility than the sorghum flour. The cyanide content of sorghum flour was higher than the maize flour. The compressive strength increase as the age of curing increases. Sorghum flour had higher values of compression strength than maize flour. The optimum compressive strength of the test specimen is achieved at 3% dosage of maize and sorghum flour added to the cement. Maize and Sorghum flour improved the workability of concrete; it was observed that as the dosage of cereal flour increases, the slump increased. Maize and sorghum flour also delay the setting time of cement, for sorghum flour added to cement the setting time is achieved at 410 minutes while for maize is 248 minutes. Sorghum and maize flour are good sources of retarding admixture to concrete.

Keywords: cereal flours, compressive strength, concrete, retarding admixture, setting time

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EFFECT OF PALM KERNEL SHELL AS COARSE AGGREGATE ON THE PROPERTIES OF CONCRETE

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The prospective shortage of conventional aggregate and the environmental impact due to its production are some of the driving forces promoting the use of agricultural or industrial wastes as aggregate for concrete production. This study investigated the influence of palm kernel shell (PKS) as partial replacement of coarse aggregates on the properties of concrete. Concrete specimens containing 0-30% PKS to partially replace coarse aggregate (crushed granite stone) were produced and subjected to workability, compressive and tensile strengths, abrasion, absorption and sorptivity tests. The specimen with 0% PKS is the control for comparison. The result showed that PKS improved workability but reduced compressive strength, tensile strength and abrasion resistance of concrete. However, the specimen containing 10% PKS showed comparable performance with the control. Therefore, 10% PKS could be used to partially replace crushed granite stone for concrete production.

Keywords: absorption, aggregates, concrete, durability, palm kernel shell (PKS), sorptivity

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EFFECT OF PETROLEUM CONTAMINATION ON PROPERTIES OF COMPRESSED STABILIZED EARTH BRICK (CSEB)

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The Niger Delta region is the epicenter of petroleum exploration and extraction activities in Nigeria contributing to oil spills experienced in the region. Attention has been drawn to its effects on fishing and farming activities while less attention is paid to effects on soils for construction activities. This research ascertained the effect the presence of petroleum had on properties of compressed stabilized earth bricks (CSEBs) made from artificial petroleum contaminated laterite. Three sets of bricks were produced having a binder made up of rice husk ash (RHA), carbide and cement in predetermined proportions. Out of the three sets, two sets were made from laterite artificially contaminated with 2% and 3% petroleum while the third set had no contamination and acted as the control (0%). The results revealed that bricks made from petroleum contaminated laterite performed favourably on all selected tests in relation to the control at the various allotted test days respectively. It can therefore be inferred that laterite having petroleum contaminants in very minute quantities in combination with pozzolans like rice husk ash (RHA) and carbide can be used for the production of CSEBs and utilized in building construction in the Niger Delta region of Nigeria.

Keywords: compressed stabilised earth brick, laterite, petroleum, pozzolans

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EFFECTS OF MAXIMUM AGGREGATE SIZES ON FLEXURAL STRENGTH OF RECYCLE IRON AND STEEL SLAG CONCRETE

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The needs for sustainable development to meet the increasing demand of granite for infrastructural development couple with environmental degradation and pollution caused by depletion of natural igneous deposit.Studies on structural integrity of recycled iron and steel slag (RISS) as aggregate in concrete have not been adequately investigated especially flexural characteristics of RISS concrete. The study adopted experimental approach to evaluating the effects of maximum aggregate sizes (MAS) on flexural strength of RISS concrete.Laboratory tests conducted on both granite and RISS aggregate include aggregate crushing value (ACV),aggregate impact value (AIV), Sieve analysis and X-ray fluorescence (XRF);flexural strength test was conducted on the concrete prism. Two sets of 600mm × 150mm × 150mm concrete prism were cast viz control and treatment; treatment concrete contains RISS aggregate at 10, 20, 40 and 60 % replacement level. The concrete prism were subjected to flexural strength test at 28 day curing.The results obtained for ACV, AIV and Sieve analysis showed that RISS aggregate are durable, tough, hard and well graded. Flexural strength values for mix ratios 1:1½:3, 1:2:4 and 1:3:6 ranges from 0.229 – 0.255 MPa, 0.210 – 0.219 MPa and 0.152 – 0.215 MPa for treatment concrete and 0.225 – 0.234 MPa, 0.202 – 0.205 MPa, and 0.134 – 0.174 MPa for control concrete these values were within the values of 0.130 – 0.250 MPa specified by BS 8500 -2: 2015. In conclusion flexural strength for both concrete increases as the maximum aggregate size decreases. RISS concrete can be use in road pavement and where high flexural strength is required.

Keywords: flexural strength, maximum aggregate size, riss aggregate, steel slag, x–ray fluorescence

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EFFECTS OF SAND ON THE PROPERTIES OF CEMENT-LATERITE INTERLOCKING BLOCKS

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In recent years, the attention of researchers is shifting towards the optimization of building materials by using local contents, indigenous materials, and local industrial by-products that are abundant in certain localities. This study investigates the effect of sand on the properties of cement–laterite interlocking blocks. Cement-laterite interlocking blocks were prepared with lateritic soil which was replaced with conventional fine aggregate (sand) from 5 to 25% by weight. Cement-laterite interlocking blocks without sand (0%) served as control. The blocks produced were tested to determine their density, compressive strength, and tensile strength. The average density of cement-laterite interlocking blocks increased as the percentage of sand content in the blocks decreases. The highest compressive strength (9.1 MPa) at 28-day curing of the cement-laterite interlocking blocks was obtained at 5% sand replacement, which is about 13% increase in strength over the control blocks. It was further revealed in the stress-strain relationship result that the 5% sand replacement of laterite achieved the highest stress while the 15% replacement achieved the highest strain of the cement-laterite interlocking blocks. The highest tensile strength (0.707 MPa) at 28-day curing of the cement-laterite interlocking blocks was also obtained at 5% sand replacement, which is about 9% increase strength over the control blocks. The study concludes that the sand replacement laterite in cement-laterite interlocking blocks have the potential of supporting the sustainable housing concept, and therefore recommends to manufacturers 5% sand replacement of laterite in producing cement–laterite interlocking blocks.

Key words: compressive strength, interlocking blocks, laterite, tensile strength

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ENABLERS OF MUTUAL SATISFACTION IN TRANSNATIONAL PUBLIC INFRASTRUCTURE DEVELOPMENT: THE CASE OF SINO-GHANA

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Sino-Ghana relations have steadily grown over the years and have influenced the increase in various economic sectors especially infrastructure development in Ghana. The unique nature of Chinese corporations heavily engaged in Ghana's infrastructure development has captured research attention. Although several studies have been done on Sino-Ghana trade and infrastructure relations, little attention has been placed on the achievement of mutual satisfaction (MS) for both parties. It is crucial to empirically investigate MS in these partnerships since both parties having distinct interests, collectively work towards the provision of public infrastructure. This study adopted a three-staged approach of identification, assessment, and modelling of factors that enable the achievement of MS in transnational infrastructure partnerships. This involved an extensive review of literature and elicitation of views from purposively sampled private and public experts. The Interpretive Structural Modelling (ISM) approach was adopted in modelling the enablers which generated a systemic structure highlighting their relationships. Results indicated that enablers of achieving MS in these partnerships are interrelated and collectively act to create an environment of achieving mutual satisfaction. The enablers of MS include fair risk-bearing, equal and active participation of project parties, flexible contracting, strategic negotiation, efficient private and public sector capabilities, equitable distribution of project benefits, existence of mutual trust, and commitment. This paper provides an objective approach towards the quest for achieving mutual satisfaction and summarizes enablers that can be used in pushing the attainment of MS in China-Ghana infrastructure relations. Findings can be used as a basis for policy development uniquely for these partnerships to also improve the achievement of value for money and overall project success in China-Ghana infrastructure relations.

Keywords: Interpretive Structural Modelling (ISM), Mutual Satisfaction (MS), public infrastructure, Sino-Ghana, transnational

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EVALUATION OF HEALTH AND SAFETY COMPLIANCE OF CONSTRUCTION PROJECTS IN SOUTH EAST NIGERIA

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This research is about the evaluation of the level of construction projects compliance to health and safety regulations (South East Nigeria) with a view to identifying action plans for enhancing the compliance in South East Nigeria. This study which is essentially survey based and empirical, where quantitative data and qualitative data was derived from responses generated by the questionnaire survey and field work. The questionnaires were administered to indigenous construction firms and professionals in the construction industry in Abia, Anambra, Imo, Enugu and Ebonyi States of the South East area of Nigeria which are the study population. The tools used for data analysis were Regression using Friedman Q Test Ranking, cross tab, while descriptive statistics used for analyzing others include bar charts, pie charts, tables, chi square, and ranking analysis. All hypotheses were tested at 5% level of significance. The findings revealed that there is association in level of compliance in construction projects to existing Health and Safety (H&S) regulations in South East Nigeria. The study further reveals that the challenges affecting health and safety compliance in South East Nigeria are bribery and corruption, ignorance of the benefits of compliance, lack of health and safety culture, perception of stakeholders, neglect of human rights and moral values, non-commitment of the major construction players, inadequate training of staff and lack of skilled health and safety personnel, non-inclusion of health and safety in contract document & tendering process and inadequate funding. The research also found out that there is significant relationship between health/safety regulations and enforcement of health and safety measures in South East Nigeria and that there is significant positive relationship between health/safety regulations and Action plan for enhancing health safety measures in South East Nigeria. It therefore concludes that effective health and safety practices and planning for construction projects in South East Nigeria are yet to be fully appreciated and implemented among construction firms. This study observes that the lack of awareness and understanding of H&S significantly hinders H&S. The study recommended that to ensure high level of compliance in all the states, allocating H&S responsibilities, which are bound by local laws, will significantly contribute to improving H&S and there should be workable and mandatory H&S consultants for every project. Also the stakeholders in the construction industry (e.g. clients and professionals) should team up to provide enforceable Health and Safety practices and plans that are in sync with health/safety regulations in the Nigerian construction industry and the world at large.

Keywords: construction, construction projects, health, health and safety, safety compliance, safety

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EXAMINATION OF ENERGY CONSUMPTION REDUCTION MEASURES FOR RESIDENTIAL BUILDINGS IN TROPICAL CLIMATE: A CASE STUDY OF BIRNIN KEBBI, NIGERIA

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Reducing energy consumption in the buildings sector is important and requires significant changes in terms of technology, human behavior, operation and management of the building in order to continue enjoying improved indoor environment without any prejudices on the environment. It is on the premises of this need that this study sought to examine the energy consumption reduction measures applicable to the tropical climate taking the Kebbi state as a case and with particular interest in residential buildings given that household consumption is one of the important factors of reducing energy consumption. It was effected using a structured questionnaire issued to occupant of the residential building (ranging from the less, medium and high energy consuming building benchmarking). Also, information on the energy consumed bills and consumption patterns of the household were collected and examined. Data collected were analyzed using the Statistical package for Social Science (SPSS) version 20 and the result presented using mean and Relative Importance Index (RII) for simplicity and to rank the severity of the energy reduction measures identified as opined by the respondents. The result revealed among others that: 'Consider lower energy consuming appliances, equipment when buying 'and 'the use of Daylight for reading and working in the building 'both (RII=0.8985) were ranked the most promising energy saving measure in the tropical climate. Other measures arranged in their order of viability are: 'keeping light and lighting fixtures clean '(RII=0.8955); and 'Switching off water heater, HVAC systems, pressing iron, and microwave after use '(RII=0.8895) among others. Consequently the Research recommends an orientation residential building occupants on measure that can improve the human behaviour in the use of energy such as paying attention on the energy label of appliances before purchase. Finally, the study recommends the adoption of automatic control system as it will help to cub human behavioural excesses

Keywords: behaviour, benchmark, energy consumption, reduction measure, residential building

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FACTORS AFFECTING THE DELIVERY OF BUILDING CONSTRUCTION PROJECTS FUNDED BY DISTRICT ASSEMBLIES COMMON FUND (DACF): THE CASE OF SELECTED REGIONS IN GHANA

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Work delivery has been one of the effective avenues for appreciating value for money in this current economic situation, especially in the construction industry. Metropolitan, Municipal and District Assemblies (MMDA's) are mandated by legislative and executive functions to also develop local infrastructure. This, thus prompted for the introduction of District Assemblies Common Fund (DACF) as one of the major funding sources for infrastructure project delivery at the various MMDA's. However, the recognition of DACF by the MMDA's in this respect on construction project delivery over the years seems to have been stifled as priority has been given to other sectors other than how these projects should be delivered. The study sought to investigate the factors affecting the delivery of building construction projects funded by DACF. This was achieved by employing a cross-sectional survey in the design from participants in Ashanti, Greater Accra, and Bono East regions in Ghana. The outcome of the study revealed that contractor, project funding, supply chain, site, and client related factors are the 5 main factors affecting the delivery of building construction projects. The findings again identified 7 major effects of these factors; which were cost and time overrun, poor quality standard work, unexploited completed project, contractor bankruptcy or liquidation, accident/disaster, loss of workers, and profit and loss of stakeholders 'trust and confidence. It was concluded that MMDA's building construction project delivery funded by DACF efficiency stands a chance to be improved. It is therefore recommended for the Ministry of Local Government and Rural Development (MLGRD) to review DACF guidelines for utilisation and introduce a project charter in MMDA's building construction project delivery.

Keywords: building construction industry, District Assemblies Common Fund (DACF), Metropolitan Municipal and District Assemblies (MMDA's), project delivery

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FACTORS INFLUENCING PERCEIVED VALUE OF RESIDENTIAL PROPERTIES IN FREE STATE PROVINCE, SOUTH AFRICA

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Various factors influence the value of property and may differ between the different stakeholders in the residential property market. Limited research focuses on the concept of perceived value and how it differs between the professional valuers, real estate agents and homeowners. The aim of this study is to determine the factors that increase the value of residential properties as perceived by homeowners, real estate agents and professional valuers. The study adopted quantitative data, collected through questionnaires distributed among homeowners, real estate agents and professional valuers. Both descriptive and inferential statistics were adopted for data analysis. The results of the study indicated that different stakeholders in the property industry perceive the factors that affect the value of residential properties differently. Professional valuers are far less likely to allocate great importance to single factors that may have an influence on residential property. The results also indicated that certain individual factors that affect property values are perceived as being more important than others by the different groups. Based on the results, it is recommended that concepts such as perceived value are included in training programs for professionals to better understand factors that homeowners perceive as value adding to their properties. Future research can investigate the reasons why certain factors are valued differently by the different groups and how gender influences the perceived value of residential property.

Keywords: homeowners, professional valuers, property value determinants, real estate agents, residential property

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HOUSEHOLDS' EXPOSURE TO INDOOR AIR POLLUTION FROM FOSSIL FUEL ELECTRIC GENERATOR USE IN MINNA NIGERIA

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Lack of reliable access to modern energy in Minna Niger state results in households 'use of inefficient alternatives especially fossil fuel generators for domestic purposes. The study analyses indoor air pollution from households 'use of generator with a view to determining their exposure to Carbon monoxide. The concepts of energy access, poverty and generator pollution were reviewed. The research employed empirical approaches and adopted the multi-stage sampling technique. The study area has a population of 63,873 households. MSA Altair 5X Multigas detector was employed in the detection of pollution (CO) levels emanating from the generator use. It revealed that inefficient use of generator, generates 60 ppm, above the WHO and NAAQS threshold of 10 ppm. 66.4% of the generator using households are exposed to dangerous levels of CO pollution from generator use at ≤4 meters 'distance in Minna, Nigeria. The study concluded that households 'access to adequate electricity de-emphasizes the need for generator ownership and use. Households 'liveability is undermined by high level of pollution. It recommended enlightenment on the dangers of exposure to carbon monoxide and that generators should be operated at a minimum distance of 4 meters away from residential buildings.

Keywords: carbon monoxide, domestic energy, energy poverty, generator

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HOUSING AFFORDABILITY IN OSOGBO OSUN STATE NIGERIA

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The aim of this study is to determine housing affordability in Osogbo using Olorunda local government area as case study. Survey research design was adopted and data were collected from both primary and secondary data, primary data were gathered by administering structure questionnaires to 343 owners – occupiers and rentals. Random sampling technique was adopted in administering the questionnaires, The Pearson Product Moment Correlation and Regression involving dummy variables (logit model) was used to test the stated hypothesis. Findings show that the rate at which rent on houses and the cost of building houses did not correspond to the rate at which salaries/incomes of household increases. Only 37 (10.8%) earns above #200.000. the cost of construction is above #5m, 39(21.4%).73 (45.1%) of the respondents paid between #5,000 and #15,000 rent every month. Majority of the people find themselves living in houses that do not reflect their social economy status, furthermore, 17.8% of the residents are left with 20% to 29% of their income after paying their rent, this study reveals that more than 30% of their income is spent on housing indicating that housing are not affordable this shows that there is a positive relationship between construction cost and capital value (.384 < 0.05), the simple Regression analysis shows that the overall level of explanation of expenditure by income is 85% (r2 of 0.85). The income of respondents is not sufficient to pay the rent for decent houses, thus housing is unaffordable. Government should adopt policies that will increase the mobilization of housing finance system for the provision of affordable houses.

Keywords: affordability, housing, income, occupiers, rent

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IMPACT OF RISK FACTORS ON CONSTRUCTION PROJECTS ' QUALITY IN NIGERIA

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One of the primary objectives of every construction project is meeting or exceeding the quality requirements of clients. The nature and complexity of construction projects encompass a lot of risks, which could hinder the attainment of the desired project quality. Evaluating the impact of risk is essential for determining the extent to which it could derail the attainment of project objectives. This study assessed the impact of risk factors on construction projects 'quality in Nigeria. Quantitative research method comprising questionnaire survey was used for the study. Data was obtained using close ended structured questionnaires distributed to 192 construction practitioners. The impact of 65 risk factors on construction project quality was evaluated. Descriptive statistics was used to analyse the data. The study found eighteen (18) risk factors as having high impact on projects quality; the topmost being 'shortage of skilled labour '(MS = 4.30), 'poor design '(4.19), 'inadequate experience by project team '(4.18), 'deviating from specifications due to misunderstanding of drawings and specifications '(4.05) and 'inadequate project monitoring '(3.96). The study concludes that the impact of some risk factors could adversely lead to unacceptable quality reduction. The study recommends paying more attention to managing the risk factors having high impact so as to achieve the desired projects quality.

Keywords: assessment, construction projects, impact, quality, risk factors

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INVESTIGATING THE EFFECT OF COVID-19 DRIVEN INFLATION ON COMMERCIAL PROPERTY HEDGING CAPACITY IN LAGOS, NIGERIA

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The study investigated the current effect of covid-19 driven inflation on commercial property investment in Lagos with a view to establishing the hedging capacities of the commercial property market. The study thereby focused on examining complete, partial, perverse and zero hedging characteristics of inflation driven by covid-19 in the market. The study used monthly data (March, 2020 and March 2021) on covid-19 rates, inflation rates (actual, expected and unexpected) and returns on commercial properties. The study therefore investigated the co-movement between covid-19 rates and inflation rates in order to establish the causal linkage between covid-19 rates and inflation rates using pair-wise correlation, and it was discovered that covid-19 rate caused changes in general price level. The study further established the inflationary characteristics of covid-19 on commercial properties returns. The study therefore utilized Ordinary Least Squares, Augmented Dicker Fuller (ADF), Engle Granger cointegration and cointegrating regression analysis. The result of FMOLS revealed that commercial properties in Lagos are completely hedged against actual and expected inflation rates while other were perversely and partially hedged against covid-19 driven inflation. The study therefore found that effect of disruption caused by covid-19 pandemic in the economy has not fully manifested in the real estate market, but there is possible future far-reaching effect if measures are not put in place. Property market is thereby susceptible to loss of value by continue locking down the economy over a long period.

Keywords: commercial properties, hedging capacity, inflation, rental price

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INVESTIGATING THE EFFECT OF CURING METHODS ON THE STRENGTH PROPERTIES OF CONCRETE

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In the hot humid climate, the method of curing used is critical in achieving the needed strength of concrete for construction application. This study sought to investigate how the different curing methods can influence the compressive and flexural strengths of concrete in the hot humid climate. The targeted compressive strength of the concrete at 28-day of curing was 20 N/mm2. Plain concrete cubes and beams were prepared with a mix ratio 1:1.5:3 by weight and 0.6 water-cement ratio. A total of 120 concrete specimens were prepared, comprising 60 each for cubes and beams. Four different curing methods (immersion, wet jute sack covering, plastic sheet covering and water sprinkling) were adopted. The concrete specimens were tested on 7, 14, 21, 28 and 56 days of curing. It emerged that the immersion curing method recorded the highest compressive values of 23.43 and 25.83 N/mm2, respectively for the 28 and 56 days curing at a significant difference of 16% increase strength over the sprinkling method. It was also found that the immersion curing method obtained the highest flexural strength of 2.81 and 3.49 N/mm2, respectively for the 28 and 56 days curing at 14% increase strength over the sprinkling method. The study, therefore, concludes that the use of appropriate method of curing can have an effect on the flexural and compressive strengths of the concrete, and therefore recommend the adoption of immersion curing method, especially in the hot humid climate for precast and laboratory-based concrete units 'production.

Keywords: compressive strength, concrete, curing method, flexural strength, slump tests

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KEY FACTORS FOR ELECTRONIC PROCUREMENT SYSTEMS IN THE PROMOTION OF SUSTAINABLE PROCUREMENT IN CONSTRUCTION PROJECTS

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The current drive for digitalization in the construction industry has increased the attention on various construction processes including construction procurement. To improve efficiency in construction procurement, electronic procurement systems (EPS) were introduced to automate the process. However, there are global concerns for construction industry's contribution to sustainability. Hence, the interest for digital transformations to focus on sustainability underscores the use of sustainable procurement initiatives in construction procurement. Although, EPS have gained some attention in literature, their relationship with the dimensions of sustainability are limited in extant literature. Therefore, the aim of this study is to identify EPS relationships with the initiatives of sustainable procurement in the construction industry. Specifically, the key issues needed to enhance EPS contribution to sustainable procurement are highlighted. A systematic literature review was conducted using a three-stage process to examine previous studies. The findings revealed that EPS mostly contributes to economic cost sustainability. Environmental and social sustainability issues need to be improved with the use of EPS. Especially, the contribution of EPS towards to green criteria and local inclusiveness have to be strengthened. Future research directions were provided to address the knowledge gaps identified in literature. This study provides researchers and practitioners with knowledge on EPS areas that needs to be strengthened to enhance the promotion of sustainable procurement initiatives in construction procurement.

Keywords: construction industry, construction procurement, electronic procurement, sustainable procurement

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MICRO-CLIMATIC BENEFITS OF GREEN INFRASTRUCTURE (TREES) IN A HOUSING ESTATE IN ABUJA, NIGERIA

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Urban overheating and the consequent outdoor thermal discomfort is plaguing many cities. Notably, housing development to cater for urban population explosion has increased grey infrastructure at the expense of urban vegetation which serves as green infrastructure. The integration of green infrastructure such as trees, green-roof and vertical greening is now being advocated and re-implemented in many cities around the world. This study presents an evaluation of the thermal benefits of greening a housing estate – King's Park Estate in Abuja, Nigeria. Three different greening scenarios namely "current greening", "one tree, one house" and "one street, one house plus street trees" were evaluated for their outdoor thermal comfort outcomes using the ENVI-met simulation tool. The ENVI-met software helps to simulate the micro-climatic impacts of the interactions within urban systems by assessing the effects of vegetation, materials etc. Result shows that planting one tree per house combined with street trees can offer up to 10ºC reduction in Physiological Equivalent Temperature (PET). To have sustainable built environment, it is important to consider the addition of trees per house and on streets in current and future housing estate development.

Keywords: ENVI-met, green infrastructure, thermal comfort, urban design

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MODELLING OF FUTURE LAND USE/LAND COVER CHANGE DYNAMICS IN LAGOS, NIGERIA USING CELLULAR AUTOMATA AND MARKOV CHAIN (CA-MARKOV) MODEL

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Many cities in developing countries have witnessed rapid urbanization, resulting in various land use/land cover (LULC) changes. However, few studies focus on the growth and development of African cities. As a result, this study aims to predict the future land use/land cover of Lagos, Nigeria, from 2020-2050 using a combination of cellular automata and the Markov Chain model (CA-Markov). The CA-Markov model utilises historical land cover data and transition probabilities to simulate future LULC patterns through Geographic Information System (GIS) techniques. In this study, the land use/land cover pattern of Lagos was modelled and validated using the city's historical maps. The maps were derived from satellite images using the maximum likelihood classification. The historical LULC indicates that Lagos had witnessed an increase and decrease in the city's different land-uses, comprising built-up areas, vegetation, barren land, and water bodies. Over the last 20 years, the city's built-up areas and barren land have increased by approximately 19.81 km2 and 3.13 km2 per annum, while vegetation and water bodies have decreased annually by 15.89 km2 and 7.06 km2, respectively. The Land Change Modeler (LCM) of TerrSet software was utilised in simulating the CA-Markov model to forecast the city's future land cover based on the historical LULC trends. The predicted result reveals that in 29 years, Lagos will experience a notable increase in built-up areas from 1255.91 km2 in 2020 to 1544.95 km2 in 2050, while barren land will expand by 257.62 km2. This change is expected to occur at the expense of vegetation, and water bodies, which will decline by approximately 314.76 km2, and 231.90 km2. Therefore, this study provides critical data useful to urban planners, policy, and decision-makers in formulating strategies and initiatives for a sustainable built environment in Africa's most populous city.

Keywords: CA Markov, Geographic Information Systems(GIS), land use/land cover change, LULC prediction, remotely sensed data

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MODELLING OPTIMAL UNCONFINED COMPRESSIVE STRENGTH OF GEOTEXTILE REINFORCED SOIL FOR FLEXIBLE FOUNDATION CONSTRUCTION

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Extreme vertex design (EVD) provides an efficient approach to mixture experiment design whereby the factor level possess multiple dependencies are expressed through component constraints formulation. EVD was deployed for the modeling UCS of a geogrid reinforced problematic soil aimed at checking the validity in subgrade construction. Geogrids are geosynthetic materials, which possess an open mesh-like structure and are mostly used for soil stabilization. Geogrids present permeable layer to support the soil and foundation by improving the stiffness characteristics. It is cheap compared to other construction materials and possesses unique light weight properties with greater strength improvement on the soil layer when used. Minitab 18 and Design Expert statistical software were utilized for the mixture design experiment computation. To fully explore the constrained region of the simplex, I-optimal designs with a special cubic design model were utilized to formulate the mixture component ratios at ten experimental runs. I-optimality and D-optimality of 0.39093 and 1747.474, respectively, were obtained with G-efficiency of 64.8%. The laboratory responses were taken together with the mixture ingredients as the system database for the model development. Statistical influence and diagnostics tests carried out on the generated EVD model indicated a good correlation with the experimental results. Graphical and numerical optimizations were incorporated using desirability functions that ranged from 0 to 1, which helped to arrive at the optimal combination of the mixture components. 0.2% of geogrid, 9.8% of water, and 90 % of soil yielded the optimal solution with a response of 41.270kN/m2 and a desirability score of 1.0. Model simulation was further carried out to test the model's applicability in subgrade construction with the results compared with the actual results using student's t-test and analysis of variance. The statistical results showed p-value>0.05 which indicates good correlation.

Keywords: constrained simplex method, design expert, extreme vertices, geogrid, soil, unconfined compressive strength

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PERFORMANCE–BASED EPC CONTRACTING: A PRELIMINARY STUDY OF THE CHALLENGES OF ENGINEERING PROCUREMENT AND CONSTRUCTION PROJECTS IN NIGERIA

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Engineering Procurement and Construction (EPC) project harnesses contractors ' ingenuity towards delivering value by affording them flexibility in procurement. However, while EPC projects in developed economies are generally characterized as delivering value in procurement, those in Nigeria are not. The challenges responsible for these under-performances within the Nigerian construction industry remains largely unknown, this is in spite of the 2014 Federal Government Procurement Guidelines which advocated for the implementation of EPC projects using performance-based contract (PBC). Therefore, this paper aims to identify potential challenges facing EPC projects with the view to providing a structure to investigate PBC related challenges for an ongoing PhD research. The report in this paper is the outcome of a preliminary investigation involving an EPC contracting organization and a client organization in the energy sector. The interview technique was used to collect data from two respondents (one from each organization) with experience of 15 and 30 years respectively. The data collected were analysed using qualitative content analysis. The preliminary findings revealed two distinct sets of challenges, client- and contractor-specific. For instance, client-specific challenges include: "loss of control", "non-assurance of quality", and "lack of performance evaluation criteria". Contractor-specific challenges include: "client's inexperience in EPC projects", "inaccuracies contained in BOQs" and "pricing issues". Those challenges clearly have their root causes to the non-implementation of EPC projects based on PBC. This finding points to the fact that EPC projects in Nigeria are mainly based on non-PBC. With the emergence of these challenges, going further thereof, the main investigation will infuse them in a structured interview survey toward discovering the root causes of these challenges. It is hoped that such discoveries will lead to getting the ingredients necessary for developing strategies for the implementation of EPC project using PBC in the Nigerian Construction industry.

Keywords: energy sector, engineering procurement and construction (EPC), Nigeria, performance-based contracting (PBC), implementation

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PREDICTORS OF ACADEMIC ATTAINMENT IN A NIGERIAN POLYTECHNIC: PERCEPTIONS OF ESTATE MANAGEMENT STUDENTS

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Determinants of students' academic performance have continued to receive substantial consideration in the extant literature, and it remains a contested subject. Students' performance is influenced by different individual factors grouped under several themes, including school factors, teaching methods, assessment methods, lecturers, students' factors, and parental background. The influences of these factors are thought to vary from one academic environment to another. This study investigates estate management students' perceptions of predictors of academic attainment in Federal Polytechnic Ede, Nigeria, intending to identify critical areas that could inform reform. This study employs a quantitative research design to examine 35 individual factors under the six thematic categories earlier mentioned. All graduating students were examined, and a sample of 86 students was selected through purposive sampling. Descriptive statistics (mean score and standard deviation) were applied. The results revealed 23 out of the 35 individual factors as significant predictors of Estate Management students' academic attainment. A further analysis based on the thematic categories showed that assessment methods, lecturers and family background with mean values of 5.20, 4.74 and 4.67, respectively, are the top three thematic categories that predict Estate Management students' academic attainment. The paper concludes that there is a need to review the approach employed in imparting knowledge and assessment of Estate Management students. Improved lecturers' attitudes and assessment strategies are necessary to heighten the students' morale, which would, in turn, translate to better academic attainment.

Keywords: academic performance, Ede, graduating students, real estate

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RESPONSIBLE MATERIAL SOURCING: AN ASSESSMENT OF FACTORS INFLUENCING CONSTRUCTION MATERIAL SUSTAINABILITY

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The term "responsible materials" refers to products that have been certified as meeting sustainability standards. Thus, the ethical management of sustainability challenges in the construction product supply chain is referred to as responsible sourcing. It encourages the appropriate availability of measurements that increase sustainability by assessing the environmental impact of materials in the construction supply chain. Due to its health implications, environmental pollution caused by material sourcing and usage has been a hot topic of investigation. Construction specialists responsible for selecting materials with low environmental footprints have a tough time doing so. In addition to the obstacles faced by essential specialists in material selection, numerous aspects must be considered in the sourcing and selection processes, such as comparing policies, to result in better material usage beginning with the design phase. This research is aimed at assessing the factors that influence material sourcing in the construction industry in which sustainability is promoted. A survey of Ghanaian construction professionals involved in the selection and procuring of construction materials was conducted. The variables were evaluated based on the mean of their ratings. All of the variables deemed to influence responsible sourcing of construction materials were subjected to a principal component analysis (PCA). PCA found four components with eigenvalues greater than one, accounting for 34.2 per cent of environmental criteria, 12.10 per cent of resource consumption criteria, 8.4% of technological criteria, and 6.9% of socio-economic criteria. As a result, all of the variables were significant, confirming the conclusions of the literature. Despite being considered an essential factor, eutrophication earned the lowest rating in the environmental factor category; this is a cause for concern in ecosystem management. The study contributes to the management of material sustainability in the Global South to promote the required material sourcing and selection response from decision-making professionals.

Keywords: global south, material sustainability, responsible material, responsible sourcing

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REVIEW OF RISK MANAGEMENT STUDIES: TOWARDS A FRAME OF REFERENCE FOR LARGE PROJECTS

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Construction is a high risk industry that operates a very complex and dynamic environment, which significantly contributes to the existence of high uncertainty and risk in construction projects. Journal articles on review of literature surrounding risk abounds in construction management studies. However, such considerations have assumed a silo approach to risk management, for instance, focus on processes, thereby neglecting the holistic perspective to risk management. The absence of this holistic perspective results in sub-optimality in knowledge within this domain. Therefore, this study aims to undergo a systematic literature review, with the purpose of bringing forth a holistic perspective of researches in this field. Findings shows that studies in this domain have largely focused on three main themes of risk management, namely: practices, maturity and processes, with particular emphasis on processes. While the overwhelming majority of these studies are replicative, they fail to advance the frontiers of risk management knowledge for large projects. Such advancement is recognised within risk systemicity. However, studies focused within risk systemicity have continued to follow the trend in generic risk management considerations i.e. the silo approach. Although, risk systemicity consideration is relatively new, the lack of research on interactions and interdependencies within and between sub-systems opens newer directions for risk management studies, particularly large projects. For instance, bringing out the components of a risk management system and studying the interactions within each component and those across them. Hence, the outcome of this paper, amongst others, contributed immensely as part of an on-going PhD research on modelling the dynamic interaction of risk in large construction projects.

Keywords: large projects, risk interdependences, risk management, risk systemicity

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SOCIAL PROCUREMENT AND SUSTAINABILITY IN THE NIGERIAN CONSTRUCTION INDUSTRY

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Social sustainability transition in the construction sector seeks to improve safety and health of workers, gainful employment and total inclusiveness. However, one less debated domain within this framework is how employment requirements provide opportunities for the socially disadvantaged such as the poorly educated, youths, immigrants, and disabled individuals to be employed in the construction industry. In Nigeria, there are over 86.9 million people living in extreme poverty. Hence, social procurement as a strategic tool should be used to create employment for these disadvantaged people in the construction sector. Drawing on a systematic review of relevant literature using Prisma to improve the reporting of reviews and analyses, this research examines social procurement practices in other countries with the aim to fill the gap in literature for the Nigerian construction industry highlighting the barriers and strategies for diffusing the approach into the construction industry. The outcome of the result initiates a research domain and promote sound academic debate towards improving total inclusiveness in the Nigerian and African built environment. It was discovered from the results of the study that barriers to social procurement and sustainability in other climes are replica of the Africa's and Nigerian built industry with women having been the most socially disadvantaged groups. It concludes and advocates for a complete overhaul of procurement policies in Nigeria to accommodate the socially disadvantaged groups providing an alternative solution to the increasing shortage of skilled labour force in the construction industry in Nigeria.

Keywords: construction industry, social procurement, social sustainability, socially disadvantaged groups, total inclusiveness

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SOCIO-PSYCHOLOGICAL MOTIVATIONAL NEEDS OF UNSKILLED WOMEN WORKING IN NIGERIA'S CONSTRUCTION INDUSTRY

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The construction sites are characterised by poor planning, deregulation and poor protection in the Nigerian construction industry. This is demotivating for unskilled women workers who are unable to work effectively under such site characteristics. To address the problem, women workers need to be motivated according to the socio-psychological challenges and needs that help them to work effectively. This study explores the motivation of unskilled women site workers with an emphasis on their social and psychological challenges and needs using the qualitative research methodology. It involves a face-to-face interview of nineteen (purposively selected) unskilled women working across different construction project sites in Akure, Ondo State, Nigeria. The data obtained were analysed using the combination of inferential statistics and thematic analysis. The findings reveal the women's 'prevalent challenges on construction sites, including sexual harassment, verbal abuses, unfavourable working conditions, and stress. The findings also reveal the preference of the women for financial incentives to help them overcome the prevalent challenges and increase their morale and effectiveness at work. This study concludes that unskilled women workers can be motivated to work effectively by addressing their socio-psychological challenges and needs. This study is unique by linking women workers 'motivation to unfavourable site characteristics in a developing country. Therefore, the findings in this study can be adapted to other developing countries to motivate unskilled women working on construction sites.

Keyword: challenges, construction sites, motivation, needs, unskilled women workers

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SPATIAL ACCESSIBILITY TO URBAN INFRASTRUCTURE SERVICES AMONG HOTELS IN THE SMALL CITY OF WA, GHANA

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Though access to urban infrastructure services is a critical factor that facilitates hotel investment, studies have failed to substantiate the accessibility of urban infrastructure services on hotel, most especially in smaller cities. Using the location-based accessibility measure, the study assesses the spatial impact of bus stops, hospital, banks, and shops on hotel accessibility and demand in Wa Municipality. Samples of 33 registered hotels were selected based on their geo-location and variations. The study used the buffer geo-processing model and proximity test to estimate the spatial effect of urban infrastructure services on hotel accessibility and demand. The findings revealed that, there is a weak correlation of urban infrastructure services on hotel investment which triggers low clients turn-out in Wa Municipality. This study contributes to a better understanding of the impact of spatial correlations on hotel investment. However, development planners need to adopt development-based infrastructure provision strategy that captures the impact of UIFs on hotel investment.

Keywords: commercial real estate, hotel investment, infrastructure services, small city, spatial accessibility

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STRESS-COPING STRATEGIES AMONG CONSTRUCTION PERSONNEL: AN INTEGRATIVE REVIEW

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Construction personnel are faced with a considerable amount of stress, which negatively impacts their health and well-being. This has spurred research into stress and mental health in the industry. However, studies reviewing stress-coping strategies adopted by construction personnel are lacking. The study integratively reviewed articles on stress-coping strategies among construction personnel to determine the coping strategies employed in the industry and the effect of such strategies on personnel's performance and health. The database of PubMed, Scopus, and Web of Science was searched to retrieve relevant literature within the period 1990 to 2020. Using the PRISMA guidance and CEBM critical appraisal tool, a total of nineteen studies met inclusion criteria. The literature on stress-coping strategies was classified into four categories: family, mental ill-health, workplace stressors, and coping strategy influencers. Project performance increased with the adoption of problem-focused coping and emotion-focused coping behaviors. Cultural values, income, and motivation influenced the type of coping strategy adopted. Problem-focused coping strategies (particularly active coping, social support, religion, and positive reappraisal) alleviated depression, anxiety, and stress. This study informs on appropriate methods and policies for researching stress-coping strategies in the construction industry. There is a need for investigations into resilience as a coping resource, future-oriented stress-coping along the generational gap, and assessment of stress-coping interventions on a "pre and post-intervention" and "short and long time" basis.

Keywords: construction personnel, coping strategies, generational gap, stress, workplace

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STUDENTS' PERCEPTIONS ABOUT TRAINING ON PROPERTY VALUATION TECHNIQUES IN SELECTED TERTIARY INSTITUTIONS IN NIGERIA

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Techniques employed in property investment valuation have continued to serve as an endless discussion topic among academics and professionals in the real estate. Throughout the discussion, a common thread is a need for property valuers to be adequately trained on critical valuation techniques, which is necessary for ensuring that property investment valuations are reliable and compare with other investment mediums in the investment market. Over the years, real estate students' training on valuation methodologies has followed two distinct techniques, namely, conventional and contemporary valuation techniques. This study assesses students' perception of property valuation techniques in selected tertiary institutions in Nigeria to identify gaps in knowledge. The study's data was collected through a survey of all graduating real estate students from two universities and two polytechnics in South-west, Nigeria. A total of 114 students across the identified institutions was selected using purposive sampling. Descriptive statistics were utilised in analysing the data obtained. Analyses are presented for the students ' level of awareness and understanding of conventional and contemporary property valuation techniques. The results show that awareness and understanding levels are higher for conventional valuation techniques with group mean scores of 3.96 and 3.80, respectively. Further analysis on students 'views on the teaching and learning of property valuation techniques was conducted. The respondents strongly agreed that practical-based training would promote a better understanding of property valuation techniques. The study concludes that a practical-based property valuation curriculum in the Nigerian tertiary institutions is necessary to equip graduates with the requisite knowledge that aligns with the needs of the property investment market.

Keywords: conventional and contemporary valuation methods,, learning and teaching, polytechnic, real estate investment, university

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SUCTION OF CLAYEY SOIL TREATED WITH QUARRY DUST BASE GEOPOLYMER CEMENT FOR SUSTAINABLE PAVEMENT SUBGRADE CONSTRUCTION

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Suction is a very important factor in pavement subgrade materials whether treated or untreated, and it is more important with the influence of seasonal changes in moisture for hydraulically bound environments. This physical property was investigated in a cemented and uncemented clayey soil treated with quarry dust based geopolymer cement (QDbGPC). The representative clayey soil was preliminarily studied and was classified as A-7-6 group soil according to the AASHTO classification system. It was also classified according to USCS as poorly graded clay (CP) with high clay content (CH). It was further classified as highly expansive and highly plastic with plasticity index above 17%. 200g of the representative sample was further treated with synthesised QDbGPC at temperature of 20˚C. The effect of the varying proportions of the treatment mixed in the proportions of 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5, 25, 27.5, 30, 32.5, 35, 37.5 and 40% by weight of dry soil on the suction of cemented and non-cemented test soils was observed. The stabilisation procedure was conducted under varying curing time on the soil. The results obtained showed a consistent reduction in suction with increased proportion of QDbGPC and with increased curing time. But cemented soil showed a slightly higher reduction in suction than the non-cemented soil. Portland cement had high shrinkage, and less suction tendencies, though it showed lower values of suction but the difference between cemented and non-cemented soil was too small that QDbGPC can totally replace OPC because of the properties it exhibits as a modifier construction material in compacted subgrade.

Keywords: clayey soil, geopolymer cement, pavement subgrade, quarry dust, suction

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THE BENEFITS OF BUILDING INFORMATION MODELING IN ARCHITECTURAL EDUCATION IN NIGERIA

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The contemporary built environment is defined by complex infrastructural designs and plans. Architects are confronting and overcoming these challenges through the aid of technological innovations such as Building Information Modeling, BIM. Architects, engineers and construction, AEC professionals with the aid of BIM are to efficiently plan, design, construct, and manage buildings and infrastructure. This study examined the benefits and also identify challenges of BIM education in Nigeria among architects. A field survey was be conducted using structured closed-ended questionnaires administered face-to-face and via email, WhatsApp and internet using google form to practicing architects and architects in the academia. The data collected was analysed using SPSS 16. The major findings in this study reveal the provision of BIM awareness, knowledge and skills for present and future generation of architects to achieve success in productivity and sustainable future and also collaboration between project participants in AEC industry are the most important benefits of BIM education. The major challenges to BIM education in architecture include lack of trained teachers/staff, lack of collaboration between the academia and practicing architects and lack of clear government mandate on adoption. The study concluded by recommending that NUC in collaboration with tertiary institutions through the colleges of engineering, should sponsor teachers in AEC for training on BIM in countries where such programmes are offered to enable them have the requisite knowledge to train others learners in schools of architecture.

Key words: architects, BIM, BIM education, BIM tools, BIM usage architects

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THE IMPACT OF PROJECT CONTRIBUTORY FACTORS ON THE COST PERFORMANCE OF BUILDING PROJECTS

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Construction projects are complex and vast in nature with a large number of available procurement options, participants, directions, technologies and external factors which are generally deduced as contributory factors and can influence the attainment of project objectives. These demands and pressures for the attainment of project objectives from the client have led to the consideration of the most appropriate contributory factors for a given project, being seen as an important issue in construction project performance. In view of this, the research explored the impact of project contributory factors on building project cost performance based on the attacked level of perception on the extent to which contributory factors(NPRC/PRC) impact on cost performance of building projects . To achieve this goal, the research identify projects contributory factors that impact on the cost performance of building projects and to determine the extent to which contributory factors (NPRC/ PRC) impact on the cost performance of building projects. The aim was achieved by administering 120 questionnaires to professionals in State Universal Basic Education Board (SUBEB) and Government Agencies who have handled SUBEB building projects across the twenty three local government areas in Kaduna State. The obtained data were statistically analysed using descriptive statistics. The results revealed that for non-procurement related factors, client financial stature and project size and complexities are the most popular contributory factors impacting building cost performance. The research further ascertained that for procurement related contributory factors project procurement method used and project responsibilities, contractual obligations to people and organizations are the most popular contributory factors that impact building construction cost performance. The study concluded that NPRC and PRC do exist and can impact cost performance at varying extent. The findings necessitate NPRC and PRC appropriateness by the construction professionals involved in building construction to ensure better cost performance.

Key words: building projects, cost performance, impact, project contributory factors

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THE POTENTIAL ROLE OF GREEN INFRASTRUCTURE ON MENTAL HEALTH AND WELL-BEING: THE COVID-19 PANDEMIC EXPERIENCE

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Urban Green Infrastructure (GI) is an essential element in the urban environment, providing multiple ecosystem services that could help combat many urban environmental challenges and improve physical and mental health for city dwellers. Although, rapid changes in urban growth rates has put these facilities under intense pressure in cities worldwide, the present challenges of COVID-19 pandemic have declared a need to harness the potentials of available strategies that can efficiently manage the sustenance of life and the living conditions of human in the built environment. This study examined the influence of GI on mental health and wellbeing of residents affected by COVID-19 lockdowns and restriction to mobility in selected neighbourhoods in Abeokta, Ogun State. A multi-stage sampling technique was used to select 162 residents who participated in a questionnaire survey conducted in the study area. The results of the descriptive statistics reveal that 78.4% of the residents are aware of the COVID-19 and restriction to mobility. 44.4% of the participants visited GI sites within their neighborhood to ease the perceived mental stress of the lockdown, while 34.6% of the respondents confirmed that lockdown allowed them to spend more time with their family. Also, 40.7% of the respondents agreed that adequate provision of UGI facilities in their neighbourhood will enhance opportunity for recreation in case of future lockdowns. This implies that with appropriate government policies on expanding the planning and implementation of various UGI facilities and strategies both in public and private spaces, the effects on mental health and well-being of COVID-19 lockdowns and other similar crises can be sufficiently tackled among urban residents.

Keywords: COVID-19, ecosystems, environmental sustainability, green infrastructure, mental health

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THE RELATIONSHIP BETWEEN SELF-EFFICACY BELIEFS AND CAREER CHOICES OF UNDERGRADUATE BUILT ENVIRONMENT STUDENTS

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This study examines the relationship between career choices and career self-efficacy beliefs among a sample of South African university students. This study surveyed 229 conveniently sampled students, including 116 men and 113 women enrolled in construction-related programs at two universities in South Africa. The samples were drawn from student cohorts enrolled in construction management, civil engineering, property development, land surveying, building and quantity surveying. Adopting the Social Cognitive Career Theory as the study's theoretical framework, an exploratory factor analysis yielded support for 5-item scale of self-efficacy. The EFA provided support for the internal validity and reliability of the scale. Results of structural equation modeling indicated that a significant relationship exists between self-efficacy and the student's decision to undertake a career in construction. The Mann-Whitney U and Kruskal-Wallis test was conducted to test for gender and SES differences in the extent to which self-efficacy beliefs influenced a career choice in construction. No significant differences were found in in the influence of self-efficacy beliefs between men and women. The study revealed significant differences between the high and medium SES groups. Findings of the current study have meaningful implication for practice in career choice and development in built environment occupations.

Keywords: career, self-efficacy, South Africa, university students

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THE RELATIONSHIP OF ATTITUDE AND PERCEIVED BEHAVIORAL CONTROL ON BEHAVIORAL INTENTION TO PRACTICE SURVEYING

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User acceptance of information technology is attributed to individual's intention to engage in an activity or venture and perception that are factored by many indicators called items. Surveying education and practice involves series of theories and practical instructions that aimed at providing background knowledge and procedures in obtaining information about real world phenomenon. This research evaluated the behavioural intention to practice as exercised by surveyors using the Users Acceptance of Information Technology's Technology Acceptance Model (TAM)(Grun, 1998; Jatau, Fernandes, Adebomehin, and Gonçalves, 2010; Larson, 1977; RICS, 2014; Sekaran, 2003; Sharma, 1997) and Theory of Planned Behaviour (TPB). The research relied on survey instruments structurally built to obtain manifest/items that measures intention and perception based on TAM and TPB. The questionnaires and all the information gathered duly processed to obtain valid indicators that can sufficiently explain the impact and relationship among variables under consideration. Partial Least Squares - Structural Equation Modelling (PLS-SEM)(Fajemirokun, 2006) was the statistical method used for the analysis of latent constructs of endogenous and endogenous variables. The entire analysis was done with SmartPLS 3 software. The model was validated and hypotheses tested. Results shows the significance of the variables on each other, which exposes the relationship between latent constructs and their variables. It shows that self-efficacy has high impact on Perceived Behavioural Control and the latter as an important variable to measure Behavioural Intention to Practice

Keywords: PLS-SEM, practice, smartPLS, surveying, and technology acceptance model

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THE ROLE OF SAFETY ATTITUDE IN CHANGING SAFETY BEHAVIOUR AND HAZARD RECOGNITION CAPABILITY OF CONSTRUCTION WORKERS

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Worker's safety has been a major concern in the successful execution of various construction activities. Workers that are unable to recognise the active, emerging, or latent hazards, in the work environment are often exposed to safety risks, leading to catastrophic accidents and injuries. Despite research efforts on strategies to improve the safety of workers on construction sites, recent studies have reported the apparent disregard for human-related factors in the formulation of safety strategies which limits their effectiveness. In this regard, this study provides insight on the specific role worker's safety attitude plays on safety behaviour towards improving Hazard Recognition Capability (HRC) of the worker. A quantitative research approach was adopted for the study, using a structured questionnaire to collect both ordinal and nominal data. Both descriptive and inferential statistical tools were used to analyse the data. Spearman's correlational analysis technique was used to ascertain the monotonic relationship between worker's safety attitude, safety behaviour, and hazard recognition capability. Findings of the study show that worker's safety attitude has an influence on worker's safety behaviour on the job site, although no relationship was established between worker's safety behaviour and respective hazard recognition capability. This finding provides an empirical evidence on the fractional relationship between safety behaviour and HRC. Thus, it is recommended that other human-related factors be studied in relation to the area of safety management with a view to find a sustainable solution to the abysmal safety performance of the global construction industry.

Keywords: attitude, behaviour, construction industry, hazard recognition, safety

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TOWARDS A RESEARCH AGENDA FOR SMART CONTRACT ADOPTION IN LESS TECHNOLOGICALLY ENABLED CONSTRUCTION ENVIRONMENTS: A SYSTEMATIC LITERATURE REVIEW

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Smart contract (SC), a tool created for technologically enabled environments (TEEs) is poised to tackle the obsolescence within and inefficiencies of the traditional environments in construction. Generic considerations of SC are predicated on ideal TEEs, in spite of the slow pace of technology adoption in the construction industry. This is indicative of the fact that, quite a lot of less TEEs(LTEEs) still do exist in construction. But how should SC in construction be implemented within the LTEEs remains largely unknown, thereby creating the potentials for a research agenda within the LTEEs. This paper conceptualizes the state of the art of SC research in construction. A systematic literature review was undertaken to explore the ontology of SC in construction and applying the theory of technology adoption, the paper further characterized the ontological considerations into two domains i.e. TEE and LTEE. The outcome of this investigation revealed that under the LTEE perspective: existing research is challenged at addressing SC related issues; third parties are indispensable; and that the block-chain technology is most suitable for implementing SC. The findings provided information on how SC can be implemented in less technologically enabled environment. To conclude, the paper suggests that SC in construction research should be approached from a hybrid perspective whereby third parties (e.g. consultants) would still have prominent roles in contractual transactions as opposed to the fundamental principles of SC e.g. autonomous processes, and elimination of third party participation.

Keywords: construction, smart contract, technologically-enabled environment

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URBAN MORPHOLOGY AND CRIME PATTERNS IN URBAN AREAS: A REVIEW OF THE LITERATURE

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The emerging challenges of urban planning and design professionals across the globe is on how to mainstream crime prevention and control in the planning and management of cities, and that rose the interest of Environmental designers in conducting research on urban morphology and crime. Researches on urban morphology provide sufficient explorations and understandings of crime areas and fear of crime in cities. Despite the effort so far, the existing literature on morphology of crime areas and pattern of crime presents different perspectives to the study of crime and spaces, reflecting the varied field of urban morphological research. There is a need to understand these perspectives in view of their directions and inherent limitations for effective understanding of crime pattern and urban morphogenesis in cities. The focus of the paper is on the understanding of different perspectives in the study of crime pattern and urban morphology in setting up an effective mechanism for crime prevention and control. Eighteen (18) paper articles and six (6) thesis published between 2010 - 2021 where selected based on the Environmental criminological research perspectives from the field of Geography, Urban Planning, Urban Design, Landscape Architecture and Architecture; and systematically reviewed based on their characteristics and then classified according their relevance to environmental criminology for analysis and drawing of inferences. The findings indicated that, there is inadequate empirical research on the influence of urban morphology on crime pattern in cities. Therefore, the paper recommends for further researches to focus on exploring the various elements of urban morphology and how they help in understanding the spatial distribution of crime in areas and the explanations they could provide for effective crime prevention and control in cities.

Keywords: built environment, crime pattern, environmental criminology, urban morphology

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USERS' ASSESSMENT OF THE RELATIONSHIP BETWEEN HOUSING QUALITY AND THE CONDITIONS OF RESIDENTIAL OUTDOOR SPACES IN ILESA, NIGERIA

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The community space is utilized as a vital strategy for developing housing product. The house and its surroundings directly affect human beings to the extent that it sometimes serves as vital determinants of wellbeing and quality of life. Consequently, this study seeks to understand if there exist a relationship between the condition of residential outdoor space (CROS) and Housing quality (HQ) in Ilesa, Nigeria. The study selected 231 household heads using systematic random sampling technique for questionnaire administration in the study area. The quality of housing and residential outdoor space were assessed using five point likert scale to determine the quality index (QI). Findings revealed that CROS (Condition of residential outdoor space) and HQI (housing quality index) were 3.84 and 3.52 respectively indicating a good condition of housing and residential outdoor space in the area. The study further established a statistical significant relationships between CROS and HQ ($R2 = 0.959$, $F(1 \& 11) = 232.340$, and $P \leq 0.000$), meaning that 95.9% of the variation in HQ(y) is explained by CROS. Therefore, the outcome of this study could contribute immensely in evolving policies formulation towards improved residential housing design and sustainable city development.

Keywords: building design, housing, quality, residential outdoor space, sustainable development

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WATER ABSORPTION QUALITY OF CLAY BRICKS MADE BY EMERGING MANUFACTURERS IN SOUTH AFRICA

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Masonry walling comprising clay units in South Africa is required to comply with SANS227, in addition to other South African National Standards. The water absorption quality of clay masonry is an important characteristic since it determines the flexural strength of masonry walls. The prevalence of substandard materials and the inability to enforce construction standards by statutory bodies and the existing legislation in South Africa (SA) creates a breach between the intentions of the designer and what can be achieved physically on site. Two sites in Qwaqwa and Newcastle, South Africa, where clay bricks are manufactured by the community, were identified. From these sites, 11 samples of each unit type, namely; low (11 number off) and high (11 number off) burnt units were purchased from each site over a 12-month period. These samples were newly made clay bricks. A total of 264 units per site (11 units x 2 types x 12 months) were purchased from developing/local entrepreneurs/manufacturers, for testing for the water absorption quality. Considering only the manufacturing site and the water absorption of brick purchased from them, they produced the following results: (1) Qwaqwa had 27.3% with a standard deviation of 6.6; (2) Madadeni had 34.3% with a standard deviation of 9.6. In view of the site only and with respect to the brick type, the investigation yielded the following means: (1) Qwaqwa had 32.2% with a standard deviation of 7.5 which means that the data is more spread out; (2) Madadeni had 29.4% with a standard deviation of 10.1, which means that the data is more spread out. Even though hard burnt has a slightly higher value than low burnt, the difference in the water absorption is not significant ($p = 0.287$). Besides the water absorption quality being far above the recommended range of between 12% and 20%, the water quality varies significantly. Citizens who purchase clay bricks for the construction of their homes have little or no knowledge of the hidden water absorption quality problem which significantly affects the flexural strength of structural elements, such as cantilevered masonry retaining walls and walls required to have flexural strength. The South African Bureau of Standards must enforce good quality of clay bricks made by emerging manufacturers in South Africa.

Keywords: clay bricks; flexural strength, masonry walling, water absorption quality

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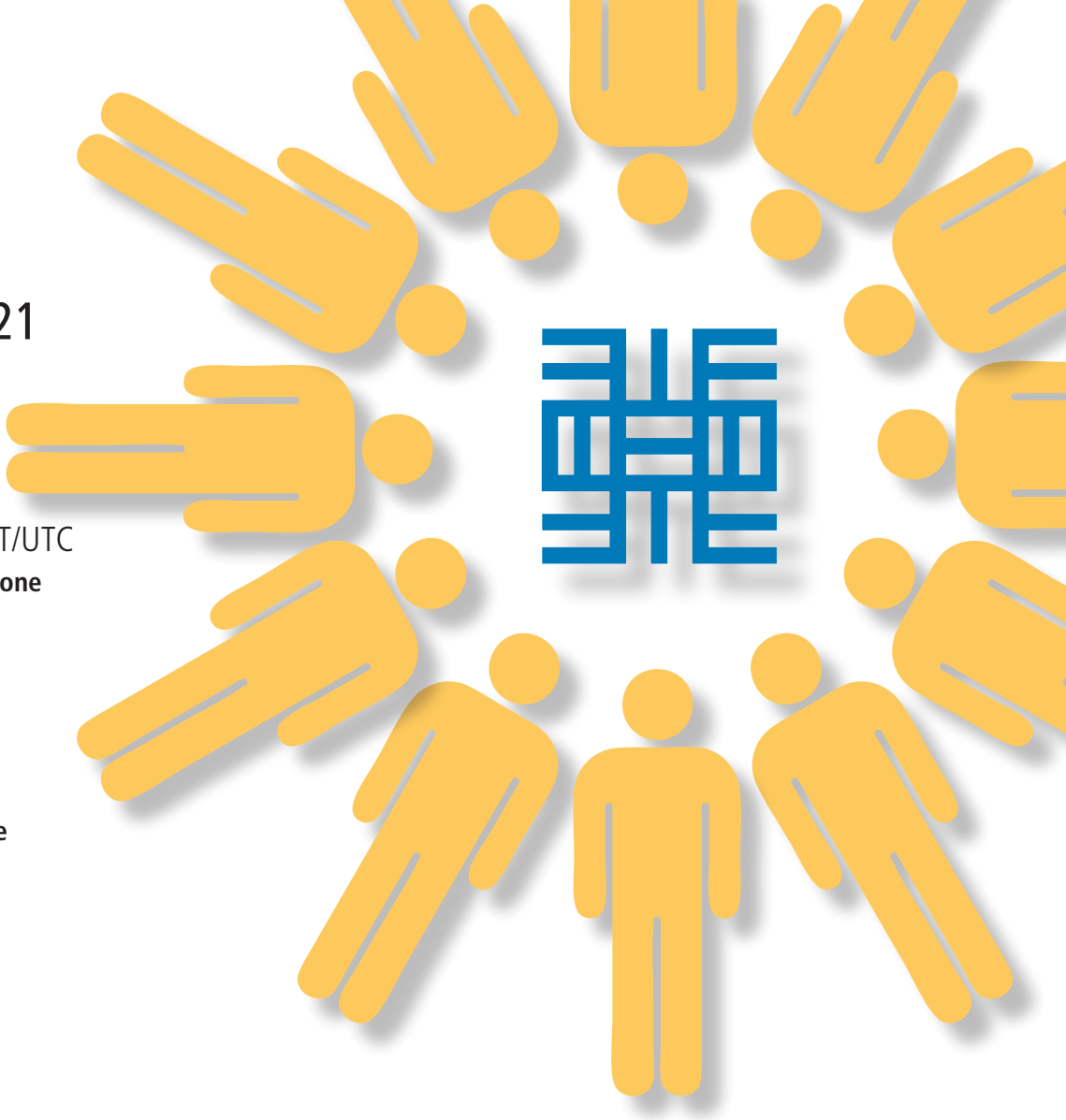

9-11 AUGUST 2021

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