DUT DURBAN UNIVERSITY OF TECHNOLOGY

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PROCEEDINGS OF THE CONSTRUCTION BUSINESS & PROJECT MANAGEMENT CONFERENCE

THEME: Conceptualising challenges and opportunities in the construction industry

24 - 25 JUNE 2021

UCT GRADUATE SCHOOL OF BUSINESS, ACADEMIC CONFERENCE CENTRE
CAPE TOWN, SOUTH AFRICA

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Cape Town, South Africa, 24 – 25 June, 2021.

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Correspondence:
All correspondence relating to the Construction Business and Project Management Conference should be addressed to:

Professor Abimbola Olukemi Windapo (Chair)
University of Cape Town, South Africa
Abimbola.windapo@uct.ac.za

Dr Ayodeji Olatunji Aiyetan (Co-chair)
Durban University of Technology, South Africa
Ayodejia@dut.ac.za

DECLARATION

Eighty-one submissions were received for the Conference from 30 Universities, Polytechnics and Organisations located in Australia, Ghana, India, Malaysia, New Zealand, Nigeria, South Africa, the United Kingdom and Zambia, out of which 41 full papers were accepted. All full papers in this publication went through a double-blind peer-review process which involves abstracts assessment by the scientific committee, feedback to authors on abstracts submitted, submission of full papers for the accepted abstracts, review of full papers by the scientific committee and panel of reviewers, feedback to authors on full papers submitted which included a decision on acceptance and evaluation of the revised papers by the scientific committee and reviewers to ensure the quality of content.

CBPM 2021 Conference Stats

Abstract/Full Paper	Full Paper	
Institutional Affilliation	**Count of Affiliation**	**Affiliation (%)**
Durban University of Technology	4	7.02%
Ahmadu Bello University, Zaria	4	7.02%
University of Cape Town	4	7.02%
Nelson Mandela University	3	5.26%
University of South Africa	3	5.26%
Federal University of Technology, Minna	3	5.26%
Moshood Abiola Polytechnic, Abeokuta	3	5.26%
Obafemi Awolowo University, Ile-Ife	3	5.26%
Univerisity of Ilorin	3	5.26%
Univerisity of Kwa-Zulu Natal	3	5.26%
University of Johannesburg	2	3.51%
University of The Free State	2	3.51%
Kingston University, London	2	3.51%
Walter Sisulu University	2	3.51%
Niger State Polytechnic, Zungeru	1	1.75%
Curtin University	1	1.75%
Kwame Nkrumah University of Science and Technology	1	1.75%
Denel	1	1.75%
Akwa Ibom State Polytechnic, Akwa Ibom	1	1.75%
Olabisi Onabanjo University, Ago-Iwoye	1	1.75%
Department of Science and Innovation, South Africa	1	1.75%
Stellenbosch University	1	1.75%
Modibbo Adama University, Yola	1	1.75%
University of the Witwatersrand	1	1.75%
University of Manchester	1	1.75%
Waziri Umaru Federal Polytechnic, Birnin Kebbi	1	1.75%
Darik Homes Limited, Abuja	1	1.75%
The Federal Polytechnic Ilaro	1	1.75%
Bayero University, Kano	1	1.75%
The Oke-Ogun Polytechnic Saki	1	1.75%
Grand Total	**57**	**100.00%**

PREFACE

Dear Conference Participants,

It is a pleasure to welcome you to the Construction Business and Project Management (CBPM) Conference, 24-25 June 2021. The conference is organised under the auspices of the University of Cape Town and Durban University of Technology.

The construction industry plays a vital role in the economy of any nation, and it is a significant contributor to economic growth. It creates employment, especially for unskilled workers, which can be used in the development and transfer of technology, creating many opportunities for enterprises and contributing directly to improving the quality of life of its users. The construction industry is more than a single industry comprising a complex cluster of sectors, including banking, materials and equipment manufacturers, contracting organisations, consultancies and suppliers of goods and services.

In 2013, the construction sector in South Africa contributed 13% of the GDP with expectations for an increase to 15% by 2020. However, a dismal contribution of the construction industry to the GDP has been observed in South Africa and globally. The current COVID-19 pandemic has now worsened this dismal performance. Furthermore, society faces numerous problems concerning infrastructure delivery and management and the failure of construction companies. In the ten years leading up to the Covid pandemic in 2020, many small and medium-sized construction companies underwent business rescue. However, the challenges also extend to large companies whose failure has also led to the collapse of many smaller companies – their appointed sub-contractors.

This conference aims at conceptualising the various challenges and opportunities in the construction industry by providing a platform that brings all stakeholders involved in the construction industry, both academia and practitioners, to collaborate and brainstorm on the challenges of, opportunities and the future directions for construction business and project management. It is believed that through its collaborative motive, this forum will bring about changes in the delivery of sustainable construction businesses, professional practices and projects. Furthermore, sharing experiences and ideas in infrastructure delivery, management and procedures should be an ongoing priority as infrastructure is required for economic growth and development.

To stimulate interaction between the conference participants, the organising committee has designed a programme that enables networking, learning, and discussion opportunities. In addition to four keynote addresses and the presentation of 41 papers, the conference takes place immediately after a public lecture on "Leading inclusive change in Affordable Housing and Development in African cities," and a workshop on "The use of Local Building Materials/Alternative Technologies in housing construction."

Based on examination of the abstracts and full papers submitted by the Keynote speakers and authors from 30 institutions and 13 countries, I am convinced that this will be an inspiring event. Furthermore, the event will generate new insights and solutions to the myriad challenges facing the construction industry, identifying opportunities for growth and research collaborations.

Finally, I wish to thank all our Local Organising Committee and Scientific Committee members who gave their time selflessly to the organisation and realisation of the CBPM conference. I also want to thank all other individuals who played an important role in the logistical support of the conference. I wish you all a stimulating conference, and to those who made it to Cape Town, I wish you a pleasant stay.

Prof. Abimbola Windapo
Chair, Scientific Committee CBPM 2021 Conference

ORGANISING COMMITTEE

Abdulrauf Adediran	University of Johannesburg, South Africa
Amanda Mtya	University of Cape Town, South Africa
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Chioma Okoro	University of Johannesburg, South Africa
Kehinde Alade	University of Cape Town, South Africa
Nnedinma Umeokafor	Kingston University London, United Kingdom

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Mochelo Lefoka	University of Cape Town, South Africa

THE PEER REVIEW PROCESS

All the full papers in this publication went through a rigorous two-stage blind peer review process by no less than two acknowledged experts in the subject area. Experts, including industry professionals and academics, were assigned to ensure that high-quality scientific papers were produced and included in the proceedings.

The first stage of review

Submitted abstracts were double-blind peer-reviewed. Each abstract was reviewed in terms of relevance to the conference theme and objectives, academic rigour, contribution to knowledge, originality of material and research methodology. Authors whose abstracts were accepted were provided with anonymous reviewers' comments and requested to address the review comments when developing their full papers.

The second stage of review

The submitted full papers were first of all checked originality and inappropriate copying using Turnitin/Ithenticate software. After that, the papers were assigned to experts in the field based on their areas of expertise for review. The full papers were reviewed in terms of relevance to the originality of the material; technical writing; academic rigour; contribution to knowledge; pertinent literature review; research methodology and robustness of analysis of data; empirical research findings; and overall quality and suitability of the paper for inclusion in the conference proceedings.

The third stage review

Authors whose papers were accepted after the second review were provided with additional anonymous reviewers' comments on evaluation forms, and requested to submit their revised full papers. Evidence was required relative to specific actions taken by the authors regarding the referees' suggestions. Final papers were only accepted and included in the proceedings after satisfactory evidence was provided. To be eligible for inclusion in the conference proceedings, these papers were required to receive a unanimous endorsement by the Scientific Committee and Review Panel that the paper had met all the conditions for publication. Out of 81 submissions, 41 papers were finally accepted and included in the CBPM-2021 conference proceedings.

At no stage was any member of the Scientific Committee, Review Panel or the Organising Committee, or the Editors of the proceedings involved in the review process related to their own authored or co-authored papers. The role of the editors and the scientific committee was to ensure that the final papers incorporated the reviewers' comments and to arrange the papers into the final sequence as captured on the USB memory stick and Table of Contents.

Prof. Abimbola Windapo
Chair, Scientific Committee CBPM 2021 Conference

ENDORSEMENTS

The Construction Business and Project Management Conference is accredited by the South African Council for the Project and Construction Management Professionals (SACPCMP) for 8 CPD points. The conference is also supported by the Journal of Construction Business and Management.

SACPCMP

The South African Council for the Project and Construction Management Professions

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KEYNOTE SPEAKERS

The Conference Organising Committee would like to thank our keynote speakers for accepting our invitation to come and share their presence and thoughts with us. Thank you very much.

Dr Kgosientsho Ramokgopa

Dr Kgosientsho Ramokgopa is currently the **Head of the Investment and Infrastructure office** in the office of the President of South Africa. Before this, Dr Ramokgopa was Gauteng MEC (Member of Executive Committee) for Economic Development, Agriculture and Environment. Previously, he has held the position of Executive Mayor of the City of Tshwane between 2010 and 2016, at the time he was one of the youngest Mayors of a Metropolitan in the country. Dr Ramokgopa's previous positions include holding the position of CEO for both the Metropolitan Trading Company and the Johannesburg Market and he has previously been the Deputy Chairperson of the board of Trade and Investment in Limpopo.

Dr Ramokgopa holds a PhD and a Masters of Public Administration from the University of Pretoria, and a Masters of Business Leadership from the University of South Africa. He completed his BS in Civil Engineering at the University of Durban Westville in 1998. MEC Ramokgopa's political participation dates back to the '80s when he was 14 and participating in the Atteridgeville-Saulsville Residents Organisation (ASRO). Dr Ramokgopa offers lessons in leadership and public management at various tertiary institutions as a guest lecturer, something he does pro-bono. Dr Ramokgopa lives by the motto; "If you live truthfully, you shall prevail against all adversity."

Prof Chimay Anumba

Professor Chimay Anumba is Dean of the College of Design, Construction and Planning at The University of Florida. He is a Fellow of the Royal Academy of Engineering, FREng (the United Kingdom's National Academy of Engineering). He holds a Ph.D. in Civil Engineering from the University of Leeds, UK; a higher doctorate – D.Sc. (Doctor of Science) - from Loughborough University, UK; and an Honorary Doctorate (Dr.h.c.) from Delft University of Technology in The Netherlands. He has over 500 scientific publications and his work has received support worth over $150m from a variety of sources. He has also supervised 52 doctoral candidates to completion and

mentored over 26 postdoctoral researchers. He is the recipient of the 2018 American Society of Civil Engineers' Computing in Civil Engineering Award and a member of the US National Academy of Construction (NAC).

Prof John Smallwood

Prof John Smallwood is the Professor of Construction Management in the Department of Construction Management, Nelson Mandela University, and the Principal, Construction Research Education and Training Enterprises (CREATE). Both his MSc and PhD (Construction Management) addressed construction health and safety (H&S). He has conducted extensive research and published in the areas of construction H&S, ergonomics, and occupational health (OH), but also in the areas of the environment, health and well-being, primary health promotion, quality management, and risk management.

Prof Bhekisipho Twala

Bhekisipho Twala is the Executive Dean of Engineering and Built Environment and Professor in Artificial Intelligence and Data Science at the Durban University of Technology, South Africa. Before then, he was the Director of the School of Engineering at the University of South Africa and the Institute for Intelligent Systems at the University of Johannesburg. Prof Twala's current work involves promoting and conducting research in Artificial Intelligence within the Big Data Analytics field and developing novel and innovative solutions to key research problems in this area. He earned his Bachelor's degree in Economics and Statistics from the University of Swaziland in 1993; followed by an MSc in Computational Statistics from Southampton University (UK) in 1995; and then a PhD in Machine Learning and Statistical Science from the Open University (UK) in 2005. Prof. Twala was a post-doctoral researcher at Brunel University in the UK, mainly focussing on empirical software engineering research and looking at data quality issues in software engineering. His broad research interests include multivariate statistics, classification methods, knowledge discovery and reasoning with uncertainty, sensor data fusion and inference, and the interface between computing and statistics. He has particular interests in applications in finance, medicine, psychology,

software engineering and most recently in robotics and has published over 180 scientific papers. Prof Twala is currently an associate editor of the Information Sciences Journal, Intelligent Data Analysis Journal, Journal of Computers, International Journal of Advanced Information Science and Technology, International Journal of Big Data Intelligence, Journal of Image and Data Fusion, Journal of Information Processing Systems, and a fellow of the Royal Statistical Society. Other professional memberships include the Association of Computing Machinery (ACM); the Chartered Institute of Logistics and Transport (CIT), South Africa and a Senior Member of the Institute of Electrical and Electronics Engineers (IEEE). Twala is the recipient of the TW Kambule research and its outputs award, the highest honour bestowed by the South African government on outstanding scientist for up to fifteen years after the award of a PhD or equivalent.

PROGRAMME

Construction Business and Project Management Conference, 24-25 June 2021
Venue: UCT Graduate School of Business, Cape Town/Online
Theme: Conceptualising Challenges and Opportunities in the Construction Industry

Day 1 - Thursday, June 24th			
2021-06-24	8:30-09:00	**Registration and Welcome (Prof Bheki Twala)**	
2021-06-24	09:00-09:30	**Keynote Address 1**	
	09:00-09:30	S1	**Dr Kgosientso Ramokgopa. Contextualizing Infrastructure Delivery and Management in South Africa**
2021-06-24	09:30-11:10	Session 1: Day 1: Session A. Session Chair - Prof. Abimbola Windapo	
	09:30-09:48	2	Kehinde Alade and Abimbola Windapo. A leadership and strategic decision framework for construction company survival.
	09:48-10:06	36	Luyanda Ngomane and Nthatisi Khatleli. Rethinking Resilience: A review of the infrastructure management capability maturity levels in South African category B4 municipalities: The Case of Nyandeni Local Municipality
	10:06-10:24	58	Oluwole Olatunji and Ephraim Osaghae. Dynamic Capabilities in Multicultural Project Teams: Conceptual Review, Framework Analysis, and Practical Implications
	10:24-10:42	61	Tselane Chicks and Makgopa Tshehla. Procurement Innovation and Transformation in Commercial State-Owned Enterprises (SOES) – Infrastructure Projects
	10:42-11:10	81	Amit Rambaruth, Jamila Khatoon Adam and Suresh Babu Naidu Krishna. Strategic Management in construction firms with focus on small and medium enterprises: A case study of eThekwini, South Africa
2021-06-24	11:10-11:30	Session: Tea Break	
2021-06-24	11:30-13:00	Session 2: Day 1: Session B. Session Chair - Dr Ayodeji Aiyetan	
	11:30-11:48	18	Chinedu Adindu, Chioma Okoro, Ikechukwu Diugwu and Saheed Yusuf. Prospects of Multi-skilling as Strategic Construction labour response to Covid-19 Pandemic: A Study of selected Projects in the Federal Capital Territory area councils, Nigeria.

	11:48-12:06	22	Afia Attrams and Professor Makgopa Tshehla. Determinants of small and medium enterprises financing sources: evidence from Ghana
	12:06-12:24	32	Sihle Mbekushe and Christopher Amoah. Impact of unskilled labourers on the construction productivity
	12:24-12:42	55	Athenkosi Sogaxa and Stoffel Fourie. Sustainable Construction Project delivery: A Skills Availability Assessment in the Eastern Cape Province of South Africa
	12:42-13:00	75	Justin van Wyk, St John Wilson and Mochelo Lefoka. Management Tools and Techniques Impacting On-site Labour Productivity
2021-06-24	13:00-14:00	Session: Lunch Break	
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	14:00-14:30	S2	**Prof. Chimay Anumba. Towards Smart and Resilient Built Environments**
2021-06-24	14:30-16:10	Session 3: Day 1: Session C. Session Chair - Dr Emmanuel Nkeleme	
	14:30-14:48	8	Bello Mahmud Zailani, Mu'Awiya Abubakar, Yahaya Ibrahim Makarfi, Kabir Bala and Muhammad Sadiq Abdallah. Integrating Building Information Modelling (BIM) Tools and Techniques in Construction Organizations: Effect on Culture and Structure
	14:48-15:06	26	Dillip Das and Ayodeji Olatunji Aiyetan. Exploring the use of Drones for sustainable construction in developing countries
	15:06-15:24	41	Lily Dixon and Nnedinma Umeokafor. Determinants of Smart Technology adoption in the Construction Phase of Projects: A Scoping Study of the United Kingdom
	15:24-15:42	62	Micayla Prozesky, Shweeta Bagoandas, Amanda Mtya and Abimbola Windapo. Benefits of the adoption of digital technologies on South African construction projects
	15:42-16:00	63	Tinotenda Chirenda, Ellis Chitakatira, Reyaboka Mpeke, Amanda Mtya and Abimbola Windapo. Capability factors influencing the adoption of Building Information Modelling (BIM) by South African AEC organizations
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2021-06-24	16:30-18:00	Session 4: Day 1: Session D. Session Chair – Mr Kenny Alade	

	16:30-16:48	3	Babatunde Dosumu, Obuks Ejohwomu and Akilu Yunusa-Kaltungo. Development of a project risk/cost estimation framework: a case study of Nigeria.
	16:48-17:06	19	Jan Wium and Chris Jurgens. Benefits of the application of data sciences in construction
	17:06-17:24	38	Ikechukwu A. Diugwu, Haruna Musa, Nnedinma Umeokafor and Yekeen Sanusi. A scoping study of barriers and drivers of sustainable design and construction in Nigeria
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	17:42-18:00	78	Emmanuel Ifeanyichukwu Nkeleme, Ikem Mbammali and Winston Shakantu. Effects of combustion generated pollutants on the indoor air quality of university laboratories.
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	09:00-09:30	s3	**Prof John Smallwood. Adaptation, Resilience and Mental Health Post-Covid**
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	09:48-10:06	37	Muziwandile Mabaso and John Smallwood. Fatal Trench Collapses on Sewer Reticulation Projects in the Construction Industry
	10:06-10:24	48	Ayodeji Olatunji Aiyetan and Opeyemi Ayobami David. Causes of fatality relative to construction site accidents in the KwaZulu-Natal construction industry
	10:24-10:42	53	Mwewa Mambwe, Erastus Mwanaumo, Wellington Thwala and Clinton Aigbavboa. Employee Wellbeing Factors for Improving Occupational Health and Safety Performance by Small-Scale Electrical Contractors in Zambia
	10:42-11:00	60	Takalani Sigama, Mabila Mathebula and John Smallwood. The impact of Business Forums on Construction Health and Safety (H&S) in South Africa

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2021-06-25	11:30-13:00	Session 6: Day 2: Session B. Session Chair - Dr Ayodeji Aiyetan	
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	11:48-12:06	14	Ranti Taibat Adebiyi, Ganiyu Amuda-Yusuf, Abdulkadir Shehu Rasheed and Scholastica Fidelis Ekanem. Women Career Advancement for Sustainable Development in Construction Industry in Nigeria
	12:06-12:24	45	Tshepang Mosiea, Precious Lukhele, Sijekula Mbanga and Dr Sithembiso Myeni. Assessing the role of institutionalised self-help housing in achieving United Nations Sustainable Development Goals in Post-Apartheid South Africa
	12:24-12:42	54	Athenkosi Sogaxa, Ruben Ndihokubwayo and Eric Kwame Simpeh. Effective material Management practices adopted by SMEs to achieve project success: a perspective of construction industry in the Eastern Cape Province
	12:42-13:00	80	Samuel Olatunbosun, Sunday Odediran and Azeez Akinborode. Factors Influencing Construction of Sustainable Buildings in Lagos Metropolis, Nigeria
2021-06-25	13:00-14:00	Session: Lunch Break	
2021-06-25	14:00-14:30	**Keynote Address 4**	
	14:00-14:30	S4	**Prof Bhekisipho Twala. Big analytics in the construction industry**
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	14:48-15:06	13	Lukman Olarewaju Olorunoje, Sunday Julius Odediran and Ganiyu Amuda-Yusuf. Entry modes used by multinational firms in crossing borders into the Nigerian construction market
	15:06-15:24	34	Solomon Ojo and Sodiya Abiodun. Frameworks for Renumeration of Construction Consultants during unwarranted Project Time Overrun in Nigeria

	15:24-15:42	65	Modupe Mewomo and Ayodeji Aiyetan. Unethical Behaviour in Construction Industry – The South African Construction Professionals Views.
	15:42-16:00	76	Makgopa F Tshehla and Tsholofelo M Mokoma. The effect of Incubation Programme Small, Micro and Medium Enterprises Development: A cross-sectional survey
2021-06-25	16:10-16:30	Session: Tea Break	
2021-06-25	16:30-18:00	Session 8: Day 2: Session D. Session Chair - Dr John Babafemi	
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	16:48-17:06	25	Dillip Das. Impact of construction for the expansion of National Highways on the local environment in India.
	17:06-17:24	43	Umar Obafemi Salisu, Nathaniel Oluwaseun Ogunseye, Ayobami Ademola Akanmu, Simeon Oluwagbenga Fasina, Wakeel Iyanda Solabi and Abeeb Olawale Olanipekun. Environmental Implications of Construction Activities in A Fast-Growing Nigerian City: A Study of Ota, Nigeria
	17:24-17:42	51	Fatimo Osho and Adeshina Dauda Adebayo. Effect of Moisture on Durability of Concrete Components in Residential Buildings
	17:42-18:00	73	Samuel Olatunbosun and Sunday Odediran. Impact of Energy Access on the Delivery of Construction Projects in Lagos Metropolis, Nigeria
	18:00-18:18	79	Dele S. Kadiri, Obiora K. Uroko, Babajide O. Onabanjo and Elijah O. Oyewole. An Evaluation of Planning Techniques Impacting Construction Project Performance in Nigeria
	18:20		**Closing and Presentation of Certificates**
2021-06-26	**10:00**		**Sightseeing - Tour of Robben Island**

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A scoping study of barriers and drivers of sustainable design and construction in Nigeria

Ikechukwu A. Diugwu[1], Haruna D. Musa[2], Nnedinma I. Umeokafor[3], and Yekeen A. Sanusi[2, 4]

[1]Department of Project Management Technology, Federal University of Technology Minna, Niger State, Nigeria
Email: i.diugwu@futminna.edu.ng

[2]Department of Urban and Regional Planning, Federal University of Technology Minna, Niger State, Nigeria
Email: musaharunad@futminna.edu.ng

[3]Department of Civil Engineering, Surveying and Construction Management, Kingston University, London
Email: nnedinmaik@hotmail.com

[4]Email: yasanusi@googlemail.com

Abstract:
Construction stakeholders have been under pressure to reduce the industry's environmental footprint by adopting new technologies. In a two-round Delphi survey, a panel of 12 experts were required to rate and rank the importance of 75 drivers and 21 barriers to sustainable design and construction. After the second round of the survey, 61 drivers and 15 barriers were rated with a high degree of group agreement (Kendall's W =.511; p.001). A high Spearman's rank correlation.value (rho = 0.923, p <.001) indicated a strong degree of convergence between rounds. Also, the result (Kendall's W = 0.76; p < 0.000) indicated a high panel consensus on ranked barriers items with lack of government policy, misconception of construction cost overrun, no reflection of recovery of long-term savings in service fee structure, conflicting public policy and/ or regulations, lack of awareness from clients (Owner/ Developer), a limited knowledge and understanding of sustainable issues by customers, deployment of resources to back technological changes, and lack of knowledge and understanding from design professionals were ranked low as barriers to sustainable design and construction. The findings from the study would provide information on regulatory and socio-economic factors that impact sustainable design and construction in Nigeria, and strengthen the implementation of sustainability in the construction industry.

Keywords:
Infrastructure, Sustainable construction, Sustainability, Urban development, Urban growth

1 Introduction

By 2050, approximately 68 percent of the global population will be living in cities, with new urban dwellers in India, China, and Nigeria accounting for about 35 percent of this (UN DESA, 2019). By 2030, it is expected that developing countries (mostly in Asia and Africa) will account for roughly 80% of those living in urban areas (UN-HABITAT, 2006). According to some estimates, about half of Nigeria's population will have moved to urban areas by 2020 (Bloch, Monroy, Fox, & Ojo, 2015). Rapid population growth has been related to urban growth and expansion (Sharifi & Hosseingholizadeh, 2019; Zhang & Xie, 2019), negatively impacting sustainable development (Ejaro, 2009). Therefore, fast-growing cities like Abuja will have

pronounced growth, such that current space and facilities would be insufficient to accommodate the increasing population and expanding area. Indeed, rapid urbanisation has had a detrimental effect on the FCT's long-term growth (Ejaro & Abubakar, 2013). Serious and persistent construction sustainability challenges have been observed in FCT Abuja (Ekpetere, Faith, & Eziechi, 2019; Windapo & Rotimi, 2012). Using Abuja (the Federal Capital Territory) as a case study, this paper seeks to identify the primary drivers and barriers to sustainable design and construction in Nigeria's construction industry.

It uses Delphi techniques to study the views of a panel of expert and determine the major drivers and barriers of sustainable design and construction. Findings from the study would provide information on regulatory and socio-economic factors that impact sustainable design and construction in Nigeria.

2 Literature Review

The demand for affordable housing, transport systems, and other infrastructure increases with urban growth. However, this would have negative consequences. Indeed, it is well recognized that urbanisation and spatial changes have significant environmental, social, and economic implications for long-term sustainability (Keivani, 2010). Cities are responsible for a greater percentage of greenhouse gas (GHG) emissions (Hoornweg, Sugar, & Trejos Gómez, 2011). Efforts at mitigating these harmful emissions should be targeted at areas with higher socio-economic and health benefits (Urge-Vorsatz & Novikova, 2008). The construction industry should strive to balance the various aspects (social, economic, and environmental) of human activity, by encouraging the implementation of construction processes that incorporate basic sustainable development objectives of sustainable (Liu, Pypłacz, Ermakova, & Konev, 2020). These three dimensions of sustainable construction are discussed in detail, highlighting the key themes and principal issues (Akadiri, Chinyio, and Olomolaiye (2012).

Sev (2009) classifies sustainable construction into environmental, social and economic dimensions. Sustainable construction processes bring about a profitable and competitive industry capable of addressing changes in user requirements (Raynsford, 2000). This enables environmental responsibility, social awareness, and economic profitability, and provision of facilities for the wider community. There are observations that the focus of the construction industry is no longer limited to the minimization of energy consumption, but has extended to other functions of planning of sites, waste management, materials selection and design, which are critical to solving environmental crisis caused by the industry’s activities (Mir-Babayev, Gulaliyev, Shikhaliyeva, Azizova, & Ok, 2017). Kibert (1994) conceptualises sustainable construction as a tripartite interaction of stages or phases, required resources, and principles in the design and execution of construction projects.

Various factors that enhance or inhibit sustainable design and construction have been extensively studied and documented in earlier studies (Ahn, Pearce, Wang, & Wang, 2013; Augenbroe & Pearce, 2009; Hale, Legun, Campbell, & Carolan, 2019; Ifije & Aigbavboa, 2020; Lopez-Chao, Casares Gallego, Lopez-Chao, & Alvarellos, 2020; Mohammed & Abbakyari, 2016). It has been suggested that a major factor that drives the implementation or adoption of sustainable construction practices is a buy-in or concern by the management of an organisation (Shen, Tam, Tam, and Ji, 2010).

3 Research Methodology

3.1 Study Location

Abuja FCT occupies a land mass of about 8000km^2 in the Guinea-Savanna vegetation zone (Idoko & Bisong, 2010). It is situated between latitude 7°25′N and 9°20′N and longitude 5°45′E and 7°39′E (Enoguanbhor, Gollnow, Walker, Nielsen, & Lakes, 2020), and bounded by Kaduna State in the North, Nasarawa State in the East, Kogi State in the South, and Niger State in the West (Musa, Oguche, & Onyekwulu, 2020). Abuja, Nigeria's largest construction area, has been described as an unsustainable city (Obiadi, Onochie, & Uduak, 2019).

3.2 Delphi Panel and Consensus Criteria

Expert opinion was sorted through a two-round Delphi survey to identify and rank the importance of the key drivers and barriers of sustainable design and construction in the construction industry in Nigeria. Seventy-five drivers (grouped into four sustainable dimensions (Chao et al., 2020), and twenty-three barriers identified from the review of web of science and literature were presented to the panellists. Fifteen potential panel members were invited through email to participate in the study, twelve indicated interest to participate. The purposively sampled panel consisted of twelve (*n =12*) sustainable design and construction experts (two academics, one urban planner, four architects, and five construction professionals), seven of whom have experience ranging between 11-25years. The qualification of the panellist ranged from degree (5), Master's degree (4) and PhD (3).

A questionnaire with a total of ninety-eight questions related to drivers and barriers of sustainable design and construction was developed for the panel of experts. Experts were asked to rank the factors on a scale between 1 and 5 (1= Not at all important, 2=Somewhat unimportant, 3=Neither/not important, 4=Somewhat important, 5=Extremely important). In the first round, the experts were asked to rate the relevance of the items in driving sustainable design and construction, while in the round 2, the experts were asked to rank in addition the barriers items to sustainable design and construction among construction industries. Consensus was reached on a questionnaire item based on 75% of respondents rate of an agreement on individual items on 5-point Likert scale. Kendall's coefficient of concordance (Kendall's W) ($\geq .5$; $p > .05$) and Spearman rho ($\geq .9$; $p > .05$) was employed to compute level of consensus among individual experts in a round; and stability or convergence of expert response between Delphi rounds respectively. Delphi method is a suitable technique used to reach a consensus on a complex research problem in which there is no precise information available (Linstone & Turoff, 2011)

4 Findings and Discussion

The results of the rounds of the Delphi expert rating of drivers of sustainable design and construction in Nigeria are presented on Tables 1 to 4. In the first round, 12 experts out of 15 contacted participated. The expert panel has an understanding of sustainable design and construction practices, with experiences and interest in the green construction market. The result of the first round revealed a good agreement (≥75 % of agreement) in 63 of the 75 items across the four dimensions. However, the level of consensus among the experts was low (Kendall's W = .369; $p < .00$). This indicates that the experts had strong agreement on selected items. However, no consensus was achieved among panel in the first round. Delphi process is iterative and incremental; thus, second around is required to review panel judgement. In the second round, the 12 experts were asked to reassess their responses, taking into account the

results in the first round. In this round, the result revealed a good agreement (≥75 % of agreement) in 63 of the 75 items across the four dimensions. However, the level of consensus among the experts was high with an increase in Kendall's coefficient of concordance (W = .511; p<.00). In the second around, under the environmental sustainability criteria, the experts maintained their position on 'Waste reduction and management - reuse and recycle '(item 7), renewable energy, (item 9) ‘preserve and enhance bio-diversity’(item 11), ‘creating a non-toxic environment – including high indoor air ’(item 12), ‘protect and enhance sensitive landscapes including scenic, cultural, historical and architectural’(item 16), and ‘balance between natural and the built environment’(item 21), which failed to gain consensus.

In the economic sustainability dimension, ‘recognition of commercial buildings as productivity assets’ (item 6), gain expert agreement in first round failed in the second round, while the 'using life cycle costing' (item 14) gained expert acceptance (≥75(75.0). The expert panel maintained their position on ‘support of local economies’, Whole/Integrated building design approach’, ‘decreased initial project costs’, and ‘New cost metrics based on economic and ecological value systems’, which failed to gain consensus. In the social sustainability dimension, 'improving human health and productivity' (item 8), and 'recruitment and retention' (item 20) failed to gain expert agreement in the second round along ‘diversity (cultural diversity) in development planning’ (item 16) and equality (item 21). In the governance dimension, the experts maintained a level of agreement of all items in both rounds. The difference in the level of agreement between rounds may be due to the different backgrounds of the panel group. Consensus was not reached on environmental factors (waste reduction and management – reuse, preservation and enhancement of bio-diversity, creation of a non-toxic environment, and protection and enhancement of sensitive landscapes, achieving a balance between natural and built environment); economic factors (whole/integrated building design approach); social factors (improvement in human health and condition, seeking intergenerational equity and reducing cost for future generations, recruitment and retention, as well as equality).

Table 15: Environmental Sustainability Drivers

	Variables	R1		R2	
		Mean	**Consensus (%Agreement)**	**Mean**	**Consensus (%Agreement)**
	Environmental Sustainability Criteria				
1	Energy conservation and efficiency	4.63	≥75(100)	4.58	≥75(100)
2	Water conservation and efficiency	4.88	≥75(100)	4.67	≥75(100)
3	Environmental /resource conservation	4.50	≥75(75)	4.17	≥75(75)
4	Indoor environmental quality	3.87	≥75(91.6)	4.42	≥75(100)
5	Land use regulations and urban planning policies	4.63	≥75(100)	4.75	≥75(100)
6	Plans and design (urban structure, open spaces and green areas	5.00	≥75(100)	4.83	≥75(100)
7	Waste reduction and management - reuse and recycle	3.62	**≥75(50.0)**	3.67	**≥75(58.3)**
8	Pollution minimization (Land, Water, Noise (and efficiency)	4.50	≥75(100)	4.42	≥75(100)
9	Renewable Energy	3.75	**≥75(50)**	3.25	**≥75(50)**
10	Resource conservation	4.23	≥75(75)	3.58	≥75(75)
11	Preserve and enhance bio-diversity	3.50	**≥75(66.7)**	3.17	**≥75(41.7)**
12	Creating a non-toxic environment – including high indoor air	4.13	**≥75(50.0)**	3.50	**≥75(68.0)**
13	Visual impact	3.75	≥75(75.0)	3.75	≥75(100)
14	Site and design (land use, conservation, reuse)	4.88	≥75(100)	4.83	≥75(100)
15	Transport – including provision of public transport	4.88	≥75(100)	4.83	≥75(100)
16	Protect and enhance sensitive landscapes including scenic, cultural, and historical	4.75	**≥75(50.0)**	4.17	**≥75(66.7)**
17	Creating a healthy, non-toxic environment – including high indoor air quality	4.50	≥75(100)	4.33	≥75(100)
18	Environmental Impact (process and product)	4.50	≥75(100)	4.58	≥75(100)
19	Re-use existing built assets	4.38	≥75(88.8)	4.33	≥75(88.8)
20	Green building rating systems (LEED, Green Globes)	4.38	≥75(100)	4.25	≥75(100)
21	Balance between natural and the built environment	3.87	≥75**(66.7)**	3.67	≥75**(66.6)**
	Number(n)	12		12	
	Kendall's W[a]	0.333		0.465	
	Significance	.000		.000	

Table 26: Economic Sustainability Drivers

S/N	Variables	R1		R2	
		Mean	**Consensus (%Agreement)**	**Mean**	**Consensus (%Agreement)**
	Economic Sustainability Criteria				
1	Proactive role of materials manufacturers	3.88	≥75(100)	4.17	≥75(100)
2	Financial affordability for intended beneficiaries	4.63	≥75(100)	4.50	≥75(100)
3	Product and material innovation and/or certification	4.25	≥75(75.0)	3.50	≥75(75.0)
4	Support of local economies	4.00	≥75**(66.7)**	3.50	≥75**(50.0)**
5	Adoption of incentive programmes	4.50	≥75(75.0)	3.83	≥75(75.0)
6	Recognition of commercial buildings as productivity assets	4.50	≥75(75.0)	2.25	≥75**(41.7)**
7	Whole/Integrated building design approach	4.50	≥75**(50.0)**	4.00	≥75**(66.6)**
8	Decreased initial project costs	3.88	≥75**(66.6)**	3.92	≥75**(66.6)**
9	Viability	4.25	≥75(75.0)	4.33	≥75(91.7)
10	Client worries in profitability	5.00	≥75(100)	4.67	≥75(100)
11	Competitiveness	4.63	≥75(100)	4.42	≥75(100)
12	Productivity	4.88	≥75(100)	4.58	≥75(100)
13	Value for money	4.13	≥75(100)	4.17	≥75(100)
14	Using life cycle costing	4.75	≥75**(66.6)**	4.50	≥75(75.0)
15	Creating and maintaining high and stable levels of employment	4.13	≥75(100)	4.17	≥75(100)
16	Investment (green products and in the use of renewable resources	4.00	≥75(100)	4.08	≥75(100)
17	Use of Key Performance Indicators (KPIs)	4.63	≥75(91.6)	4.50	≥75(100)
18	Maintaining high and stable levels of economic growth	4.50	≥75(100)	4.67	≥75(100)
19	New cost metrics based on economic and ecological value systems	4.38	≥75**(50.0)**	3.33	≥75**(66.7)**
20	Encourage use of local resources	4.63	≥75(75.0)	3.75	≥75(100)
	Number(n)	12		12	
	Kendall's W[a]	0.179		0.383	
	Significance	.000		.000	

Table 37: Social Sustainability Drivers

	Variables	R1		R2	
		Mean	**Consensus (%Agreement)**	**Mean**	**Consensus (%Agreement)**
	Social Sustainability Criteria				
1	Education and training	4.00	≥75(100)	4.42	≥75(100)
2	New kinds of partnership and project stakeholders	4.50	≥75(100)	4.33	≥75(100)
3	Improving occupants' productivity	4.00	≥75(100)	4.00	≥75(100)
4	Improving indoor environmental quality	4.75	≥75(100)	4.50	≥75(100)
5	Increase of awareness from clients	4.38	≥75(100)	3.42	≥75(75.0)
6	Community and social benefits	4.63	≥75(100)	4.42	≥75(91.7)
7	Building strong communities	4.00	≥75(100)	4.08	≥75(100)
8	Improving human health and productivity	4.38	≥75(100)	3.67	≥75**(66.7)**
9	Protecting and promoting human health and wellbeing	4.38	≥75(91.7)	4.33	≥75(91.7)
10	Participation of stakeholders –including community involvement	4.75	≥75(91.7)	4.58	≥75(91.7)
11	Improving public space quality	4.38	≥75(100)	4.50	≥75(100)
12	Making provision for social self-determination/enhancement	4.75	≥75(100)	4.75	≥75(100)
13	Training and development (skills training and capacity enhancement)	4.13	≥75(100)	4.33	≥75(100)
14	Equitable distribution of the social costs and benefits of construction	4.00	≥75(100)	4.58	≥75(100)
15	Seeking intergenerational equity and reducing cost for future generations	4.13	≥75(100)	4.08	≥75(100)
16	Diversity (cultural diversity) in development planning	3.87	≥75**(50.0)**	4.27	≥75**(63.6)**
17	Social inclusion	4.88	≥75(100)	3.92	≥75(91.7)
18	Improving image/reputation	5.00	≥75(100)	4.92	≥75(100)
19	Employment –including equal employment opportunities	4.50	≥75(100)	4.08	≥75(75.0)
20	Recruitment and retention	4.75	≥75(75.0)	4.25	≥75**(66.6)**
21	Equality	3.38	≥75**(66.6)**	4.00	≥75**(66.6)**
22	Accessibility	4.88	≥75(100)	4.25	≥75(75.0)
23	Work in occupied premises	4.38	≥75(100)	4.25	≥75(100)
24	Working environment	4.50	≥75(100)	4.33	≥75(100)
25	Security (minimising crime)	4.63	≥75(100)	4.75	≥75(100)
26	Satisfaction (workforce and user satisfaction)	4.25	≥75(100)	4.75	≥75(100)
	Number(n)	12		12	
	Kendall's W[a]	0.207		0.339	
	Significance	.000		0.000	

NOTE: The items that did not gain consensus are in **bold** typeface on Tables 1 to 3; %Agreement**:** ≥75 expert's response on item ≥4 on 1-5 Likert Scale (1=Not at all important to 5 =Extremely important); a: Kendall's coefficient concordance

Table 48: Governance Sustainability Drivers

S/N	Variables	R1		R2	
		Mean	**Consensus (%Agreement)**	**Mean**	**Consensus (%Agreement)**
	Governance Criteria				
1	Incentive programmes	4.63	≥75(100)	4.42	≥75(100)
2	Performance-based standards	4.62	≥75(100)	4.50	≥75(100)
3	Re-engineering the design process	4.62	≥75(75.0)	4.50	≥75(100)
4	Sustainable construction materials	5.00	≥75(100)	4.75	≥75(100)
5	Re-engineering the design	4.25	≥75(100)	4.42	≥75(100)
6	City planning and innovation (Smart city policy and	5.00	≥75(100)	4.92	≥75(100)
7	development				
8	Integrating agenda 21into urban planning	4.13	≥75(91.6)	4.00	≥75(100)
	Transparency and open Government	5.00	≥75(100)	4.67	≥75(100)
	Number(n)	12		12	
	Kendall's W[a]	0.298		0.383	
	Significance	.000		.000	
	Overall:				
	Number(n)	12		12	
	Kendall's W[a]	0.369		0.511	
	Significance	.000		.000	

In overall, the results from the second (and final) round revealed a high consensus (Kendall's W = .511; p <.001) reached on 63 drivers of sustainable design and construction. The

spearman's rank correlation computed to determine the stability of the level of expert ratings between the Delphi rounds reveals strong and positive correlation value (rho = 0.923, p <.001), indicating high degree of convergence implying that the stoppage criteria is achieved.

The result of the rounds of the Delphi expert rating of the barriers to sustainable design and construction in FCT Nigeria is presented on Table 5. The result reveals Kendall's W = 0.76 (p < 0.000) indicating that the panel's consensus with each other on the items is high. The mean rank of the items indicated that the most rated barrier item among the construction industries in Abuja was the tendency to maintain current practices. Barriers such as Lack of government policy (9.67); Misconception of Construction cost overrun (8.67); Recovery of long-term savings not reflected in service fee structure (8.54); Conflict public policy and/ or regulations(8.46); Lack of awareness from clients (Owner/Developer)(7.50); Limited sustainable knowledge and understanding from customers(7.42); Deployment of resources to back technological changes(6.92); and Lack of knowledge and understanding from design professionals(3.42) were ranked low. However, Tendency to maintain current practices (17.63), Ignorance of life cycle cost (16.29) and Unfamiliarity of sustainable materials and products (15.04) were the highest-ranking barriers.

Table 5: Expert ranks on barriers to sustainable design and construction in Abuja

	Variables	***Mean Rank***
1	Tendency to maintain current practices	17.63
2	Lack of an integrated work environment among all stakeholders	16.29
3	High building cost	15.50
4	Ignorance of life cycle cost	15.50
5	Unfamiliarity of sustainable materials and products	15.04
6	No understanding of the benefits of sustainable construction	15.00
7	Limited sustainable knowledge and understanding from subcontractors	14.58
8	Limited supply of sustainable materials and products	14.33
9	Extension of project schedules	14.25
10	Lack of public awareness	13.67
11	First cost premium of sustainable design and construction	13.63
12	Delay in decision making	13.50
13	Requirement for long payback periods from implementing sustainable practices and technologies	12.71
14	Concerning warranties and risks on non-standard sustainable materials and methods	12.25
15	Initializing sustainability due to lack of building regulations	11.54
16	Lack of government policy	9.67
17	Misconception of Construction cost overrun	8.67
18	Recovery of long-term savings not reflected in service fee structure	8.54
19	Conflict public policy and/or regulations	8.46
20	Lack of awareness from clients (Owner/Developer)	7.50
21	Limited sustainable knowledge and understanding from contractors	7.42
22	Deployment of resources to back technological changes	6.92
23	Lack of knowledge and understanding from design professionals	3.42
	Number(n) Kendall's W[a] Significance	12 0.762 0.000

The last two factors were awareness-related factors and are consistent with the finding of Marsh, Brent, and de Kock (2020), who found that lack of knowledge is one of highest ranked barriers to implementing sustainable development in South Africa. Again, this finding aligns with the views expressed by Enshassi, Ayash and Sherif (2018) that insufficient capacity to implement sustainable practices is a major barrier. The findings also support earlier findings and conclusions by Daniel, Oshineye and Oshodi (2018) about critical barriers to sustainable construction practices in Nigeria. This suggests the need for context-based strategies that will focus on increasing or improving awareness in sustainable design and construction among stakeholders. Most importantly, the study's findings show the

barriers and drivers to sustainable development that the respondents view as important. The study shows that the respondents agreed on many factors; however, this should not be misconstrued as being the correct answer or opinion of judgement rather as stimulation to debate on the issues and an avenue for structuring group discussions (Hasson, Keeney, & McKenna, 2000). However, the method has been criticised for having the potential to produce forced consensus.

5 Conclusion and Further Research

The study used a two-round Delphi method to identify a set of drivers and barriers that represent consensus-based factors for sustainable design and construction in Abuja. The factors are consistent with previous research. Academics, the government, and professional institutions are encouraged to develop localised strategies to improve stakeholder knowledge of sustainable design.

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