



**NIGERIAN INSTITUTE OF QUANTITY SURVEYORS:
5TH RESEARCH CONFERENCE– NIQS RECON5
9TH – 10TH NOVEMBER 2020**

THEME:
**Confluence of Research, Theory and Practice in the
Built Environment**

EDITORS:
Dr Y. D. Mohammed
Dr A. A. Oke
Dr W. A. Ola-awo
Dr A. M. Kassimu
Dr L. O. Oyewobi

© Nigerian Institute of Quantity Surveyors, 2020

Proceedings of the 5th Research Conference of the Nigerian Institute of Quantity Surveyors

All rights reserved No part of this publication may be reproduced, stored in a retrieved system or transmitted in any form or by any means, electronic or mechanical, photocopying, recording or otherwise without prior written permission of the Publisher.

ISBN: 978-978-962-473-7

Correspondence:

Chairman
Association of Quantity Surveyors Lecturers/Educator
The Nigerian Institute of Quantity Surveyors
No.84,4th Avenue Gwarinpa, Abuja,
Nigeria.

NOV. 9TH – NOV. 10TH 2020

Federal University of Technology, Minna 2020

FOREWORD

The development of a country's economy depends on the activities of its construction industry, as construction plays a significant role in providing the infrastructure required to sustain any country's growth. This by implication means that no country can witness any growth without an efficient and effective construction industry. However, the construction industries of most developing countries continue to be a serious concern to all the stakeholders not only because of poor performance but due to lack of enabling environment to engender cutting edge research that will reposition the industry and infrastructure development at large. Against this background, the Nigerian Institute of Quantity Surveyors (NIQS) conceived the idea of research conference to bring people together; both the academics and practitioners to engage in fruitful discussions that will provide the foundation for research that will enhance the growth of Nigeria's Construction Industry and lead to the emergence of new research focus in Quantity Surveying and Built Environment in general. The conference holding in Minna, Niger State Nigeria has as its theme Confluence of Research, Theory and Practice in Quantity Surveying Profession for a Sustainable Built Environment.

Over the years, Nigerian Construction Industry (NCI) practitioners have given teaching experience to their numerous organizations and institutions. There is, however, a paradigm shift in the way Quantity Surveying and therefore all professions in the Built Environment are practiced. Conventional functions and obligations are being developed beyond the previous standard. There are evolving roles which need to be addressed, and one way to do so is to conduct research into the potential application of those concepts and theories that govern these roles.

The conference welcomes paper submissions from all over Nigeria, the host nation. This represents the interest of the stakeholders in the NIQS research conference. The research papers consist of 56 papers on all sub-themes. Research papers have undergone a two-stage paper review process. The first stage included the screening of the abstracts and, if necessary, the review of each abstract by the members of the International Scientific Committee of the Conference. The second stage included the review of the original full article of each accepted abstract by at least two members of the Scientific Committee. The two-stage review process has helped to raise the quality and standard of the papers accepted for the conference.

The LOC hopes that the delegates will gain substantial benefits from the research papers presented at the conference, both in terms of research and professional practice. This will help to achieve the key aim of the Nigerian Institute of Quantity Surveyors Research Conference, which is to serve as a bridge between academics and construction industry practitioners. On this note, I would like to warmly congratulate the Institute's Professional Development and Library Committee, the Chairman and the Members of the Conference Organizing Committee and all those who have contributed to the success of the conference.

QS Mohammed Abba Tor FNIQS, FSCI Arb, FNIMN, MBA
President

The Nigerian Institute of Quantity Surveyors
November, 2020

PREFACE

It is with great delight and profound pleasure that I gladly welcome all of you, esteemed attendees, to this first virtual edition of the Fifth Research Conference of the Nigerian Institute of Quantity Surveyors (RECON5), organized by the Association of Quantity Surveyors / Educators. NIQS RECON is a bi - annual conference, and RECON5 is the fifth of the series.

The 5th Research Conference (RECON5) of the Nigerian Institute of Quantity Surveyors (NIQS) is a follow-up to previous four editions, which was hosted last by Enugu State University of Science & Technology, Enugu. The goal of the Research Conference is to provide a forum for researchers and practitioners in the Built Environment to address key issues and broaden knowledge domains in such a way as to include new thematic areas in order to promote greater participation and to eliminate barriers in areas of research interest that are fast becoming global best practice.

It was expected that the theme — the Confluence of Research, Theory and Practice in the Built Environment — would increase the required knowledge and understanding of the topical issues of collaboration between scholars and/or professionals. The level of participation in the subject matter of the conference has been sustained since the previous event, when hundreds of related abstracts were submitted for presentation at the conference. They were subjected to a double-blind peer review process prior to the publication of the final papers for the conference.

It is expected that presentations at the conference will be able to inform policy formulations across Nigeria and the Built Environment in particular. The broad sub themes covered by the conference include:

Construction

Building Information Modelling (BIM)
Cost and value Management
Construction Procurement and Contract administration
Change management
Financing of Infrastructure projects
Construction education and training
Disaster management
Concept of sustainability in construction
ICT in construction
Knowledge management and construction organisations
The construction industry and national economy
Project management
Public private partnership
Health and safety

Real Estate and Land

Housing policy and property
Planning challenges in Urban development and management
Asset, property and Facilities management

Ethics and Legal Issues in Construction

Alternative Dispute resolution
Building Regulation Control
Construction Contract Laws
Law of property
Legal educations in Construction and property
Professional Issues and Ethics in the Built Environment
Taxation

Warm appreciation is expressed to researchers who have successfully undergone a two-tier peer review procedure in order to have their papers accepted and published in this proceeding. The review process would have not been possible without the kind support of the members of the Scientific and Technical Committee. The LOC is grateful for this voluntary service, which is central to the quality of accepted papers

I would like to take this opportunity to appreciate the President of The Nigerian Institute of Quantity Surveyors, Abba Tor, FNIQS, the past and the current National Executive Council (NEC) for their commitment and support. I also wish to thank the local organising committee led by Dr Yakubu Mohammed for their commitment to the success of the conference.

QS Dr Ganiyu Amuda-Yusuf FNIQS

Secretary, Professional Development & Library

9th -10th November 2020

Federal University of Technology, Minna

The Nigerian Institute of Quantity Surveyors
November, 2020

ACKNOWLEDGEMENTS

The Organizing Committee of the NIQS Research Conference (RECON 5) would like to express its gratitude to the President, the Nigerian Institute of Quantity Surveyors, QS Abba Tor, FNIQS and to the entire past and present Executive Council of the Institute for the Support of the Association of Quantity Surveying Lecturers / Educators (AQSLE) and to individuals for their support of the conference. The organisers are appreciative of the efforts of Dr Ganiyu Amuda-Yusuf, Secretary of Professional Development and Library towards the success of RECON 5.

We thank Prof. Ahmed Doko Ibrahim, Chairman of the Quantity Surveyors Lecturers/Educators' Forum, for the vision of the Research Conference as a platform for developing strong research work in the industry. We are also grateful to the Chairman of the Organization Committee, Dr. Yakubu Danasabe Mohammed, for his contributions and unflinching support. The Niger State Chapter of the NIQS is commended for their efforts to carry out this enormous mission.

The efforts and unique support of the Scientific and Technical Committee, which has worked hard and long to prepare refereed and edited articles and written conference proceedings, are truly appreciated. The contributions of Dr Luqman Oyekunle Oyewobi, Prof A. D. Ibrahim, Dr Kasimu Alhaji Mohammed, Dr Abdulganiyu Adebayo Oke, Dr Abdulwasilu Adeniran Ola-awo and Mr Ibrahim Inyass Adamu (Conference Editorial Assistant) are warmly welcomed. We are truly thankful to the authors, participants, conference organizing committee and all academic colleagues especially Dr A. A. Shittu, for their immense contribution to the success of this conference.

Finally, we are thankful to Prof R. A. Jimoh of Building Department, Federal University of Technology Minna, for his support in the review process. Any mistake contained in this work is accidental and very greatly regretted.

Dr Y. D. Mohammed
Chairman, Local Organising Committee

DECLARATION

All the papers in this conference proceedings undergone double-blind review process at both abstract and full paper stage by members of the Scientific Committee. This process involves detailed screening of the abstracts and papers by at least two referees, reporting of comments to authors, modification of papers by authors whose papers were accepted by the reviewers, and re-evaluation of revised papers to ensure quality of content.

THE PEER REVIEW PROCESS

In order to maintain and ensure a high-quality conference process, the organizers of this conference adapted a comprehensive two-stage peer review process to the papers submitted by at least two recognized experts in the field of the paper.

At the first stage of the reviews, each abstract received was reviewed in order to ensure: its appropriateness to the theme of the conference, originality of the paper, the intellectual rigour and the intended contributions to the knowledge after which it was sent to at least two reviewers. At this point, a total of 111 abstracts were received and sent to the reviewers. Subsequently, the authors of approved abstracts received comments from the reviewers and were recommended to proceed to complete paper submission, including all suggested changes in the revised abstracts.

A total of 61 full papers were obtained and submitted for peer reviews. The comments and suggestions arising therefrom were then forwarded to the authors of the accepted papers requiring that they address all of the issues raised by the reviewers. Follow-up revisions made by reviewers to the original authors' papers were also provided to the authors to aid in the revision of their papers. Authors whose papers were rejected were also provided with comments from the reviewers so that they could understand the flaws identified by the reviewers. It was assured that, during the peer review process, members of the paper review committee, editors and conference organizers were not involved in the review of any paper they wrote or co-authored.

A total of 56 papers in which the authors showed clear evidence that all the suggestions of the reviewers had been addressed were accepted in the conference proceedings.

SCIENTIFIC COMMITTEE

Prof. D. R. Ogunsemi	Federal University of Technology, Akure. Nigeria
Prof. K. T. Odusami	University of Lagos, Yaba
Prof. Y. Ibrahim	Abubakar Tafawa Balewa University, Bauchi, Nigeria
Prof. O. S. Oyediran	University of Lagos, Yaba
Prof. O. Babalola	Obafemi Awolowo University, Ile-Ife, Nigeria
Prof. G. O. Jagboro	Obafemi Awolowo University, Ile-Ife, Nigeria
Prof. A. D. Ibrahim	Ahmadu Bello University, Zaria, Nigeria
Prof. Y. M. Ibrahim	Ahmadu Bello University, Zaria, Nigeria
Prof. S. I. J. Onwusonye	Imo State University, Owerri, Nigeria
Prof. A. Dahiru	Bayero University, Kano, Nigeria
Prof. U. Ajator	Nnamdi Azikiwe University, Awka
Dr. P. O. Lawal	Joseph Ayo Babalola University, Ikeji, Arakeji
Dr. Y. G. Musa-Haddary	Ahmadu Bello University, Zaria, Nigeria
Dr. J. O. Dada	Obafemi Awolowo University, Ile-Ife, Nigeria
Dr. G. K. Ojo	Obafemi Awolowo University, Ile-Ife, Nigeria
Dr. O. A. Awodele	Federal University of Technology, Akure. Nigeria
Dr K. J. Adogbo	Ahmadu Bello University, Zaria, Nigeria
Dr. J. E. Idiake	Federal University of Technology, Minna. Nigeria
Dr. M. M. Andawei	Niger Delta University
Dr. K. A. Mohammed	Federal Polytechnic Bida, Nigeria
Dr. I. I. Inuwa	Abubakar Tafawa Balewa University, Bauchi, Nigeria
Dr. (Mrs). A. D. Lamptey-puddicambe	Niger Delta University
Dr. P. G. Chindo	Ahmadu Bello University, Zaria, Nigeria
Dr. M. Abdulrazaq	Ahmadu Bello University, Zaria, Nigeria
Dr. L. O. Oyewobi	Federal University of Technology, Minna. Nigeria
Dr. A. Y. Ganiyu	University of Ilorin, Nigeria
Dr. I. Katun	Federal Polytechnic Bauchi, Nigeria
Dr. A. R. Kolawole	Federal Polytechnic Bauchi, Nigeria
Dr. N. Gambo	Abubakar Tafawa Balewa University, Bauchi, Nigeria
Dr. M. M. Muktar	Abubakar Tafawa Balewa University, Bauchi, Nigeria
Dr. A. Y. Waziri	Abubakar Tafawa Balewa University, Bauchi, Nigeria
Dr. A. A. Shittu	Federal University of Technology, Minna. Nigeria
Dr. Y. Mohammed	Federal University of Technology, Minna. Nigeria
Dr. M. Anifowose	Federal University of Technology, Minna. Nigeria
Dr. B. O. Ganiyu	Federal University of Technology, Minna. Nigeria
Dr. I. Saidu	Federal University of Technology, Minna. Nigeria
Dr. A. Adamu	Federal University of Technology, Minna. Nigeria
Dr. A. A. Ajayi	Federal Polytechnic Offa, Nigeria
Dr. M. Y. Adinoyi	Federal Polytechnic Nasarawa
Dr. A. O. Sanni	Bells University of Ota,
Dr. O. Oyeyipo	Bells University of Ota,
Dr. S. A. Abdulrasheed	Yaba College of Technology, Yaba-Lagos
Dr. S. Ofide	Discrete Consultant Ltd. Gaduwa Estate, Abuja, Nigeria
Dr. E. T. Adu	University of Uyo, Akwa Ibom State
Dr. F. O. Akinradewo	Federal University of Technology, Akure. Nigeria
Dr. J. A. Akinola	Federal University of Technology, Akure. Nigeria

Dr. E. O. Nnadi
Dr. E. Oke
Dr A. M. Lashinde

Federal University of Technology, Akure. Nigeria
Federal University of Technology, Akure. Nigeria
University of Uyo

CONFERENCE ORGANISING COMMITTEE

Prof. A. D. Ibrahim (Chairman)	Ahmadu Bello University, Zaria.
Prof. D. R. Ogunsemi	Federal University of Technology, Akure
Dr. G. Amuda-Yusuf	University of Ilorin
Dr. I. Katun	Federal Polytechnic, Bauchi
Dr. A. A. Arowosegbe	Federal Polytechnic, Offa.

LOCAL ORGANISING COMMITTEE

Dr. Y. D. Mohammed (Chairman)	Federal University of Technology, Minna, Nigeria
Prof. A. D. Ibrahim	Ahmadu Bello University, Zaria.
Dr. A. A. Oke	Federal University of Technology, Minna, Nigeria
Dr. K. A. Mohammed	Federal Polytechnic Bida, Nigeria
Dr. A. W. Ola-awo	Federal University of Technology, Minna, Nigeria
Mrs. H. M. Audi	NIQS, Niger State Chapter
Mr. S. Ibrahim	NIQS, Niger State Chapter
Mr. I. I. Adamu (Co-opted)	Federal University of Technology, Minna, Nigeria
Dr. L. O. Oyewobi (Sec. LOC)	Federal University of Technology, Minna, Nigeria

CONTENTS

TABLE OF CONTENTS

Contents	
Foreword	III
Preface	ERROR! BOOKMARK NOT DEFINED.
Acknowledgements	V
Declaration	VI
The Peer Review Process	VI
Scientific Committee	VII
Conference Organising Committee	VIII
Local Organising Committee	VIII
Table Of Contents	X
Perceived Education Courses That Inculcate Sustainability Awareness In Students Of Higher Institution Of Learning In Nigeria	1
Women Quantity Surveyors' Participation In The Construction Industry	9
Impact Of Health And Safety Prevention Cost On Construction Cost In Kwara State	23
Appraisal Of The Level Of Awareness And Practice Of Total Quality Management (Tqm) Principles In The Construction Industry In Imo State, Nigerian	35
Constraints To Implementation Of Public Private Partnership Infrastructure Projects In North Central, Nigeria	49
Predesign Cost Planning Of Building Wall Envelopes Using A Novel Mathematical Model	61
Impact Of Non-Monetary Incentives On Workers Performance In Nigeria Construction Firms	76
Determination Of Activity Based Safety Risk Hazard In Building Construction Projects In Abuja, Nigeria	87
Mitigating The Effects Of Delay On Educational Institutional Building Projects In Niger State	97
Critical Success Factors For The Adoption Of Lean Principles In Construction Firms In Abuja	111
Framework For Integrated Web-Based Price Analysis To Incorporate Builders Mark-Up's Decision	122
Practices Of Performance Measurement Of Construction Firms In Abuja, Nigeria	136
Motivation As A Management Strategy For Improving Productivity In Construction Projects In Abuja	152
Influence Of Materials Price Fluctuation On Cost Performance Of Building Contractors In Abuja, Nigeria	162
Assessing The Willingness Of Quantity Surveyors To Pay For 5d Bim	177
Prioritizing Evaluation Criteria For Contractor Selection In Nigerian	204
Effect Of Supervision On Construction Project Delivery In Abuja, Nigeria	222

Assessing Change Order Causes In The Pre-Construction And Construction Phase Of Construction Projects	238
Determination Of Effective Strategies For Truck Transit Parks Management Practice	259
Multiskilling Of Quantity Surveyors In The Nigerian Construction Industry: Empirical Analysis Of Propelling Measures	275
Assessment Of The Occurrence Of Construction Claims In Building Projects In Nigeria	282
A Conceptual Framework For Developing Machine Learning Models For Procurement Processes	293
Influence Of Critical Success Factors And Constraints On The Implementation Of Quality Management By Construction Firms In Bauchi State	306
Appraisal Of Bidding Strategy For Quantity Surveyor's Consultancy Services In Lagos State, Nigeria	325
Enriching Quantity Surveying Curriculum For Leadership In The Built Environment	335
Project Managers' Performance On Sustainable Construction Of Residential Estates In Abuja, Nigeria	352
Assessment Of Financial Risk Factors In Adoption Of Building Information Modelling For Construction Projects In Abuja	367
Evaluation Of Causative Factors Of Construction Delay In High-Rise Building Projects: A Case Of Lagos State	376
Assessment Of Level Of Application Of Knowledge Management Systems In Construction Firms In Abuja, Nigeria	387
Appropriateness Of The Methods Used By Building Contractors For Allocating Overhead Cost In Nigeria	402
Innovation Drivers And Barriers In The Nigerian Construction Industry	409
Impact Of Stakeholders On Public Private Partnership Projects Delivery In Nigeria	420
Assessment Of Health And Safety Tools Used On Construction Projects In Lagos State, Nigeria	426
Appraisal Of The Level Of Awareness On Health And Safety Measures Among Construction Workers In Lagos State, Nigeria	437
Development Of Forensic Framework For Post Contract Construction Cost	450
Assessment Of Communication Channels In Use By Professionals On Construction Projects In Abuja, Nigeria	461
Inhibiting Factors To The Adoption Of Digital Technologies In The South African Construction Industry	474
Whole Life Costing Practices Employed By Design Teams Of Building Construction Projects In Abuja, Nigeria	481
Development Of A Readiness Assessment Tool Kit For Partnering Adoption In The Nigerian Construction Industry	494
Assessment Of Risk Management Capability Level Of Building Clients In Abuja, Nigeria	513
Assessing The Readiness Of Clients To Implement Whole Life Costing In The Construction Industry	525

Assessing The Pattern Of Quantity Surveying Practice In The Nigerian Informal Sector	539
Evaluating The Gap Between Educational Training And Industry Expectations Of Quantity Surveying Graduates In Nigeria	551
Assessment Of Risk Management On Construction Project In Abuja, Nigeria	565
Where Exactly Are We On Sustainable Construction? The Role Of The Quantity Surveyor	578
Assessment Of Private Sector Participation In Infrastructure Development In South-Eastern Geo-Political Zone, Nigeria	588
Developing Conceptual Process Models For The Nigerian Manual Based Procurement Process Towards Digitization	609
Factors Influencing The Choice Of Housing Financing Models That Enhance Delivery Of Housing Project In Niger State	627
Influence Of Project Risk Management In High-Rise Building Construction On Productivity Of Workers In Abuja, Nigeria	642
Assessment Of The Most Popular Social Media Sites Among Quantity Surveying Students In Southwest Nigeria	655
Assessment Of Entry Modes Among Nigerian Quantity Surveying Firms In International Construction Consulting Business	667
An Appraisal Of Project Managers' Role In Bim-Based Projects	678
Construction Project Delivery In A Deregulated Economy	688
A Review Of Procurement Strategies To Enhance Sustainable Housing Project Delivery In Abuja	701
Assessment Of The Barriers To Knowledge Management Practices Among Construction Organisations In Abuja, Nigeria	716
Developing A Framework For Partnering With Quantity Surveying Firms In Nigeria	731
Upskilling Artisanal Competencies For Improved Project Delivery In Ekiti State- Nigeria	747
Dimension Of Corporate Culture In Quantity Surveying Firms In Abuja, Nigeria	761
The Adoption Of E-Tendering System For Nigerian Construction Contract-Issues And The Way Forward	775

CONSTRAINTS TO IMPLEMENTATION OF PUBLIC PRIVATE PARTNERSHIP INFRASTRUCTURE PROJECTS IN NORTH CENTRAL, NIGERIA

Yusuf B. Gognaje, Bashir O. Ganiyu, Luqman O. Oyewobi and Abdulganiyu A. Oke

Quantity Surveying Department, Federal University of Technology Minna, Niger State, Nigeria

ABSTRACT

In spite of the increasing adoption of Public Private Partnerships (PPPs) in Nigeria, the experiences have not always been positive due to failures, delays, and revocation of concessions agreements, particularly in the North Central Region. However, there are still scant studies on Critical Failure Factors (CFFs) of PPPs in the Nigerian context despite the huge failures experienced in implementation of PPPs infrastructure projects. Therefore, to bridge the knowledge gap, CFFs constraining the implementation of PPPs were identified with a view to minimising PPP projects failure in Nigeria. A total of 12 structured interviews were conducted from three PPP case studies in Niger State. Content analysis and Failure Mode and Effects Analysis (FMEA) were employed in analysing the data. A total of 18 failure and 10 success factors were identified. Corruption in public sector and, Lack of transparency and competition in procurement processes were the 2 CFFs constraining PPPs, while 4 CSFs were responsible for certain degrees of success on the projects, namely; Transparency in procurement process, Availability of suitable financial markets, Favourable investment environment and Trust between stakeholders. Therefore, these results may serve as a reference for PPP stakeholders to develop effective strategies to minimising failure in PPP projects implementation.

Keywords: Critical Failure Factors, Critical Success Factors, Nigeria, Infrastructure Projects, Public Private Partnership.

INTRODUCTION

Public- Private Partnership (PPP) is a generic term for different forms of relationship existing between the public sector and the private sector with the aim of financing, developing, constructing and for the effective management of public infrastructure (Robinson *et al.*, 2010; Amadi *et al.*, 2014). These relationships are usually long term where the concession arrangement could last up to 35 years to enable the private sector repay loans sourced from the financial institutions (Smyth and Edkins, 2007). Globally, PPPs have become a popular institutional arrangement and many public infrastructure projects such as Roads, rail, airports, hospitals, housing, and schools among others have been procured through PPPs. Despite the increasing adoption of PPPs in Nigeria including the North Central region of Nigeria, the experiences have not always been positive due to controversies, failures, delays, and revocation of concessions agreements (Babatunde *et al.*, 2015). Similarly, Yang *et al.* (2010) asserts that some infrastructure partnerships between the public and private sectors in the past are yet to provide evidence of successful completion. Many empirical studies revealed that most PPP infrastructure projects implementation in Nigeria, including the North Central region of Nigeria are characterised by controversies, failures, delays, litigations, revocations among others; and has caused diminishing interests of both the local and foreign private investors. (Oyewobi, *et al.*, 2012; Sanusi, 2012; Babatunde *et al.*, 2015, Mudi *et al.*, 2015; Sanda *et al.*, 2016).

This research aims to examine Critical Failure Factors (CFFs) constraining PPP infrastructure project implementation. However, to examine the projects failure through CFFs, it is imperative to know the definition of failure. Oxford: Advanced Learner's Dictionary (Hornby, 1995) provides the definition of "failure" as "lack of success in doing or achieving something.". Project failure can also be defined as the set of project objectives that did not hierarchically meet Program schedule, cost and specification (Trangkanont and Charoenngam, 2016).

Several studies have been undertaken to identify factors constraining the implementation of Public Private Partnerships infrastructure projects in both developed and developing countries. However, there are still scant studies on Critical Failure Factors (CFFs) of PPPs in the Nigerian context despite the huge failures experienced in the implementation of PPPs projects. Therefore to bridge the knowledge gap, this paper aims to identify the CFFs constraining PPPs, with a view to minimising PPP projects failure in Nigeria with specific focus on the North Central region of Nigeria.

PUBLIC- PRIVATE PARTNERSHIP INFRASTRUCTURE PROJECTS DEVELOPMENT IN NORTH CENTRAL, NIGERIA

Public Private Partnerships (PPPs) is one of the Public Finance Initiatives (PFIs) and is a contractual agreement between the public and the private sectors to share financial, technical and management risks in project development and management. (Oyedele, 2012). PPP is perceived by many as the almighty formula in infrastructure provision especially with the economic crunch ravaging the Nigeria economy. PPP has been adopted in the provision of public infrastructure projects in Nigeria including the North Central region of Nigeria. These Projects includes; the concession of Nnamdi Azikiwe International Airport Abuja, concession for complete infrastructure provision at Kataempe district Abuja, the concession for the provision of Minna City housing project in Maikunkele, Construction of Minna Five Star Hotel, The Concession of Benue Cargo airport which was awarded to Aerotropolis Development Company Ltd, construction of Jos Main Market, the provision of Hospital facilities in Jos East, construction of road networks in FCT as the Federal Government pursues the implementation of the Abuja Master plan, Development of 1MW Hydropower Doma Dam in Nasarawa State, among others (Adeogun and Taiwo, 2011; Ibem and Aduwo, 2012; ICRC 2012; Taiwo, 2013; Mudi *et al.*, 2015; Ojo, 2017). As the strategies in the implementation of

PPP infrastructure in North Central, Nigeria are becoming increasingly popular, many infrastructure projects implemented through PPPs have experienced delays, termination failures and controversies among others (ICRC, 2012; Sanusi, 2012; Adamu, *et al.*, 2015). Unfortunately, the level of failure, delays and termination are due to the complexity and risks associated with PPP projects in the zone and this portrays the existence of unforeseen risk or investment risk (Lucas, 2011).

Constraining Factors to PPP Infrastructure Projects Implementation

Despite the huge recognition of PPPs and their increasing usage in infrastructure development, the experience of both the public and private sector with PPP has not always been positive. Some PPP projects are either held up or terminated (Kwak *et al.*, 2009). A number of researches have been carried out on the constraining factors to PPPs. For instance, Amadi (2012) in his literature search identified 45 constraints as inhibitors to the realisation of construction projects using PPPs; Kwak *et al.* (2009) identified lack of clear government objectives and commitment, complex decision making, poorly defined sector policies, inadequate legal/regulatory frameworks, poor risks management, low credibility of government policies, inadequate domestic capital markets, lack of mechanisms to attract long-term finance from private sources at affordable rates, poor transparency as well as lack of competition and efficiency. Other constraints as enumerated by Kwak *et al.* (2009) include; high tendering costs, political debates, public oppositions, and complex negotiation processes amongst others. While Izuwah (2011), identified various constraints to include; political involvement at the implementation level of projects, not enough due diligence by contracting firms, improper evaluation of financial models and risks, lack of transparency and competition in procurement processes, lack of institutional frameworks and legislation to foster PPPs and finally the inability of the public sector to appreciate partnerships in a PPP environment. Cheung (2009) identified factors constraining PPPs as unstable political environment, high bidding costs, cost overruns, excessive risks as well as lengthy bidding processes associated with PPPs. While Kaplan *et al.* (2012) in a World Bank Report posited that lack/poor regulatory authorities as well as poor capacity building and institutional strengthening are inhibitors to the delivery of PPPs in Liberia. Double taxation as perceived by the general public, high consumer prices on the part of consumers, the continuous reliance on external consultants as well as misconceptions on the side of government officials are said to be constraining the implementation of PPPs (Colverson and Perera 2012). While Zou *et al.* (2008) opined complexity in contractual structure, inappropriate feasibility study, poorly defined sector policies, differences in interest and expectations, lack of a reliable concessionaire consortium with strong technical strength as well as unfavourable economic conditions as impeding factors to PPPs implementation. Shendy *et al.* (2011) identified lack of legislative and institutional framework, underdeveloped PPPs pipeline, and lack of coordinated public sector strategies as hindrances to PPPs. Susilawati and Armitage (2004) also found difficulty in managing partnership as a result of their mode of incorporation as partners and the dearth of transparency in partnership arrangements as impediments to PPPs. Helmy (2011) further identified long contractual procedures on the part of public agencies, lack of awareness on PPPs laws and regulations, public agency lacking experience and knowledge of PPPs, lack of land and its acquisition procedures, and frequent conflicts between consultants and clients as constraints to PPPs in Kuwait. Michael (2012) in his study in Queensland, identified dearth of specialized PPP unit, lack of independence, lack of support and political will, forecasting error as well as misplacement of risks markets in PPPs as constraints to PPPs. Wambalaba *et al.* (2012) in a study in Dakar, also identified political interference, vested interest, corruption, distrust, lack of contract transparency and lack of supportive legal structure as impediments to PPPs implementation.

Critical Failure Factors (CFFs) in PPP Infrastructure Projects

Trangkanont and Charoenngam (2014) identified CFFs as projects Risks, which once properly identified, analysed, understood and evaluated by all parties, were allocated to the party best able to manage those risks. Cheung *et al.* (2010) supported that risks allocated beyond the capacity of the parties brought about failure in PPP infrastructure projects. And also, that the legal framework of most countries was established to cope with the traditional project procurement method with emphasis on command and control, as a result, PPP infrastructure projects needed special legislation by government and the establishment of the legislation was to formulate effective contractual vehicles for PPPs. (Zhang, 2005; Algarni *et al.*, 2007). Most PPP projects were aborted/ terminated before a contract was made because of the high transaction costs and ineffective legal framework (Trangkanont and Charoenngam, 2014). The study of Li *et al.* (2005); Trangkanont and Charoenngam (2014) summarised that both the public and private sectors were the cause of PPP projects failure. Government defective PPP policy and strategy led to poor procurement incentives and lack of coordination among government agencies. Inexperienced, poor- organized and less-committed public agencies including corruption, resulted in inefficient PPP project implementation. They further stated that the private sector, due to its lack of experience and expertise to handle the legal, technical, financial and managerial issues during project execution, suffered project suspension and termination. Li *et al.* (2005); El-Gohary *et al.* (2006) also supported that, strong public opposition due to people attitude on private sector profit-making and lack of transparency in contract award brought about project delay or outright termination in delivering PPP infrastructural projects. Other researches carried out by Zhang (2005); Xenidis and Agelides (2005); Iyer and Sagheer (2010) pointed out that, uncontrollable factors were a cause of PPP project failure such as change in law, resulted in unexpected requirements, political instability led to changes in PPP policy and inflation rate fluctuation had impacts on project cost.

Critical Success Factors (CSFs) Of PPP Infrastructure Projects

Critical Success Factors (CSFs) are key factors that if satisfactorily met, will ensure successful performance of a project (Kwak *et al.*, 2009). This factors if not well handled will lead to failure of a project. Many studies employed the concept of CSF to determine the factors that influence the success of PPP infrastructure projects. CSF requires a day to day attention throughout the life cycle of PPP projects (Rowlinson, 1999). This is corroborated by Ram and Corkindale (2014) that CSFs requires constant and careful attention of management with a view to achieving organisation performance. The identification of CSFs is regarded as the first step towards the development of a workable and efficient PPP protocol (Zhang, 2005). In view of the increasing adoption of PPP all over the world, a number of researches have been carried out on the CSFs that have seen to be responsible for the successful implementation of PPP in different countries, including Nigeria (Qiao *et al.*, 2001; Jefferies *et al.*, 2002; Jamali, 2004; Zhang, 2005; Li *et al.*, 2005; Alhashemi *et al.*, 2010; Babatunde *et al.*, 2012; Cheung *et al.*, 2012; Ibem and Aduwo, 2012; Onyemaechi *et al.*, 2015).

RESEARCH METHODOLOGY

The study utilised primary data for the analysis. The data were sourced through a face to face structured interview of purposely selected participants from both the government regulators and private developers directly involved in the selected PPP case studies projects. Qualitative data were collected from three (3) PPP case studies in Niger state using structured interviews and personal observation. A total of 12 key stakeholders comprising the public sector (i.e. Ministries, Department and agencies) and the private sector which include: consultants, concessionaires, local lenders/banks, and contractors who were directly involved in the selected 3 case studies were selected and interviewed. The respondent from the public and private sector

were the Chief Executive officers and senior staff member of their organisations directly involved on the PPP infrastructure project case study.

The interview guide was prepared, consisting of questions to be asked in interviews. During the interviews, the interviewees were interrogated on each eighteen identified failure factors and ten success factors using Failure Mode and Effect Analysis (FMEA) Technique, with the interviewer completing the scoring to determine the criticality of identified failure and success factors in each case study. Similarly, personal observation and review of documentary evidence were also carried out in each case study. Failure Mode and Effect Analysis (FMEA) technique was employed for the analysis of quantitative data obtained in the three PPP case studies.

RESULTS AND DISCUSSION

Table 1 shows the background information of interviewees from both the public and private sector organisations in terms of types of organisation, designations and years of professional experience. The table reveals that 12 interviewees (representing 4 interviewees in each case study) were top management executives from both public and private sectors with their professional years of experience ranging from 7 to 27 years, and have directly involved in the aforementioned PPP project case studies from conception to the present project status. Also, Table 2 & 3 presents the full details of assessment of the criticality of identified failure and success factors in the PPP infrastructure case studies, using the FMEA techniques. Table 2 reveals that, out of the 18 failure factors assessed, 2 Critical Failure Factors (CFFs) constraining the implementation of the PPP project case studies were identified. These includes; corruption in public sector and lack of transparency and competition in procurement process. Similarly, Table 3 reveals that, 4 Critical Success Factors (CSFs) such as; Transparency in procurement process, Availability of suitable financial markets, Favourable investment environment, and Trust between stakeholders were responsible for the little success attained in the implementation of the PPP projects case studies.

Table 1: Distribution and background information of interviewees from both public and private sector

No	Interviewee organisation	Interviewee designation	Interviewee years of professional experience
Case Study 1: Concession of Konayi Housing Estate Development			
1	Public Sector: PPP Office	DG	27
2	Public Sector: Housing Cooperation	Chief QS	20
3	Private sector: Contractor	Managing Director	13
4	Private sector: Financial Institution	Manager	21
Case Study 1: Concession of Minna Five Star hotel development			
5	Private sector: Consultant	Project Manager	21
6	Private sector: Concessionaire	Manager	25
7	Private sector: Contractor	Managing Director	15
8	Public Sector: Ministry of Investment	Director	19
Case Study 1: Concession of NSDC Hostel, IBBU Lapai			
9	Public Sector: Physical planning unit IBBUL	Chief Architect	19
10	Public Sector: NSDC office	Director	14
11	Private sector: Financial Institution	Manager	7
12	Private sector: Contractor	Managing Director	21

organisations

Table 2. Summary of the assessment of criticality of failure factors using FMEA technique in PPP infrastructure project case studies

FAILURE FACTORS		CASE STUDY 1					CASE STUDY 2					CASE STUDY 3					REMARKS		
		Public RPN		Private RPN		Total AVG RPN	REMARKS	Public RPN		Private RPN		Total AVG RPN	REMARKS	Public RPN		Private RPN		Total AVG RPN	
S/N		198	329	263	Less critical	448	712	580	Somehow critical	284	507	396	Less critical						
i	Complex and cumbersome of PPP institutional framework	364	228	296	Less critical	810	449	630	Somehow critical	657	715	686	Somehow critical						
ii	High transaction costs	171	48	110	Not critical	336	398	367	Less critical	513	420	467	Less critical						
iii	Ineffective legal framework	361	357	359	Less critical	150	745	448	Less critical	484	476	480	Less critical						
iv	Poor regulatory authorities	510	256	383	Less critical	84	408	246		480	175	328	Less critical						
v	Lack of awareness on PPP laws and regulations	702	648	675	Somehow critical	160	429	295	Less critical	528	508	518	Somehow critical						
vi	Lack of public sector to appreciate partnerships in PPP environment	364	530	447	Less critical	504	290	397	Less critical	476	410	443	Less critical						
vii	Communication constraint between the public and private sector	490	390	440	Less critical	448	367	408	Less critical	484	336	410	Less critical						
viii	Inexperience and less committed public agencies	597	950	774	Critical	630	780	705	Somehow critical	720	800	760	Critical						
ix	Corruption in public sector	356	441	399	Less critical	800	867	834	Critical	576	950	763	Critical						
x	Lack of transparency and competition in procurement processes	197	555	375	Less critical	1000	254	627	Somehow critical	336	504	420	Less critical						
xi	Lengthy bidding process and contractual arrangements	66	152	109	Not critical	384	533	459	Less critical	256	399	328	Less critical						
xii	Inconsistent risk assessment and management	261	105	183	Not critical	120	609	365	Less critical	420	495	458	Less critical						
xiii	Cost overruns	38	55	47	Not critical	30	439	235	Not critical	183	374	279	Less critical						
xiv	Inflation rate fluctuation	13	110	62	Not critical	60	499	280	Less critical	370	513	442	Less critical						
xv	Political instability and change in Government policy	730	665	678	Somehow critical	700	773	737	Somehow critical	430	555	493	Less critical						
xvi	Political involvement at the project implementation level	90	150	120	Not critical	384	475	430	Less critical	544	256	400	Less critical						
xvii	Public opposition	480	357	419	Less critical	810	437	624	Somehow critical	629	512	571	Somehow critical						
xviii	Distrust among stakeholders																		

Note: FMEA- Failure Mode & Effect Analysis; RPN- Risk Priority Number; Criticality Scale: 1-250-Not Critical; 250-500- Less Critical; 500-750-Somewhat Critical; 750-1000-Critical

9th -10th November 2020

Federal University of Technology, Minna

Table 3. Summary of the assessment of criticality of success factors using FMEA technique in the infrastructure PPP project case studies

		CASE STUDY 1												CASE STUDY 2												CASE STUDY 3				REMARKS	
		SUCCESS FACTORS												REMARKS												REMARKS					
		Public	Private	Total	REMARKS									Public	Privat e	Total	REMARKS			Publi c	Privat e	Total									
S/N		RPN	RPN	AV G RPN									RPN	RPN	AVG RPN				RPN	RPN	AVG RPN										
i	Transparency in procurement process	810	674	742	Somehow critical								810	764	787	Critical			429	372	401	Less critical									
ii	Thorough and realistic assessment of the cost and benefits	900	483	692	Somehow critical								504	509	507	Somehow critical			392	512	452	Less critical									
iii	Project Technical feasibility	548	689	619	Somehow critical								900	586	743	Somehow critical			357	525	441	Less critical									
iv	Consultation with end-user's	384	284	334	Less critical								160	557	359	Less critical			408	504	456	Less critical									
v	Clear project brief and client requirements	810	228	519	Somehow critical								810	271	541	Somehow critical			336	218	277	Less critical									
vi	Availability of suitable financial markets	327	555	441	Less critical								900	715	808	Critical			492	465	479	Less critical									
vii	Favourable legal and commercially oriented laws and regulations	448	507	478	Less critical								720	567	644	Somehow critical			390	647	519	Somehow critical									
viii	Good stakeholders' relationship	765	175	470	Less critical								392	476	434	Less critical			340	528	434	Less critical									
ix	Favourable investment environment	427	444	436	Less critical								900	933	917	Critical			440	410	425	Less critical									
x	Trust between stakeholders	696	774	735	Somehow critical								900	825	863	Critical			517	585	551	Somehow critical									

Note: FMEA- Failure Mode & Effect Analysis; RPN- Risk Priority Number; Criticality Scale: 1-250-Not Critical; 250-500-Less Critical; 500-750-Somewhat Critical; 750-1000-Critical

Assessment of criticality of the identified 18 failure factors in PPP project case studies: using FMEA technique

In this study, the infrastructure PPP project case studies investigated include the Concession of Konayi Housing Estate Development (case study 1); the Concession of Minna Five Star hotel development (case study 2); and the Concession of NSDC Hostel, IBBU Lapai (case study 3).

During the interviews, the interviewees were interrogated on eighteen identified failure factors using Failure Mode and Effect Analysis (FMEA) technique. Thus, the full details of assessment of the criticality of identified failure factors in the above three case studies are summarised and presented in Table 2, while Table 3 presents the summary of the critical success factors.

Table 2 reveals that corruption in public sector was the only critical failure factors (CFF) that made the concession of Konayi Housing Estate Development (i.e. case study 1) suffered delay and failure in its implementation. Also, lack of public sector to appreciate partnerships in PPP environment was identified as ‘somehow critical’ failure factors.

Also, lack of transparency and corruption in procurement process is the critical failure factor in the Concession of Minna Five Star hotel development (i.e. case study 2). Likewise, in this PPP case study, Complex and cumbersome of PPP institutional framework, High transaction costs, Corruption in public sector, Lengthy bidding process and contractual arrangements, Political involvement at the project implementation level, and Distrust among stakeholders were considered as ‘somehow critical’ failure factors.

In case study 3, which is the Concession of NSDC Hostel, IBBU Lapai, the results reveal 2 CFFs that are constraining the implementation of this PPP project. These include corruption in public sector, and Lack of transparency and competition in procurement processes. While high transaction costs, lack of public sector to appreciate partnerships in PPP environment, and distrust among stakeholders were indicated as ‘somehow critical’ failure factors.

Assessment of criticality of the identified 10 success factors in PPP project case studies: using FMEA technique

The details of assessment of the criticality of identified success factors in the three case studies are summarised and presented in Table 3

Table 3 indicates 5 somehow critical success factors that were responsible for the degree of success attained in the concession of Konayi Housing Estate Development, (case study 1) to include: Transparency in procurement process, Thorough and realistic assessment of the cost and benefits, Project Technical feasibility, Clear project brief and client requirements, and Trust between stakeholders.

The result of FMEA on criticality of the identified success factors in case study 2, which is Concession of Minna Five Star hotel development reveals Transparency in procurement process, Availability of suitable financial markets, Favourable investment environment, and Trust between stakeholders as the 4 CSFs that made this concession project achieved the little level of success being attained. Similarly, thorough and realistic assessment of the cost and benefits, Project Technical feasibility, clear project brief and client requirements, and favourable legal and commercially oriented laws and regulations were indicated as ‘somehow critical’ success factors (see Table 3).

Table 3 further revealed the somehow critical success factors in the Concession of NSDC Hostel, IBBU Lapai (i.e. case study 3). This includes favourable legal and commercially oriented laws and regulations, and Trust between stakeholders

Cross case analysis

Based on the assessment of the criticality of identified failure factors in the three PPP project case studies, it is important to consolidate the experience from these PPP case studies, to determine if there is any convergence or discrepancy regarding the CFFs/ CSFs that are responsible for various degrees of failure and success in the three PPP case studies. Therefore, the findings from the PPP infrastructure project case studies (case study 1-3), indicated that corruption in public sector was identified as Critical Failure Factor in case studies 1 & 3. Also, the findings reveal that lack of transparency and competition in procurement process appear as the CFF in case studies 2 & 3 (see Table 2). This finding is connected to the huge corruption been perpetuated in the public sector where construction contracts are awarded without adhering to due process and diligence in the procurement process of PPP infrastructure projects. This implies that PPP infrastructure projects in these case studies experience failures due to lack of transparency, lack of competition in procurement process and the inhabited corruption that has eaten deep to the fabrics of the public service.

In the same vein, the findings from the aforementioned three PPP infrastructure project case studies (case study 1-3) with regards to the Critical Success Factors (CSFs), table 3 indicated that transparency in procurement process, Availability of suitable financial markets, Favourable investment environment, and Trust between stakeholders were identified as the CSFs in case study 2 which is Concession of Minna Five Star hotel development. This finding confirmed that the little success recorded in case study 2 was due to the transparency exhibited in the procurement process of the PPP project. The concessionaires in the PPP case study project were able to source for funds locally (i.e. from local banks). Also, the finding indicated that the investment climate was favourable for the PPP case study to succeed, and it is most likely that the project is going to achieve appreciated success because of the trust existing between the primary stakeholders involved in the PPP case study 2. (see Table 3).

4.3 CFFs and CSFs emanating from case studies

Based on the results of assessment of the criticality of identified failure and success factors using FMEA in the three PPP case studies as previously discussed (Table 2 & 3) the results identified a total of 2 Critical Failure Factors (CFFs) that made the case studies suffered certain degrees of failures as follows:

- i. Corruption in public sector
- ii. Lack of transparency and competition in procurement processes

Similarly, the FMEA results under the aforementioned PPP project case studies (i.e. case study 1-4) identified a total of 4 Critical Success Factors (CSFs) that were responsible for certain degrees of success of these PPP project case studies as follows:

- i. Transparency in procurement process
- ii. Availability of suitable financial markets
- iii. Favourable investment environment
- iv. Trust between stakeholders.

CONCLUSION

The paper demonstrates the causes of PPP infrastructure projects failure in the North Central region of Nigeria by applying FMEA to identify, categorise CFFs, and also identify CSFs responsible for enhancing project success. The study concludes by identifying two critical failure factors (CFFs) through Failure Mode and Effect Analysis (FMEA). These include Corruption in

public sector and Lack of transparency and competition in procurement processes as factors constraining the implementation of PPPs. Similarly, four CSFs were found responsible for certain degrees of success on the PPP projects studied: Transparency in procurement process, Availability of suitable financial markets, Favourable investment environment and Trust between stakeholders. The identification of the constraining factors (CFFs) will assist the stakeholders in decision making, planning, and management of PPP infrastructure project delivery. The CSFs identified will positively influence policy development towards PPPs and the manner in which stakeholders (public sector and private sectors) involve each other in the development of PPP infrastructure projects. The paper recommends that the CFFs and CSFs identified are to be given paramount consideration by stakeholders involved in PPPs to ensure more successful implementation of PPPs infrastructure project and to prompt confidence in both local and foreign investors for investing in the Nigerian PPPs projects. Although, the research findings identified the CFFs/CSFs in only three PPP infrastructure project in North Central region of Nigeria, these lessons learned will help to minimise the probability of PPP infrastructure projects failure in Nigeria.

REFERENCES

- Adamu, M., Lowe, J., & Manase, D. (2015). Conceptual Framework for Public Private Financed Road Infrastructure Development in Nigeria. *International Journal of Engineering Research and Technology*, 4(8), 586-590.
- Alhashemi, M., Dulaimi, M., Ling, F., & Kumaraswamy, M. (2015) Critical Success and Failure Factors for Public Private Partnership Projects in the UAE. CIB W065/055 commissions: Transformation through construction 1-11
- Amadi, C., Carrillo, P., and Tuuli, M. (2014) Stakeholder management in public private partnership projects in Nigeria: towards a re-search agenda. IN: *Proceedings 2014 30th Annual Conference of the Association of Researchers in Construction Management (ARCOM 2014)*, Portsmouth, Great Britain, September 1-3 2014, (1), 423-432.
- Babatunde, S. O., Perera, S., Udejaja, C., & Zhou, L. (2014). 'Challenges of implementing infrastructure mega projects through public-private partnerships in Nigeria: a case Study of road infrastructure', *International Journal of Architecture, Engineering and Construction*, 3(2): 142-154
- Cheung, E. (2009) Developing a best practice framework for implementing public private partnership (PPPs) in Hong Kong, PhD Thesis, Queensland University of Technology, Australia.
- Cheung, E., Chan, A. P. C. & Kajewski, S. L. (2012) 'Factors contributing to successful public private partnership projects: comparing Hong Kong with Australia and the United Kingdom', *Journal of Facilities Management*, 10(1), 45-58.
- Colversons, S. and Perera, (2012) Harnessing the Powers of PPPs: The Role of Hybrid Financing Strategies in Sustainable Development. *A Report by The International Institution for Sustainable Development*. 1- 57 February.
- El-Gohary, N. M., Osman, H. & El-Diraby, T. E. (2006) 'Stakeholder management for public private partnerships', *International Journal of Project Management*, 24, 595-604.

- Helmy, M. A. (2012). Investigating the Critical Success Factors for PPP projects in Kuwait. KTH Architecture and the build Environment, *KTH Royal Institute of Technology*.
- Ibem, E. O. and Aduwo, B. E. (2012). *Public Private Partnership in urban housing delivery in Nigeria: Evidence from Ogun state*. International Journal of Architecture and Urban Development, 2(2), 5-14.
- Infrastructure Concession Regulatory Commission (ICRC) (2014) Public-private partnership projects pipeline [Online]. Available at: <http://www.icrc.gov.ng/projects.php>. Accessed on 12/03/2020.
- Iyer, K. C., Sagheer, M., 2010. Hierarchical structuring of ppp risks using interpretative structural modelling. *Journal of Construction Engineering Management*. 136 (2), 151-159.
- Izuwah, C. (2011) Vision Led Concessions for Transportation Infrastructure Provision in Nigerian- The PPPs Imperative. A Presentation by the Executive Director of the PPP Resource Centre, Infrastructure Concession Regulatory Commission of Nigeria (ICRC) c.izuwah@icrc.gov.ng assessed on www.icrc.gov.ng on 16/4/2020.
- Jamali, D. (2004). 'Success and failures mechanisms of public private partnerships (PPPs) in Developing countries', *The International Journal of Public Sector Management*, 17(5): 414-430.
- Jefferies, M. C., Gameson, R. & Rowlinson, S. (2002) 'Critical success factors of the BOOT procurement system: reflection from the stadium Australia case study', *Engineering, Construction and Architectural Management*, 9(4), 352- 361.
- Kaplan, Z. A.; Kyle, P.; Shugart, C.; and Moody, A.; (2012) Developing PPPs in Liberia. A World Bank Study. Kwak, Y. H., Chih, Y. Y. & Ibb, C. W. (2009) 'Towards a comprehensive understanding of public private partnerships for infrastructure development', *California Management Review*, 51(2), 51-78.
- Li, B., Akintoye, A., Edwards, P. J., & Hardcastle, C. (2005b) 'Perceptions of positive and negative factors influencing the attractiveness of PPP/PFI procurement for construction projects in the UK: findings from a questionnaire survey', *Engineering, Construction and Architectural Management*, 12(2): 125-148.
- Lucas, M. (2011). Clouds over public private partnership, *The Tell*, published on Thursday March 17.
- Mudi, J., Lowe, J. & Manase, D. (2015). Public-Private Financed Road Infrastructure Development in North Central region of Nigeria. *Journal of Management and Sustainability*, 5(4), 1925-4733.
- Ojo, M. (2017) Abandoned projects in Niger Sate. *thenationonline.net*. published on 22nd oct, 2017.
- Onyemaechi, P., Samy, M. & Pollard, D. (2015) An examination of the Critical Success Factors for Public Private Partnership in Housing Projects in Nigeria. *Journal of Sustainable Development in Africa*. 17(3), 1-20, 2015

- Oyedele, O. A. (2013). Public-Private Partnership and Infrastructure Provision in Nigerian Cities. *A Paper Presented at the Annual Conference of Architectural Educators, held at University of Jos on May 13, 2013, 12p.*
- Oyewobi, L. O., Ibrahim, A. D., Isa, S. and Ibrahim, Y. M. (2012) Investigating optimum conditions for Public Private Partnership in health, education and housing sectors in Nigeria. In: Laryea, S., Agyepong, S.A., Leiringer, R. and Hughes, W. (Eds) procs 4th West African Built Environment Research (WABER) conference, 24-26 July 2012, Abuja, Nigeria. 1261-1274
- Qiao, L., Wang, S. Q., Tiong, R. L. K. & Chan, T. S. (2001) 'Framework for critical success factors of BOT projects in China', *Journal of Project Finance*, 7(1), 53-61.
- Ram, J. & Corkindale, D. (2014) 'How “critical” are the critical success factors (CSFs)? Examining the role of CSFs for ERP', *Business Process Management Journal*, 20(1), 151-174.
- Robinson, H. Carrillo, P. M, Anumba, C. J. and Patel, M. (2010) “Governance and knowledge management for public private partnerships” Chichester Wiley-Blackwell.
- Sanusi, L. S. (2012) The role of development finance institutions in infrastructure development: what Nigeria can learn from BNDES and the India infrastructure finance company, Paper Presented at the 3rd ICRC PPP Stakeholders Forum, Abuja, Nigeria.
- Shendy, R.; Kaplan, Z. and Mousey, P. (2011) “Towards Better Infrastructure. Conditions, Constraints and Opportunities in Financing PPPs. Evidence from Cameroon, Cote d’Ivoire, Ghana, Kenya, Nigeria and Senegal. The World Bank Report Washington DC, 1-74.
- Smyth, H. and Edkins, A. (2007) Relationship management in the management of PFI/PPP projects in the UK. *International Journal of Project Management*, 25(1), 232-240.
- Susilawati, C. & Armitage, L. (2004) “Do PPPs Facilitate Affordable Housing outcomes in Queensland”. In *Proceedings of 11th European Real Estate Society Conference, Milan, Italy. Assessed from <http://eprints.qut.au>.*
- Trangkanont, S., & Charoenngam, C. (2014). Critical failure factors of public-private partnership low-cost housing program in Thailand, *Engineering, Construction and Architectural Management*, 21(4): 421 – 443
- Wambalaba, F. W., Wanbalaba, A. E., Sikalieh, D. (2012) Public Private Alliances: A Documentary Case Study of Strategies for Urban Restoration United State International University Nairobi Kenya. An Investment Climate and Business Environment Research Fund (ICBE-RF) Report jointly funded by Trust African and IDRC March, 2012 in Dakar.
- Xenidis, Y. and Angelides, D. (2005), “The financial risks in build-operate-transfer projects”, *Construction, Management and Economics*, 23(5) 431-441.
- Yang, J. B., Yang, C. C. & Kao, C. K. (2010) 'Evaluating schedule delay causes for private participating public construction works under the build-operate-transfer model', *International Journal of Project Management*, 28: 569-579.

Zhang, X. (2005) 'Critical success factors for public private partnerships in infrastructure development', *Journal of Construction Engineering and Management*, 131(1), 3-14.

PREDESIGN COST PLANNING OF BUILDING WALL ENVELOPES USING A NOVEL MATHEMATICAL MODEL

Oluwafunmibi Seun, Idowu* and Ka Chi, Lam
City University of Hong Kong, Kowloon, Hong Kong SAR,

ABSTRACT

Pre-design cost planning of key building elements such as the building envelope is essential in producing cost frameworks for budgetary and feasibility purposes when detailed project information is unavailable. Several alternative preliminary sketch designs and building shape indexes are required before pre-design envelope estimates can be computed—a repetitive and exhausting process. The aim of this research is to develop a model for pre-design cost planning of building envelope items prior to sketch or detailed design. Thus, enabling quick and reliable cost planning of building envelope items. Employing empirical and rational approaches, a new generalised mathematical model and a corresponding graphical model for vertical building envelope quantities was established by exploring theoretical shapes and fundamental mathematical theorem of integral calculus for “area under a curve”. The developed mathematical model was compared with the superficial cost model as a cost planning tool for external glazed curtain wall. The result showed that the proposed mathematical model provides better accuracy than the superficial cost model. To improve cost-certainty of building envelopes, it is recommended that coefficient of dimensions should be provided as a necessary preliminary information when a “design to cost” approach is adopted on building projects having limited financial and construction resources.

Keywords: building envelope, building shape index, conceptual envelope, cost planning.

INTRODUCTION

Cost is an important factor used in assessing the performance of construction projects, and a key performance index for project success (Toor and Ogunlana, 2010; Ahiaga-Dagbui and Smith, 2014). Cost control is an iterative process of measuring, evaluating, and adjusting progress, plans and finance (Olawale and Sun, 2010), and is critical for improving the cost performance of construction projects. An important objective of cost control is to achieve a balanced expenditure on various building elements within agreed amounts. Thereby, ensuring that final accounts approximates to the budget estimate. Quite often, at the initial stage of a building project, there is limited amount of project information to arrive at a reliable budget estimate (Jin et al., 2014). However, prospective building owners and investors are concerned about the financial commitment and anticipated capital outlay before project drawings are produced by professionals (Ranasinghe, 1996; Al-Hajj and Horner, 1998; Yeung and Skitmore, 2012). Therefore, obtaining reliable budgetary estimates when drawings are not available is important for pre-design cost planning and control when designing to cost.

An important and significant cost item that requires cost planning during design is the building envelope. According to Smith *et al.* (2016), the building envelope can represent 10% to 20% of a