Association of Schools of Construction of Southern Africa

The Eleventh Built Environment Conference

6 - 8 August 2017, Durban, South Africa

Conference Proceedings

International Council
for Research and Innovation
in Building and Construction

PREFACE

The ASOCSA Built Environment conference series has become the undisputed leading built environment conference on the African continent. It is one of only two construction-related conferences in South Africa that has been fully accredited by the Department of Higher Education (DHET) for subsidy. Since its inception in 2006 the blind peer reviewed conference proceedings have been referred to by private and public sector policy and decision makers. The series produces a post-conference edition of the Journal of Construction, which is on the list of journals approved by the South African Department of Higher Education and Training (DHET) for subsidy. The series continues to underwritten by major industry stakeholders that have included the Construction Industry Development Board (CIDB), Council for the Built Environment (CBE), Master Builders South Africa (MBSA), branches of the MBA, major construction companies and PPC Cement. It has been endorsed by the International Council for Research and Innovation in Building and Construction (CIB), one of the largest global built environment research organizations.

OBJECTIVES

The Eleventh Built Environment Conference continued in the tradition of previous conferences in the series and provided in an ever-increasing challenging global economic environment with shrinking sponsorship budgets an international forum with a very clear industry development and sustainability focus that provides the opportunity for researchers and practitioners from developed, developing and underdeveloped nations to deliberate topical current issues that impact the Built Environment.

The broad objectives of the conference are:

- To provide a forum for multi-disciplinary interaction between academics and industry practitioners;
- To disseminate innovative and cutting edge practices that respond to the conference theme and outcomes, namely Reflections on Directions in Construction;
- To provide a world class leading internationally recognized, accredited conference for the built environment; and
- To contribute to the existing built environment body of knowledge (BEBOK) and practice.

The conference organizers brought together in a single forum a group of researchers and academics from the full range of built environment disciplines that include engineers, architects, quantity surveyors, construction and project managers. Delegates were drawn not only from South African institutions of higher education, government agencies, and other construction-related organizations but also from the African continent, Australia, Europe and the United Kingdom.

CONFERENCE THEME AND OUTCOMES

#MAKECONSTRUCTIONGREATAGAIN

This conference sought responses to questions related to current conversations and debates on infrastructure delivery and sustainability such as, for example,

- Innovation in Construction Means, Methods and Materials
- Construction Education, Training and Skills Development
- Public Sector Innovation
- Green Building
- Construction Labour challenges
- Construction Industry Transformation
- Infrastructure Design and Delivery Challenges
- SME Contractor Development
- Construction Industry Charter
- Government Initiatives
- Public Sector Procurement and Contracting

and includes papers that address, inter alia,

· Current trends and developments
· Policies
· Legislation and regulations
· Practices
· Case studies

These internationally peer reviewed and edited proceedings were aimed at contributing significantly to the body of knowledge relative to the science and practice of construction not only in South Africa but everywhere that the products of construction are being produced.

Ferdinand Fester
Durban, South Africa
August 6, 2017

ACKNOWLEDGEMENTS

The organizing committee of the Eleventh Built Environment conference, held in Durban, South Africa, wish to thank the Council of the Association of Schools of Construction of Southern Africa and membership universities and individuals for supporting this conference through their valued contributions. Without that support this conference and the further development and growth of the Association of Schools of Construction of Southern Africa (ASOCSA) with respect to its mission in the region would not have been possible. Further, this support demonstrates the commitment to the further development of the body of knowledge relative to the science and practice of construction. This commitment is deeply valued and acknowledged.

Our thanks are extended to Professor Theo Haupt (Mangosuthu University) and Ferdinand Fester (Durban University of Technology) who worked unstintingly on every aspect of the conference. Together with the Scientific and Technical Committee and additional reviewers to whom special thanks are extended they worked hard and long to prepare refereed and edited papers and published proceedings of the highest standard that satisfy the criteria for subsidy by the South African Department of Higher Education and Training (DHET).

The contribution and excellent support of our webmaster, Wendal Koopman, in setting up and supporting our conference website is appreciated.

Finally, the sterling contribution and efforts of Ferial Lombardo to the success of this conference is acknowledged in her capacity as conference organizer working with the conference committee and evident in the superlative logistic coordination and attention to detail in every aspect of the conference organization.

ORGANISERS – SOUTH AFRICA

Ferdinand Fester, Durban University of Technology, South Africa, President
Prof Theodore Haupt, Mangosuthu University, Academic Chair
Mrs. Ferial Lombardo Haupt, Conference Organiser

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PEER REVIEW PROCESS

In order to maintain and ensure the highest quality in the conference proceedings and comply with the requirements for subsidy of the South African Department of Higher Education and Training (DHET), a rigorous two-stage system of peer review by no less than two acknowledged experts in the field has been followed. In terms of this process, each abstract received was twice blind reviewed in terms of:

・Relevance to overall conference theme and objectives;
・Relevance to selected sub-theme;
・Originality of material;
・Academic rigour;
・Contribution to knowledge; and
・Research methodology.

Authors whose abstracts were accepted after a blind peer review process was completed, were provided with anonymous reviewers' comments and requested to submit their full papers noting and addressing these comments. Evidence was required relative to the action taken by authors regarding the comments received. These resubmitted papers were twice blind reviewed again in terms of:

・Relevance to overall conference theme and objectives;
・Relevance to selected sub-theme;
・Originality of material;
・Academic rigour;
・Contribution to knowledge;
・Research methodology and robustness of analysis of findings;
・Empirical research findings; and
・Critical current literature review.

Authors whose papers were accepted after this second review were provided with additional anonymous reviewers' comments and requested to submit their revised full papers. These final papers were only included into both the conference presentation schedule and the conference proceedings after evidence was provided that all comments were appropriately responded to, having been multiple peer-reviewed for publication. At no stage was any member of the Scientific and Technical Committee or the editor of the proceedings involved in the review process relative to their own authored or co-authored papers. The role of the editor was to ensure that the final papers incorporated the reviewers' comments and arrange the papers into the final sequence based on the conference presentation schedule as captured on the conference proceedings flashdrive and Table of Contents. Of the 106 abstracts originally received, only 67 papers were finally accepted for presentation at the conference and inclusion in these proceedings, representing an acceptance rate of 63%. To be eligible for inclusion these papers were required to receive one of three recommendations from at least two reviewers, namely

- Accepted for publication or
- Provisional acceptance provided minor changes / corrections are made or
- To re-submit for publication provided author/s reconsider/s the areas of concern

LIST OF REVIEWERS

Prof. David Edwards, Birmingham City University, UK
Prof. Theodore Haupt, Mangosuthu University of Technology, RSA
Prof. Fidelis A. Emuze, Central University of Technology, RSA
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Dr. Geraldine Kikwasi, Ardhi University, Tanzania

TAX BENEFIT

ASOCSA is a registered Public Benefit Organization as defined in Section 30 of the Income Tax Act and a registered Section 21 Company as defined in the Companies Act. Therefore, all donations made to ASOCSA will be fully deductible for income tax purposes and a section 18A certificate, for proof of deductibility will be issued to the donor upon receipt of the donation. The deductible donation is limited to 10% of the donors' taxable income before providing for Section 18A and Section 18 deductions.

Association of Schools of Construction of Southern Africa

History

ASOCSA is not the first attempt to form a body that addresses, inter alia, matters of construction education and training. In the days of the Building Industries Federation South Africa and the National Development Fund there were regular annual meetings of the Heads of Departments that offered construction-related programs. Recognizing the two-tiered higher education sector in South Africa, there were separate meetings for universities and the former technikons. In the more recent past, the Chartered Institute of Building - Africa initially convened annual educators' forums that did not quite fulfill the same function as the previous forums. However, during 2005 the very first meeting of University Heads of Departments drawn from all higher education institutions in South Africa met for the very first time since the re-landscaping of the sector in the same venue to discuss matters affecting construction, and particularly construction education in the country. This meeting was repeated in 2006 where the need was expressed for the establishment of a formal forum / association of universities to engage in discussion / debate / collaboration / promotion of matters of mutual interest.

Broad Aims

ASOCSA aims to be the professional association for the development and advancement of construction education in Southern Africa, where the sharing of ideas and knowledge inspires, guides and promotes excellence in curriculums, teaching, research and service. To achieve this aim ASOCSA is partnering with the construction industry to find ways to effectively represent the interests of both construction academic and industry practitioners. ASOCSA will offer a variety of programs and services designed to help its members serve their customers more effectively and succeed in an increasingly challenging environment of construction information management and technology. To this end ASOCSA provides a forum for the debate and discussion of issues of mutual interest to all industry stakeholders. For example, one of the tasks of ASOCSA will be supporting the development of curriculums that address the needs of the construction sector in the Southern African region. ASOCSA convenes an annual conference that is one of only two construction-related conferences accredited by the Department of Higher Education and Training (DHET) where construction academics and practitioners can interact relative to practical experience and the findings of relevant research. This conference series is endorsed and underwritten by the International Council for Research and Innovation in Building and Construction (CIB) as well as several major industry stakeholders.

The Journal of Construction which is accredited by the Department of Higher Education presently published electronically four times per year is the official journal of ASOCSA and in the past more than 5,000 complimentary copies were distributed to all industry stakeholders in the Southern African region. The production and distribution of practice notes and technical papers is a further endeavor to grow the partnership between academia and industry.

With respect to the Southern African region, ASOCSA is committed to the following:

Vision

To drive innovative construction related higher education

Mission Statement

To promote, facilitate, develop and monitor the relevance and quality of construction related curricula, research and graduates in conjunction with higher education institutions, industry and government.

Strategic objectives

The objectives of the Association are:

- to promote and facilitate the development of curricula for construction related programmes
- to assist with the accreditation of construction related programmes
- to hold an annual conference that acts as a forum for multi-disciplinary interaction between academics and practitioners
- to publish an accredited research-based journal and contribute to the built environment body of knowledge (BEBOK)
- to disseminate information dealing with construction education and related matters
- to develop and maintain closer links with industry and government
- to represent the collective views of its members
- to liaise with other organisations and persons to promote the interests of its members

- to promote and support relevant postgraduate research
- to provide bursaries to postgraduate students in accordance with set criteria

ASOCSA continues to seek opportunities to promote both academic and industry employment opportunities. Finally, ASOCSA intends to play a significant role in the accreditation of construction-related academic programs.

Heads Forum meetings

ASOCSA believes that meetings of the Heads Forum comprising of Heads of School and Departments of Construction is a vital component of its functions and holds Heads meetings during each conference. It is still the aim of ASOCSA to bi-annual Heads meetings.

International Affiliation

ASOCSA has commenced discussions about closer collaboration with similar institutions such as the Associated Schools of Construction (ASC) in the United States, the Royal Institute of Chartered Surveyors (RICS), the Chartered Institute of Building (CIOB), Australian Institute of Building (AIB) and Council of the Heads of the Built Environment (CHOBE) in the United Kingdom. ASOCSA has entered into a Memorandum of Understanding with the International Council for Research and Innovation In Building and Construction (CIB).

In summary, benefits of membership of ASOCSA which are self-evident include participation in meetings of the Heads Forum throughout the region, access to the Journal of Construction, reduced rates at all ASOCSA, MBA and CIB events, involvement at regional level with industry-academia forums, interaction and networking opportunities relative to, for example, collaborative research, curriculum development, external moderation of courses, and external examination

ASSOCIATION OF SCHOOLS OF CONSTRUCTION OF SOUTHERN AFRICA

Office bearers

President	Ferdinand Fester	Durban University of Technology
Vice-president	Ephraim Zulu	University of Kwa-Zulu Natal
Immediate Past President	Prof Theo Haupt	University of Kwa-Zulu Natal

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Dr. Geraldine Kikwasi	Ardhi University Tanzania (Eastern Africa)
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Ephraim Zulu	Copperbelt University – Zambia
Ferdinand Fester	Durban University of Technology
Prof. Brink Botha	Nelson Mandela Metropolitan University
Prof. Theo Haupt	University of Kwa-Zulu Natal

Journal of Construction Editorial Committee

Editor:	Dr. Nishani Harinarain – University of KwaZulu-Natal
Associate Editor:	Dr. Justus Agumba – Durban University of Technology
Assistant Editor:	Prof Ayman Othman - The British University in Egypt

Chair of Heads Forum

Prof. Theo Haupt	Mangosuthu University of Techology

For more information on ASOCSA and its activities visit www.asocsa.org

27 July 2017

Dear Author

PEER REVIEW PROCESS: 11TH BUILT ENVIRONMENT CONFERENCE: PORT ELIZABETH, SOUTH AFRICA 2017

I confirm that the following peer review process was strictly followed relative to this conference.

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Dr. O.O. Ugwu, University of Nigeria, Nigeria
Dr. Geraldine Kikwasi, Ardhi University, Tanzania

Regards

Ferdinand Fester (ASOCSA President)

Prof. Theo C Haupt (ASOCSA Vice-President)

Ferial Lombardo (ASOCSA Conference Organizer)

ASOCSA 11th BUILT ENVIRONMENT CONFERENCE PRESENTER PROFILES

Mr Aubrey Tshalata - National President for the National African Federation or the Building Industry

Aubrey Tshalata

National President for the National African Federation or the Building Industry.

Member of Business unity South Africa Council. Chairperson (KZN – Building Industry Steering Committee).

Member of the Construction Industry Charter Council.

Member of CIDB (National Stakeholder Forum. Founder of the Emerging Contractor Publication.

Director of the Business Education Partnership Forum. C.E.O of Palcard Group of Companies.

David Edwards - Professor of Plant and Machinery Management, Birmingham City University

Professor David J. Edwards BSc(Hons), PhD, MCMPE, FIoQ, M. HM RE (Plant Branch)

David Edwards is a Professor of Plant and Machinery Management at Birmingham City University and has worked in both academia and industry over a 25 year career.

His research interests focus mainly upon the management of plant and machinery in business throughout industry. His work has been funded through engineering councils, government bodies and an extensive network of industrial collaborations. He has published over 250 scientific research papers in leading international journals as well as numerous conference contributions and textbooks. He is a peer referee for 50 scientific journals and Editorial Board member of various journals and conference events.

In 2000, he founded the Off-highway Plant and Equipment Research Centre, which today is the largest international professional body for research in this field with over 15,000 members. Whilst David enjoys pure theoretical research work, he feels most comfortable with applied work that demonstrates immediate and tangible impact. Amongst his many awards, prizes and accolades two are held most dearly; namely: i) Recipient of the Commander's coin, US Department of Defence (2011) for his work into hand-arm vibration; and ii) Chief for Education Development, Ashanti Kingdom, Ghana (2015-present) for on-going research and education conducted in collaboration with Kwame Nkrumah University of Science and Technology. He is currently working for staff at the Pentagon, US on the development of standards for safety management in the defence, automotive and aerospace industries.

Vikashnee Harbhajan – Executive Director: Masterbuilders Kwazulu-Natal

Vikashnee Harbhajan

Vikashnee Harbhajan is the Executive Director of Master Builders KwaZulu-Natal. She has held senior positions in both the public and private sector, has a Master's degree in law and is an admitted Attorney and Conveyancer of the High Court of South Africa.

She commenced her career at the University of Durban–Westville and Technikon Mangosuthu in the faculties of Law and served her articles with the Legal Aid Board. Ms Harbhajan also practiced as an attorney for her own account and served at the Free State Department of Education as Director: Legal Services and Labour Relations, before taking up a position with the National Economic Development and Labour Council (NEDLAC) as the Programme Director.

She then joined Business Unity South Africa (BUSA), the national voice of organised business in SA where she served as Executive Director responsible for Social Policy for over four years. Her portfolio at BUSA included inter alia labour market policy, education, training, skills, health, immigration, social security and anti – corruption.

She has also gained experience on several Boards and Councils, including the National Board for Further Education and Training (NBFET), Advisory Council for Occupational Health and Safety (ACOHS), the South African Business Coalition on HIV and AIDS Board (SABCOHA),

Wholesale and Retail SETA Board (WRSETA). Construction Industry Development board (CIDB) National stakeholder forum and the Essential Services Committee (ESC).

Vikashnee currently serves on the Equality Review Committee (ERC), SACPCMP Transformation Committee Chairperson, MBSA Board as well as the KwaZulu-Natal Human Resource Development Council. She is also a member of the Institute of Directors (IOD) and Business Women's Association (BWA).

In 2016, the Association of Schools of Construction of Southern Africa (ASOCSA) awarded Vikashnee Harbhajan with the ASOCSA Leadership Award for demonstrating consistent, ethical and exemplary leadership in the broader construction industry.

Rodney Milford - Programme Manager; Construction Industry Performance at the Construction Industry Development Board (CIDB)

Rodney Milford

Rodney Milford is currently Programme Manager; Construction Industry Performance at the Construction Industry Development Board (cidb), and previously Director of CSIR Knowledge Services, and Director of CSIR Building and Construction Technology (Boutek).

At the cidb, Rodney is responsible for monitoring the performance of the construction industry, the development and implementation of the cidb Contractor Recognition Scheme, the cidb Project Assessment Scheme, the cidb Register of Professional Service Providers, and the cidb's skills strategy for the industry.

Dr Claire Deacon - Managing Member of OCCUMED

Claire Deacon PhD (Constr Mgt)

Claire Deacon is the Managing Member of OCCUMED cc trading as claire deacon and associates (cd&a). Claire has practiced as an Occupational Health Practitioner [OHNP] since 1982. Claire is registered as one of the few female Professional Construction Health and Safety Agents practicing in the field (Pr. CHSA) No: CHSA010/2013.

Claire obtained her PhD (Construction Management) at NMMU in 2016. Her career commenced with a General Nursing Diploma at Groote Schuur Hospital, she qualified in Occupational Health at the University of Stellenbosch. Other post graduate training include a B.Tech in Occupational Healthat Peninsula Technikon; a BSc Med [Honours] in Biomedical Engineering/Ergonomics at the University of Cape Town, and a Masters in Nursing [MCur] [by research] at the then University of Port Elizabeth (now NMMU). Claire was admitted to the prestigious Research Capacity Initiative [RCI] with the South African Netherlands Partnership for Alternative Development [SANPAD], which was completed cum laude.

Currently one of 2 construction H&S (CHS) council members appointed to the SACPCMP for the 4th term council. Roles within the SACPCMP include: CPD Chair, HR Chair, and Registrations Committee, and CHS. Other roles include examiner and moderator for the CHS officer and manager categories, as well as any other roles required in the duties of the Council.

Claire is a member of other VAs that includes: the SA Society of Occupational Health Nurses [SASOHN], the Chartered Institute of Building [CIOB]; Graduate Member at the Institute of Safety and Health (IOSH) in the UK, and the Ergonomics Society of South Africa [ESSA]. Research projects that focus on ergonomics, occupational health and ageing workers have been the focus points over the past few years.

Claire has worked as a CHSA since 2003, on projects ranging in value from R 500 thousand to R 3 billion, across South Africa.

Prof. Ugwu - Head of Civil Engineering Department, Federal University Nigeria

Engr. Prof. Onuegbu Okoronkwo Ugwu

Onuegbu (Joseph) Ugwu is a Professor of Civil Engineering at Federal University, Ndufu-Alike Ikwo (FUNAI), Nigeria. He is the Head of Civil Engineering Department, and Director, Directorate of Research & Development FUNAI He was the Chair & Convenor of the Infrastructure Sustainability Task Force in the Centre for Infrastructure and Construction Industry Development (CICID), Department of Civil Engineering HKU from 2006 - 2008. While at HKU, he initiated pioneering research on infrastructure projects sustainability. He won the HKU Research Incentive Award in 2004. The Faculty of Engineering Research Committee, Loughborough University UK awarded him the Outstanding Researcher Award in 2001, for his outstanding contributions to Research & Development. He was a Visiting Research Scholar in the Department of Civil, Environmental and Infrastructure Engineering (CEIE) in the Information Technology and Engineering (ITE) School at George Mason University Fairfax, Virginia USA. He held the Royal Society UK Fellowship Award as a Visiting Scientist from China to Loughborough University UK, and the Republic of South Africa National Research Foundation (NRF) International Science Liaison (ISL) Visiting Fellowship [NRF-ISL] Award. In 2015, the Swiss National Science Foundation (SNSF) Switzerland invited him as an International Expert to review submitted research grant proposals.

His teaching and research interests cover construction engineering and project management, sustainable construction & development, general infrastructure and critical infrastructure systems. These include infrastructure security, whole-life-costing, project collaborative systems and collaborative technology including theoretical foundations and applications of Information and Communications Technology (ICT). He has worked on several research projects (total grant value over US$0.5Million direct cash funding), focusing on different aspects of his research and areas of expertise, as either the Principal Investigator or Co-Investigator.

Engr. Prof. Ugwu has over 120 publications in international peer-reviewed journals, conferences, books, and research reports and is actively involved in research, teaching and general activities that contribute to students learning, research and development. He has successfully supervised several undergraduate and postgraduate students in Nigeria, Asia and Europe, and was an International External Examiner for universities in the Republic of South Africa.

Dr Hendrik Prinsloo - Senior Lecturer, Department of Construction Economics

Hendrik Prinsloo (BSc (Constr. Man.), MSc (Real Estate), PhD, Pr CPM)

Hendrik Prinsloo has more than 20 year's experience in the construction industry.

As Project Manager he successfully completed various prestigious fast-track commercial and government projects. He is known in the industry not only for his ability to manage very complex projects but also for his strategic business leadership skills. The unique decision support model for the assessment of construction delay claims he developed is currently being presented and utilised in several countries.

In addition to his involvement in the industry he teaches on master's level at the University of Pretoria. He is registered as a Professional Construction Project Manager and one of a very limited number of professionals with a PhD in Construction Project Management.

Professor Theo Haupt - Research Professor: Engineering: Mangosuthu University of Technology

Professor Theo Haupt

Professor Haupt has been involved in health and safety (H&S) practice and research for several years with a PhD from the United States focusing on alternative approaches to the management of H&S on construction sites.

He has published extensively and delivered several papers on the subject in national and international journals and conferences. He regularly reviews papers on H&S and construction industry development issues for a range of internationally acclaimed journals and serves on several editorial boards.

Professor Haupt has co-authored chapters on H&S in a number of books. He is heavily involved in the International Council for Research and Innovation in Building and Construction (CIB) Work Commission W99 (Safety and Health in Construction). Given his interest in the "people" aspects of construction, his primary recent research interest includes many aspects of construction worker safety and health with particular emphasis on the performance approach to safety management, workers' compensation premium fraud, accident causation, safety and health interventions, impacts of diseases such as tuberculosis and HIV/AIDS on construction workers, and the plight of aging construction workers.

His recent focus is on the cost implication of the present OH&S legislative and regulatory framework in South Africa. He has served on the Advisory Council for Occupational Health and Safety of the Minister of Labour.

Professor Haupt also serves in the following capacities: Past Vice-President: Association of Schools of Construction of Southern Africa (ASOCSA); Chair: Heads Forum: ASOCSA; Regional Director: CIB Sub-Saharan Africa; Senior Academic Advisor: ASOCSA-CIB Sub-Saharan Student Chapter; Editor-in-chief: Journal of Engineering, Design and Technology (JEDT); Overseeing Editor: Journal of Construction (JoC)

ASOCSA PRESIDENT'S REPORT - 2017

#MakeConstructionGreatAgain – The Association of Schools of Construction Southern Africa's 11th Built Environment Conference
By Hendrik Prinsloo

In a world where conference themes can sometimes be run of the mill and mundane, with the sole purpose to cast the net as wide as possible to attract papers from all corners of industry, it was refreshing to learn that the theme of the Association of Schools of Construction Southern Africa's (ASOCSA) 11th Built Environment Conference were both forward looking and positive. One cannot be faulted to think of a recent successful presidential campaign's slogan when seeing the conference theme for first time. Like the outcome of this presidential campaign, the 11th Built Environment Conference was also a big success. The conference theme: #MakeConstructionGreatAgain formed the foundation of several thought-provoking presentations and discussions.

After taking place in Port Elizabeth last year, the conference returned to Durban, where the Department of Public Works made their conference facility available for this important industry event. The Conference commenced on 6 August 2017 with the Heads Forum where the leaders of construction departments of Southern Africa's leading Universities deliberated on challenges faced within the academic landscape and how to collectively ensure that construction education remains relevant in a changing society. The Heads Forum was followed by the ASOCSA Annual General Meeting and Council Meeting where the focus shifted to the election of new office bearers.

One of the highlights of the opening day of the conference was the keynote address by the MEC: KZN Department of Human Settlement and Public Works: Mr Ravi Pillay. The key note set the scene for further presentations and deliberation on how, through transformation, the construction industry can become a catalyst for job creation and economic growth. During the afternoon, a large number of academic papers responding to conference sub-themes of: construction innovation, construction education and sustainable construction, were presented, providing ample opportunity for debate.

The opening day concluded with another important event – the Lifetime Award Gala Dinner, where exceptional industry achievement was celebrated. Mrs Pugh, MD of FEM received a lifetime achievement award for her remarkable work during the past 48 years promoting health and safety in the construction industry. Mr Aubrey Tshalata, President of the National African Federation for the Building Industry was honoured with a leadership award for his outstanding contribution to the objective of transformation in the construction industry. The proceedings concluded with the announcement of the newly elected leadership of the Association of Schools of Construction Southern Africa. Dr Hendrik Prinsloo was elected as the new president, Mr Victor Smith as the new vice president and Prof Kahilu Kajimo-Shakantu as the chairperson of the Heads Forum. Dr Breda Strasheim (honorary treasurer), Mrs Elke Heffer, Prof Kahilu Kajimo-Shakantu and Mr Ephriam Zulu (honorary secretary) were introduced as the new members of the council. In his remarks, the new president, thanked all the past presidents and office bearers who over a long period of time worked tirelessly to make ASOCSA the successful organisation it is today. He also paid tribute to the unselfish contribution by the immediate past president, Mr Ferdinand Fester, who for a long period of time executed the duties as president with vigour and with unwavering commitment.

The final day of the conference provided further opportunity for discussion with the presentation of research papers on public sector contracting, infrastructure challenges and international construction. The conference would not have been possible without the hard work and dedication of the conference organisers.

The success of this Conference can not only be attributed to the 62 research papers presented (more than any of the previous conferences) and the large number of participants but more importantly the strides that were made to set in motion a common industry goal to #MakeConstructionGreatAgain.

PREFACE

The ASOCSA Built Environment conference series has become the undisputed leading built environment conference on the African continent.

Dr Hendrik Prinsloo
President: Association of Schools of Construction Southern Africa

CONTENTS

Session: Construction Education and Training

An Analysis of Types of Assessment Questions and Cognitive Loading in Undergraduate Students of Construction Studies at the University of KwaZulu-Natal
Ephraim Zulu and Theo C. Haupt…..…….... 1

Enhancing Self Learning through Assessment: The Case of UKZN
Jaison Konar and Nishani Harinarain…… 15

Exploring Tertiary Education Trust Fund Projects Success Delivery in the Ahmadu Bello University, Zaria- Nigeria from Stakeholders Perspectives
Gambo Sanusi, Mustapha Abdullahi Iliyasu, Winston Shakantu and Kabir Ibrahim……..... 27

Good-To-Great Concept: A Novel Approach for Addressing the Skills Gap in Architectural Design Firms in Developing Countries
Dana A. A. Sokkar, Heba A. I. Elsaay,Ayman A. E. Othman, Justus N. Agumba....…….... 37

ICT in the Training of South African Bricklaying Operatives: A Pilot in the Greater Johannesburg Area
Ozumba A.O.U., Botjie T, Daya B and Leonard JS…… 49

Innovative Solutions for Lecture Venues: The Students Perspective
Jhavan Sigamoney Pillay and Nishani Harinarain…… 60

Investigating the impact of Accreditation on Quantity surveying programmes and the professional preparedness of graduates
Theo C. Haupt and Zakheeya Armoed …… 72

Monitoring and Evaluation of the Mentoring Programme for the Bachelor of technology students: A case study of Durban University of Technology
Ivan Govender, Elke Hefer and Krishna Ramphal…… 89

Multilingualism in a Monolingual South African Built Environment
Pierre Oosthuizen…….. 99

Perceptions and experiences regarding the use of alternative building technologies in school infrastructure in the Eastern Cape Province
Bonisile Ngxito and Kahilu Kajimo-Shakantu……..... *112*

Technology for Instructors: A Pilot study
F.C. Fester, N. Harinarain ……..….. *124*

The Efficacy of introducing inquiry based learning in construction education to improve the skills of construction graduates in South Africa
Adesoji Tunbosun Jaiyeola, Nishani Harinarain and Theodore C. Haupt…… *136*

The future of Universities, the possibility of the using social media and portable devices
Nompumelelo W. Khumalo and Nishani Harinarain…… *147*

The impact of housing quality on the studies of Construction Studies Students at the University of KwaZulu-Natal
Fezile Bukeka Lovedorado Nala and Nishani Harinarain……. *156*

Session: Construction Innovation

A Decision Tree Framework for the Assessment of Construction Delays
Hendrik Prinsloo, Martinus Maritz…… *165*

An investigation into the key factors causing construction waste in Polokwane, Capricorn Municipality District of South Africa
Mewomo MC, Aigbavboa CO and Maja MR ……..…… *177*

Analysing Hidden Lean Practices in Construction: An Eastern Cape Study
Lesiba George Mollo, Fidelis Emuze, and Lonwabo Fityoli……... *187*

Analysis of Factors Influencing Productivity in South African Construction
Oluseyi Adebowale and John Smallwood…….….. *201*

Assessment of alternative building systems available in South Africa based on sustainability indicators
Frazer Howard Smith, Vittorio Tramontin, Cristina Trois…… *214*

Building Contracts, a method to manage construction processes:
A South African perspective
Hendri du Plessis and Pierre Oosthuizen ……..….... *225*

Cloud Computing, a possibility for the Construction Industry
Makwela Galane and Dr Nishani Harinarain…..…… 239

Effectiveness of client involvement in construction projects: A contractor perspective
P. S Chigangacha and T. C. Haupt…… 249

Exploratory factor analysis (EFA) to determine critical success factors of managing joint venture construction projects in South Africa
Bekale Marie Francoise, JustusAgumba and Nazeem Ansary….. 267

Fostering Innovation through Managing Diversity in Architectural Design Firms in Developing Countries
Ghada Adel, Heba Elsaay, Ayman Othman and Nishani Harinarain…….. 280

Market Availability of Information and Communication Technologies and their adoption in Site Management in South Africa
Aghaegbuna Ozumba and Winston Shakantu……... 300

The effectiveness of Quick Response Codes on construction materials in South Africa
Tashmika Ramdav and Nishani Harinarain…… 312

The efficacy of innovative technology in improving the performance of low costhousing in South Africa: A case study
Llewellyn van Wyk…….…… 322

Session: Construction Labour Challenges

An investigation into the employment of persons with disabilities in the KwaZulu Natal (KZN) construction industry
Sheldon Govender and Theo C. Haupt ……..…… 334

Perceptions on the Cost Provision for Construction Health and Safety in South Africa
Theodore C. Haupt and Elke Hefer…… 346

Views of Construction Accident Analysis in Bloemfontein
Fidelis Emuze and Madikane Yolisa……... 357

Session: Infrastructure Challenges

Evaluation of stakeholder influence on affordable housing delivery during production processes
Akinyede Imisioluseyi Julius , Fapohunda Julius Ayodeji and Haldwang Rainer …….…..... 368

Feasability of active design
Liezl Knobel, Tascha Bremer and Mart-Mari Els…….. 380

Mainstreaming Social Sustainability into Infrastructure Delivery Systems: Are There Any Benefits? A Stakeholders' Perspective
Bankole Awuzie and Thabiso Monyane…… 388

Prevalent types of errors in Construction Contract Documents
Oluwaseun Dosumo and Clinton Aligbavboa……... 402

The extent of practice of Total Quality Management (TQM) in the maintenance of university buildings in South Africa
Akinlolu M.T., Ndihokubwayo R and Simpeh F……... 414

Session: International Construction

A field study investigating the role of talent management as a novel approach for developing innovative solutions for Egyptian heritage communities' development
Mohamed H. M. H. Khalil, Heba A. I. El Saay, Ayman A. E. Othman and Justus N. Agumba……..……... 427

Case Study on the quality of tenders submitted by Occupational Health and Safety Professionals in the South African built environment
Cathy Mphahlele and Llewellyn van Wyk……..….. 441

Effects of Cash Flow on Project Delivery in the Nigerian Construction Industry
Omopariola Emmanuel Dele, Lowe, G. John and Abimbola Windapo……. 453

It's good for you don't worry: A comparison of South African and the UK consultation protocols
Nthatisi Khatleli , Matlhari Baloyi, Lindokuhle Gushu and Irshaad Khan…….…..... 465

Public Procurement reforms in Ghana: Impact on the growth of the local Construction Industry
Christopher Amoah and A Winston Shakantu…….. …….. 478

Session: Public Sector Contracting

Improving construction project performance in the South African public sector
Vukela, R, Kahilu Kajimo-Shakantu and Ncedo Cameron Xhala…… 493

Integrated Project Delivery System Implementation in the public sector in South Africa: A Pilot Study
Thamini Moodley and Theo C. Haupt..... 507

Managing demand risk in South African transport public private partnership projects
Khatleli Nthatisi, Sweta Dalal, Muhammed Hafejee and Elphas Nobela.…… 515

Occupants' satisfaction with indoor environmental quality of social mass housing projects in South Africa
Clinton Aigbavboa and Oluwaseun Dosumu…….. 529

Risk Assessment For The Importation Of Bitumen For Road Construction Into South Africa
C H Hanekom and J A vB Strasheim…….……..……... 541

Session: SME Contractor Development

Critical success metrics for measuring construction project success in small and medium enterprises: an exploratory factor analysis study
Berenger Renault, Justus Agumba and Nazeem Ansary…… 555

Strategic Alliances amongst the SMME Contractors: A Driver towards Strategic Capabilities and competencies
Anugwo Iruka and Shakantu Winston…….……... 569

Why do women-owned construction firms fail in KwaZulu-Natal? A preliminary study
Theo C. Haupt and Jabulile Ndmande.…….……..…….. 583

Session: Sustainable Construction

A conceptual framework for organizational culture, organizational structure, and sustainable construction
O.I Bamgbade and O.K Babatunde…… *593*

A Field study investigating the development of green buildings in developing countries: A sustainable project management approach
Salma H. Nassar, Heba A. I. El Saay, Ayman A. E. Othman and Nishani Harinarain…….. *608*

An Analysis of Sustainable Rating Systems in Respect to Communities for Implementation in Developing Countries
Kingu N., Tramontin V. and Stretch D ……..…….. *623*

Barriers to the effective implementation of sustainable construction in the South African construction industry
Mewomo MC, Aigbavboa CO and Thobakgale ME ……..….. *634*

Challenges to Implementing Environmental Management Plans in Construction projects in South Africa
Primrose T. Nyamazana and Aghaegbuna Ozumba…..…….. *645*

Delivering construction projects using innovative building technologies
Naa Lamkai Ampofo-Anti…….. …… *655*

Industry perceptions on cost implications of going green in sustainable human settlements
Greyling, C and Kajimo-Shakantu, K…….…….. *668*

Perimeter Walls Solar Heat Gain, a Mechanism for Building Design
Ochuko Kelvin Overen, Edson Leroy Meyer and Golden Makaka…… *681*

Policy Analysis of Carbon Emissions in Housing Stock using System Dynamics Modelling Approach
Michael G. Oladokun and Clinton O. Aigbavboa……..…….. *693*

Social Resilience in Urban Areas
Jeremy Gibberd……..…… *706*

The effects and practical implications of dated development planning practices on the University of KwaZulu-Natal
Msawakhe Mfusi and Nishani Harinarain…… *719*

The Glass is always greener on the other side: A Case Study between two residential projects
Bremer T, JC De Lange, Froise T and Els M.M…….. 731

Towards sustainable human settlements in South Africa: emerging approaches through a case study analysis
Vittorio Tramontin, Nombuso Nomfundo Qwabe…….. 743

Water Resilience in Urban Areas
Jeremy Gibberd……..……... 756

ASOCSA2017- [086]

An Analysis of Types of Assessment Questions and Cognitive Loading in Undergraduate Students of Construction Studies at the University of KwaZulu-Natal

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ABSTRACT AND KEYWORDS

Purpose of this paper. The study aims to quantify the relative amount of cognitive loading induced in students of construction studies by academic problems of varying complexity.

Design/methodology/approach. A deductive quantitative research approach was favoured using a cross sectional questionnaire survey to collect the data. Non probability sampling was used yielding a sample of 75 students from the University of KwaZulu-Natal. Factor analysis, correlation analysis and bivariate linear regression analysis were performed on the data.

Findings. Complex and ambiguous problems account for a much larger variation in cognitive loading compared to worked examples and completion problems.

Research limitations/implications (if applicable). The instruments used are new and their external validity is yet to be established. The results may not be readily generalizable since they are based on a convenience sample.

Practical implications (if applicable). To reduce cognitive loading in students of construction studies with little subject prior knowledge, complex and ambiguous questions should be avoided and simpler problems favoured especially in modules with high item interaction until students have gained sufficient subject knowledge.

What is original/value of paper. New instruments for measuring cognitive loading, use of complex and ambiguous problems, worked examples, completion problems and authentic problems have been suggested and their psychometric properties reported. The paper also provides some validation for findings indicating that complex and ambiguous questions induce high cognitive loading while worked examples and completion problems have much lower cognitive loading.

Response to conference theme. The paper responds to the theme on ***Construction education, training and skills development.***

Keywords: **Cognitive loading; Worked examples; completion problems; complex questions; authentic questions**

1. INTRODUCTION

The cognitive load theory (CLT) posits that learning will take place best when the cognitive load in working memory is directed towards construction and automation of relevant schemata (Pollock *et al.*, 2002; Sweller, 1994; Sweller *et al.*, 1998). The theory further suggests that since working memory has a very limited capacity, it can be easily overloaded with activities that impede rather than aid learning. University students in general and students studying construction related studies in particular are frequently faced with very high cognitive loading from the heavy curriculum work load they have to deal with. CLT suggests that highly complex academic problems induce high cognitive loading especially in students with little subject prior knowledge while less complex problems induce much less cognitive loading and subsequently aid learning. Some of the less complex academic problems recommended by proponents of the CLT include worked examples and completion problems. Proponents of student centred approaches on the other hand prefer the use of complex and ambiguous questions and authentic problems over less complex ones in inquiry based learning approaches. This study therefore aims firstly to propose a set of instruments for measuring cognitive loading and a number of academic problems of varying complexity and secondly to assess the relative amount of cognitive loading induced in students of construction studies by complex and ambiguous problems, worked examples,

completion problems and authentic problems which represent academic problems of varying complexity.

THEORETICAL BACKGROUND

1.1 Cognitive Load Theory

The human memory is comprised of a short-term memory (aka working memory) and a long-term memory and cognition, according to cognitive science, is comprised of processing information on the working memory and subsequently storing it on long-term memory (Moons and De Backer, 2013; Reedy, 2015; Tasir and Pin, 2012; Wong *et al.*, 2012). Working memory has a limited storage capacity and a short information decay period with visual information retained for only about several hundred milliseconds and a verbal-linguistic decay period of about 12 – 30 seconds (Moons and De Backer, 2013 citing Artkinson and Shiffrin, 1968). Long-term memory on the other hand is virtualy unlimited in capacity and has a permanent retention period (Moons and De Backer, 2013). Working memory is used for conscious activity in organising, contrasting, comparing and working on information and while it can hold only about seven items at a single time, it can only process two or three items simultaneously and it is the only memory which can be monitored (Kirschner, 2002; Sweller et al., 1998). Long term memory (LTM) on the other hand, while unlimited in capacity, its contents cannot be directly monitored unless they are loaded onto working memory.

Based on this architecture of cognition, John Sweller (1946-) postulated the cognitive load theory (CLT) which posits that learning will take place best when the cognitive load in working memory is directed towards construction and automation of relevant schemata (Pollock et al., 2002; Sweller, 1994; Sweller et al., 1998). The theory further suggests that since working memory has a very limited capacity, it can easily be overloaded with activities that impede rather than aid learning. In this regard, three different loads on working memory have been suggested, vis-à-vis, intrinsic cognitive load (ICL), extraneous cognitive load (ECL) and germane cognitive load (GCL). ICL is the cognitive load demanded by the intrinsic nature of the subject matter being learnt (Bannert, 2002; Kirschner, 2002; van Bruggen et al., 2002). ECL is generated by the design of the instructional approach used in teaching while GCL is the cognitive load generated by the construction and automation of schemata which only occurs when there is free working memory capacity available (Bannert, 2002; Kirschner, 2002; van Bruggen et al., 2002).

Knowledge stored in LTM is stored as schemata. A schema is anything that is learnt and is treated as a single entity by working memory and can incorporate a large and complex amount of information (Kirschner, 2002; van Bruggen et al., 2002). Schema can combine elements of information and production rules and become automated therefore needing less storage capacity and processing (van Bruggen et al., 2002).

CLT suggests that reducing cognitive load will make more working memory available for actual learning (Bannert, 2002). ICL, being intrinsic to subject matter being learnt, cannot be reduced while ECL, which does not

contribute to learning but instead, especially for poorly designed instructional approaches, reduces working memory capacity, is the only cognitive load which can be reduced (Bannert, 2002; Kirschner, 2002). Instructional approaches that reduce ECL will also increase GCL provided the total CL remains within the limits (Bannert, 2002; Kirschner, 2002).

Learning will hardly take place if there is little or no schemas in LTM on the subject matter because the cognitive load will be too high (Valcke, 2002). Learning involves storing information including large, complex interactions and procedures in LTM and inducing changes in the structure of the schemata (Sweller et al., 1998). It is achieved by establishing patterns in data sets which are best chosen based on the simplicity with which they explain the data and connected to existing schemas (Chater and Vitányi, 2003). Existing schemas help to interpret new information and link it with the existing schemas thereby reducing cognitive load because schemas in LTM can be easily manipulated and stored (Valcke, 2002). Owing to the significance of working memory to schemata construction and automation, Kirschner (2002); (Sweller *et al.*, 1998; Van Gerven *et al.*, 2002) posit that working memory plays a more significant role than intellectual ability in learning new skills because cognition does not stem from complex chains of reasoning in working memory which is incapable of any such complex interaction.

1.2 Types of Assessment Questions

Solving conventional problems in the absence of adequate schemas requires the deployment of a substantial amount of cognitive effort which generates a large extraneous cognitive load and is therefore not ideal for schemata construction or learning (Sweller et al., 1998). Sweller et al. (1998) argued that “means-end” search increases ECL when students with little subject prior knowledge attempt to solve conventional problems.

One strategy for reducing means-end analysis is studying worked examples which focuses attention on problem states and associated operators therefore reducing cognitive load and helping students to create schemas (Sweller et al., 1998). The effectiveness of worked examples has been demonstrated by several authors (Paas and van Gog, 2006; Rourke and Sweller, 2009; Schwonke et al., 2009; Sweller, 2006). For example, in an experimental study comparing worked examples, tutored problems erroneous examples which also represented high assistance instruction approaches and untutored problem solving which represented a low assistance instruction approach, McLaren et al. (2016) found that there was no difference based on the instruction approach in learning outcomes. However, significant differences in learning outcomes were found in both instructional approaches based on the worked examples which showed that students expended far less time and effort to achieve the learning outcomes. The reduction in time was between 46% and 68%. Mulder et al. (2014) also reported the effectiveness of worked examples in an inquiry based learning scenario. In an experimental study design of IBL through a computer simulation programme where students were required to produce computer models, the experimental group was given heuristic worked

examples to refer to while the control group was not given. It was found that the heuristic worked examples improved the students' inquiry behaviour and improved the quality of the computer models produced. However, few students produced a model with evidence of full understanding. It was proposed to improve the worked examples used.

However, some studies on worked examples have found little or no advantage in worked examples over conventional examples. In an experimental study aimed at assessing the efficiency of worked examples over conventional practice problems in both young and elderly adults, Van Gerven et al. (2002) found that young students did not profit from worked examples with mean scores even suggesting a negative effect when training with worked examples. In this instance, it was also found that studying using both worked examples and conventional problems produced relatively little cognitive load and led to nearly the same level of performance. However, it was concluded that the young may have attained their upper performance limit.

Completion problems have also been found to reduce cognitive load. In a series of experimental studies comparing completion problems, conventional problems and learner controlled condition van Merriënboer et al. (2002) found that completion problems reduce cognitive load and the completion problems group showed the highest training efficiency but a disappointing transfer performance. Mihalca et al. (2015) also found that completion problems were effective for students with low subject prior knowledge while students with higher subject prior knowledge performed better with conventional problems.

However, it should be noted that reduction of cognitive load does not guarantee that the free working memory will be used for schemata construction and automation (Bannert, 2002). Free working memory will only be effectively used in learning when the attention of learners is directed away from extraneous cognitive processes towards the germane cognitive processes of schema construction and automation (Bannert, 2002; Sweller et al., 1998).

All the suggested instructional approaches which consider CLT are applicable to students with little prior knowledge. Worked examples, and completion problems are all reported to lose their advantage in more experienced learners (Hoogerheide et al., 2014; Mihalca et al., 2015; Sweller et al., 1998; Van Gerven et al., 2002).

2. RESEARCH DESIGN, STRATEGY AND PROCEDURES

A deductive quantitative research approach was favoured using a cross sectional questionnaire survey to collect the data because of the objectivity and low cost associated with the use of surveys compared to other methods of data collection and a deductive quantitative research approach lends itself well to descriptive studies. Non probability sampling was used for convenience and economy yielding a sample of 75 2nd and 3rd year students from the University of KwaZulu-Natal in Durban, South Africa. Factor analysis, correlation analysis and bivariate linear regression analysis were performed on the data using IBM SPSS 23.

The scales in the questionnaire were operationalized by developing new instruments after suitable existing instruments could not be found. Four scales were developed for measuring Cognitive Loading (CL), Complex and Ambiguous Questions (CAP), Worked Examples (WE), Completion Problems (CP) and Authentic Problems (APr). While cognitive loading is made up of three components namely, intrinsic, extraneous and germane cognitive loads, for this study, it was conceptualised and operationalised as total cognitive load which therefore reflect only two of the three elements namely intrinsic and extraneous cognitive load. It was conceptualised mainly as the extent to which students felt overwhelmed during their previous semester and so captured total cognitive loading from all academic activities for a period of time. The concept of complex and ambiguous questions was operationalised as the frequency with which assessment questions were complex and ambiguous. The concept of worked example was operationalised mainly as the frequency with which worked examples were used in the various modules over the course of the previous semester and the same for completion problems and authentic problems. The item wording was simplified to make it appropriate for the selected sample to understand since English is not their first language. The instrument was measured on a 5 point Likert scale with 5=almost never; 4=often; 3=sometimes; 2=seldom; and 1=almost never

3. FINDINGS

The items in the measurement instruments are shown in Table 3.1 while the statistics for reliability and validity of the instrument are shown in Table 3.2. The Cronbach's alpha for all the scales ranged between 0.825 to 0.929 and the item-to-total correlations ranged from 0.501 to 0.878 indicating good internal reliability. Composite reliability ranged from 0.667 to 0.895 with one scale falling below the 0.70 recommended threshold and the average variance extracted ranging from 0.502 to 0.712 all above the recommended threshold of 0.50. Cronbach's alpha is affected by the number of measurement items with few items generally yielding low values and therefore the low alpha for the Worked Example measure by three items. Factor analysis using principle components with Varimax rotation and listwise deletion for missing data yielded factor loadings ranging from 0.573 to 0.910 after dropping two items from one scale because they did not converge on the a priori construct. Correlation analysis among the constructs are all less than 0.80 indicate good discriminant validity. Therefore, all the items converged well on their respective constructs and are good measures of their respective constructs.

Table 3.1 Measurement Instrument

Construct		**Mean**	**Std. Dev.**

Complex and Ambiguous Questions	**CAQ**		
I was given assignments and tests which were difficult to understand and solve	CAQ1	3.250	0.960
I was given problems which did not have enough information for me to solve them	CAQ2	3.153	1.002
I was required to solve questions which were not clear as to what I was expected to do	CAQ3	3.306	1.043
I was given questions which could be interpreted in more than one way	CAQ4	3.292	0.985
I was given problems which were not easy to understand clearly	CAQ5	3.11	0.928
I was given questions which were not expressed clearly	CAQ6	3.056	1.112
Authentic Problems	**AP**		
I was given problems based on actual industry real life problems	AP1	3.556	0.933
I was expected to use real life situations when doing my school work	AP2	3.817	0.883
I was required to collect some real world information to do my school work	AP3	3.831	0.862
I was given work which was relevant to actual current industry practice	AP4	3.887	0.903
I was required to come up with my own solutions to problems	AP5	3.750	0.868
Worked Examples	**WE**		
I was given some worked examples to practice on	WE1	3.411	1.039
I was given examples with clearly defined steps on how to solve problems to practice on	WE2	3.438	0.957
I was given problems with model solutions to practice on	WE3	3.274	1.109
Completion Problems	**CP**		
I was given partially worked examples to complete	CP1	2.767	1.137
I was given partly finished model solutions to problems to finalise the solution	CP2	2.822	1.170
I was given problems which were partly solved to practice on	CP3	2.836	1.214
I was given problems and part of the solution to work on	CP4	3.00	1.323
I was given problems which had gaps that I had to fill in	CP5	2.973	1.213
Cognitive Loading	**CL**		
I was expected to remember too many things from each lecture	CL1	3.487	0.910
I was overwhelmed with the amount of information I was expected to remember	CL2	3.438	0.882
I was given with too much information during the lectures	CL3	3.324	0.761
The information I was given during lectures was	CL4	3.069	0.983

confusing			
The information I was given in class was complicated and difficult to understand	CL5	3.162	1.007
I was overwhelmed with the amount of work I had to do	CL6	3.473	1.023
I was given too many projects, assignments and tests	CL7	3.432	0.952

Table 3.2 Measurement Instrument Analysis

Research Constructs		**Mean**	**Cronbach's Test**		**C.R.**	**AVE**	**Item Loadings**
			Item-total	**α Value**			
Complex and Ambiguous Questions	CAQ1	3.194	0.550	0.848	0.744	0.564	0.610
	CAQ2		0.734				0.842
	CAQ3		0.805				0.873
	CAQ4		0.501				0.633
	CAQ5		0.613				0.779
	CAQ6		0.598				0.729
Authentic Problems	AP1	3.794	0.591	0.855	0.813	0.622	0.706
	AP2		0.782				0.865
	AP3		0.761				0.837
	AP4		0.607				0.773
	AP5		0.613				0.753
Worked Examples	WE1	3.374	0.595	0.825	0.667	0.502	0.752
	WE2		0.780				0.753
	WE3		0.685				0.610
Completion Problems	CP1	2.879	0.800	0.929	0.895	0712	0.846
	CP2		0.841				0.887
	CP3		0.878				0.910
	CP4		0.781				0.760
	CP5		0.728				0.807
Cognitive Loading	CL1	3.811	0.473	0.856	0.720	0.543	0.573
	CL2		0.624				0.711
	CL3		0.683				0.779

	CL4		0.535				0.685
	CL5		0.732				0.842
	CL6		0.724				0.822
	CL7		0.604				0.712

The factor analysis with principle component analysis and Varimax rotation with Kaiser normalisation converged in 6 iterations. KMO and Bartlett's test for the factor analysis of 0.782 shown in Table 3.4 indicates a very acceptable sample size for the factor analysis.

Table 3.3 Rotated Component Matrix[a]

	Component			
	1	2	3	4
CAQ1	0.610		0.512	
CAQ2	0.842			
CAQ3	0.873			
CAQ4	0.633			
CAQ5	0.779			
CAQ6	0.729			
AP1		0.706		
AP2		0.865		
AP3		0.837		
AP4		0.773		
AP5		0.753		
WE1			0.752	
WE2			0.753	
WE3			0.610	0.525
WE4				0.649
CP1				0.846

CP2				0.887
CP3				0.910
CP4				0.760
CP5				0.807

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 6 iterations.

Table 3.4 KMO and Bartlett's Test for Types of Questions

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.782
Bartlett's Test of Sphericity	Approx. Chi-Square	860.623
	Df	190
	Sig.	0.000

Work Examples had 4 items but only 3 converged on a single construct after factor analysis while two items from worked examples loaded on completion problems. The distinction between completion problems and worked examples is little and so they exhibit fairly similar properties.

Table 3.4 shows that all the inter-construct correlations are less than 0.80 indicating good discriminant validity. The results indicate that cognitive loading is positively correlated with deep learning but the correlation is weak and not significant while it is moderately positively and significantly correlated with surface learning. Deep learning approach is positively correlated with schema construction and the correlation is moderate and significant at 95% confidence level and surface learning approach is positively correlated with schema construction but the correlation is weak and not significant. Cognitive loading is positively correlated with schema construction, but the correlation is not significant.

Table 3.5 Correlations

		CAQ	AP	WE	CP	CL
CAQ	Pearson Correlation	1				
AP	Pearson Correlation	0.100	1			
WE	Pearson Correlation	0.246*	0.294*	1		
CP	Pearson Correlation	0.271*	0.179	0.592**	1	
CL	Pearson Correlation	0.644**	0.185	0.306**	0.395**	1

*. Correlation is significant at the 0.05 level (2-tailed).

4.1 Regression Analysis

It was expected that cognitive loading would be higher in complex questions (CAP) and the relationship between CL and CAP was tested.

The correlation between these two variables is shown in Table 3.5 and is 0.644 and significant at 99% confidence interval suggesting that when the level of complexity of assessment questions increase, the value of CL would increase quite considerably. From the regression Model 1 in Table 3.6, there is a linear relationship between CL and CAP since the R^2 value is greater than 0 (0.415) and the relationship is significant at 99% confidence interval as shown in Table 3.7 with 41.50% variance in CL explained by CAP. The null hypothesis that there is no relationship between CL and CAP is rejected and it can be concluded that there is a statistically significant relationship between the two variables.

It was expected that cognitive loading will be lower when worked examples (WE) were used. The correlation between the two variables is shown is 0.306 and statistically significant at 99% confidence interval and is shown in Table 3.5 suggesting that worked examples also increase the value of CL. The regression Model 2 in Table 3.6 and Table 3.7 show that there is a linear relationship between CL and WE and the relationship is statistically significant at 99% confidence interval with only 9.40% of variation in in CL accounted for by WE.

It was expected that cognitive loading will be lower when completion problems (CP) were used. The correlation between the two variables is 0.395 and statistically significant at 99% confidence interval and the two variables also have a statistically significant linear relationship as shown by the regression Model 3 with 15.60% of variation in CL being explained by CP suggesting that completion problems also induce some cognitive load.

It was expected that cognitive loading will be higher when authentic problems (APr) are used. While there is a positive relationship between the two variables, it is not statistically significant and even the regression Model 4 is not statistically significant. Therefore, any co-variation in the two variables can be attributed to chance.

Table 3.6 Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.644[a]	0.415	0.406	0.52529
2	0.306[b]	0.094	0.081	0.65157
3	0.395[c]	0.156	0.144	0.62864
4	0.185[d]	0.034	0.021	0.67257

a. Predictors: (Constant), CAP
b. Predictors: (Constant), WE
c. Predictors: (Constant), CP
d. Predictors: (Constant), AP
e. Dependent Variable: CL

Table 3.7 ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	13.693	1	13.693	49.626	0.000[b]
	Residual	19.315	70	0.276		

	Total	33.008	71			
2	Regression	3.114	1	3.114	7.334	.008[b]
	Residual	30.142	71	0.425		
	Total	33.256	72			
3	Regression	5.198	1	5.198	13.153	0.001[b]
	Residual	28.058	71	0.395		
	Total	33.256	72			
4	Regression	1.139	1	1.139	2.517	0.117[b]
	Residual	32.117	71	0.452		
	Total	33.256	72			

a. Dependent Variable: CL
b. Predictors: (Constant), CAP

4. DISCUSSION AND IMPLICATIONS OF FINDINGS

This study reported results of the psychometric properties of the instruments developed and also the results of the measures from the instruments. The results show that cognitive loading follows a continuum with simple type problems being statistically significantly associated with lower levels of cognitive loading and the complex questions being associated with much higher cognitive loading in students consistent with findings by many others. Worked examples represent about the simplest type of problems which can be given to student while completion problems are a little more complex and on the extreme end of the continuum lies complex and ambiguous questions.

These findings have both theoretical and practical implications. The theoretical implications are that by conceptualising and operationalising cognitive loading, use of complex and ambiguous problems, worked examples, completion problems and authentic problems different from other authors, new instruments are proposed for measuring these constructs. The psychometric properties of these instruments indicate that they are reliable measures with good scores for Cronbach's alpha, composite reliability, average variance extracted and item factor loadings and so provide a reliable alternative for measuring these constructs which is of value to any researcher looking to measure these constructs. The new instruments can provide a starting point for establishing the appropriate level of cognitive loading for effective learning. The practical implications for teaching and learning of construction related disciplines are that problems which are highly complex and ambiguous and which are often favoured by

construction related disciplines induce comparatively high levels of cognitive loading compared to problems which are more simplistic. Since high levels of cognitive loading impede effective learning especially in students with little subject prior knowledge and more so for modules with high item interaction, it would be more appropriate to assign students with more simplistic problems until they have gained sufficient subject knowledge.

5. LIMITATIONS

The study is limited by the fact that measurement instruments used are new and their psychometric properties have not been validated. Therefore, further research on different populations would be required to validate both the measurement instruments and the results of this study. The study is further limited by the fact that the sample used was purposively selected. Therefore, a more representative sample using random sampling over the population of students in construction studies in South Africa would better establish the validity of the results found in this study.

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Enhancing Self Learning through Assessment: The Case of UKZN

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ABSTRACT

Purpose of this paper
At the University of KwaZulu-Natal (UKZN) Howard College, the Construction Studies discipline has undergone numerous changes in terms of the assessment methods applied with the aim of promoting self learning among students. This paper presents findings on students perceptions of assessment and its application within the Construction Studies Discipline.

Design
This is a quantitative study whereby questionnaires were distributed among all undergraduate students (first year to third year) in the Construction Studies discipline. The data collected was analysed using SPSS version 24. Mean values, standard deviations and reliability values were computed.

Findings
It was found that the majority of students felt that current methods of assessment promoted self-learning through requiring them to find information on their own, this lessened the dependency on lecturers and increased the importance of assessment. When this is incorporated with feedback it enhances self-learning as well as students approach to future assessments.

Research limitations
This study was limited to the Construction Studies discipline of undergraduate students with UKZN.

Value
The current paper seeks to provide additional insight into achieving student self-learning through assessment.

KEYWORDS
Key words: Assessment, Student/Learner, Integrative, Self-learning.

Response to the Conference Theme
Construction Education, Training and Skills Development

1. INTRODUCTION

The world of academia is continually looking to evaluate and better assess the practises within higher education. This is with the aim of providing efficient student assessment and ultimately producing industry prepared graduates (Braun, 2008; South African Qualifications Authority (SAQA), 2008). This in collaboration with life-long learning skills are important for undergraduate learners as well as postgraduate individuals in industry (Boud and Falchikov, 2006).

It is therefore necessary to implement assessment practises which develop not only technical skills but also soft and life-long learning skills. Soft skills are also known as people skills or social skills and can be defined as the set of skills applied in the management of people interaction and being able to communicate effectively (Matteson, Anderson, and Boyden, 2016). Hard skills in contrast are technical skills (Laker and Powell, 2011) and lifelong-learning skills are a set of skills which enables an individual to facilitate future learning (Crisp, 2012). Such skills can be promoted through assessment (Matteson *et al*, 2016).

This study assesses the enhancement of self-learning through assessments methods implemented in the construction faculty of the University of KwaZulu-Natal. An assessment can be defined as the medium by which the intellectual skills of an individual is measured and developed on a particular area of study.This is vital for learners in construction programmes that look to graduate into the construction industry as it is a core contributor to a countries development not only structurally but economically (Harinarain and Haupt, 2016).

There is uncertainty as to the preparedness of graduates entering the construction industry (Haupt, 2009a, 2009b). As assessments are key to the development of learner skills, it is therefore important in efficiently preparing potential graduates for industry. Various approaches to assessment have been implemented in the university from standardised tests, assignments and exams to studio based learning whereby students are assessed through real-life industry related projects and presentations (Harinarain and Haupt, 2016). Below is a more comprehensive review on assessment within higher education.

2. ASSESSMENT: AN OVERVIEW OF STUDENT LEARNING

Assessment is a crucial part of not just higher educational institutions but educational institutions as a whole. It is the means by which student self-learning is measured and more importantly developed. Higher educational institutions regard assessment as key in obtaining its learning goals in addition to providing vital evidence of student learning for the purposes of accreditation. Assessment can be said to have a number of purposes, some of which are:

- To enhance student learning;
- To identify the strengths as well as the weaknesses of students;
- To analyse and evaluate the effectiveness of teaching and various teaching strategies;
- And to provide the collection of data for the purposes of bettering decision making in terms of student learning (Alade and Buzzetto-More, 2006).

Assessments are often assumed to be teacher controlled and not a task that students relatively look forward to. This conception requires a paradigm shift as assessments are vital in the learning process of students (Boud, *et al.*, 2006).

Involving the student in the process of assessment encourages student participation (Boud, *et al*., 2006). This active participation from the inception phase where learners may pick the material on which the assessment is based to evaluation phase where such learner is provided the chance to assess and judge not only their own work but that of their fellow colleagues, it better helps students identify short comings and therefore facilitating the pathway for future development (Boud, *et al*., 2006; Gibbs, 1992:17).

There are however challenges as not all learners are the same. There are intrinsic learners who require the need to know the relevance and importance of what is assessed and there are non-intrinsic learners who view assessments as an obstacle that is needed to pass. This learner does not seek the relevance of the assessment in real life situations and therefore a surface approach to learning is convenient for them whereas a deep approach is more suitable for intrinsic students (Dochy, Janssens and Struyven, 2005).

A deep approach facilitates learner activity interaction with others and incorporates an integrated assessment system where knowledge is required to be related to other knowledge (Dochy, *et al.*, 2005; Gibbs, 1992).

Constructive alignment is a principle which incorporates teaching methods and assessments in order to satisfy the learning outcomes/objectives which facilitates student learning. This principle is achieved by identifying transparent and precise learning outcomes; designing assessment tasks to effectively meet all the learning outcomes and by formulating suitable learning prospects for learners to get them to a point in which they may successfully commence assessment tasks (Biggs, 1999:11; Rust, 2002).

This paves the path for student-self learning and reduces the dependency on educators (Boud, *et al*., 2006). Self learning, also known as self-regulated learning is the ability of an individual to undergo a learning process without guidance (Zimmerman and Schunk, 2001). It is achieved through understanding how to learn without external aids in a way to pave the path for future learning (Kumon, 2017).

Self-learning can be promoted by assessment through the designing of assessment, peer-assessment and reviews, the latter allows the student to critically analyse his/her colleagues work and thereby aiding him/her to analyse their own work. Promoting self-learning skills is critical in producing industry prepared graduates (Boud *et al.*, 1999).

The design of assessments is probably the most critical step in the process of instilling self-learning characteristics among students as it is the first stepping stone that will structure and set the pace throughout assessment implementation of formative tasks right through to the summative tasks that sum up and evaluate a student's learning over the course of the module (Boud, Cohen and Sampson, 1999). Ultimately the goal of assessment is to develop skills and to equip the learner for self learning, this can further be enhanced through feedback (SAQA, 2008).

Feedback is a vital part in the assessment process, it lays the pathway in facilitating future learning. It must however be applied correctly, if not, it will lead to frustration for both educators and students. Students may become frustrated and view feedback as unhelpful, demotivating and unclear. In addition to this, although feedback may be given, learners are not provided with insight as what to do with that feedback and therefore creates a dead-end (Spiller, 2009).

In order to be effective for students, feedback must be provided within a reasonable timeframe, in a manner that is unambiguous and that clearly defines the areas in which a learner can undertake to improve his/her learning. However in considering this, it is up to the students to use that feedback otherwise educators are left frustrated (Duncan, 2007; Spiller, 2009).

Factors that could lead to educator frustration could be the failure of students to use feedback (Duncan, 2007). This is evident in future assessments that requires the application of such feedback in which learners fail to show signs of acknowledging the feedback originally given to them (Spiller, 2009; Taras, 2003).

There are however, many forms of assessment that one must consider before looking towards potential future solutions to the implementation of assessment as well as feedback given on them.

2.1 Types of assessment

2.1.1 Formative assessment

Formative assessment is defined as a formal, informal or non-formal method of assessment whereby results are recorded and count towards promotion marks. Formative assessment is used for the facilitation and development of future learning for students. This type of learning enforces current learning for the purpose of future learning is known as dynamic assessment. Learning for formative assessments may be quantified by examining student performances through summative tasks which relate to formative ones. (Crisp, 2012; SAQA, 2008).

2.1.2 Summative assessment

As defined by the national policy framework, summative assessments are that which conclude at the end of learning segments or programs and strictly evaluates and certifies the learning that took place in that programme. Summative assessment only presents itself formally and is measured through an accumulation of marks and this measure identifies improvements in learning (SAQA, 2008).

2.1.3 Integrated assessment

Integrated assessment is one that consists of theoretical written assessments in addition to practical demonstrations of competence to replicate authentic learning environments and in so doing adds value. This method of assessment determines a learners understanding through identifying the approach taken upon by a learner. Further defined by the South African Quality Assurance Agency integrated assessment incorporates both formative and summative assessments and which allows the learner to demonstrate applied competence (SAQA, 2008; Van Zyl and Massyn, 2008).

2.1.4 Diagnostic assessment

Diagnostic assessment is implemented before teaching and training to identify student weaknesses. The primary aim of diagnostic assessment is to identify gaps and deficiencies in learner understanding and also prior knowledge and skill levels. The identification of such elements are critical for the facilitation and development of future learning (Crisp, 2012).

2.1.5 Portfolio assessment

Portfolio assessment can be described as the organised collection of student's work which is able to act as evidence for such a student's learning. This evidence aims to provide students the opportunity for reflection upon their learning, therefore promoting self-learning (De Valenzuela, 2002). The above mentioned assessments are implemented and play a vital role across all levels of academia, including tertiary institutions such as the University of KwaZulu-Natal.

2.2 An overview of UKZN

The South African universities of government in 2004 was looking to introduce multidisciplinary institutions, in support of this vision the decision was taken upon to adjoin the then separate higher educational institutions being the University of Natal and the University of Durban Westville which were originally formed in the years 1910 and 1960's respectively. This merger formed what is now known as the University of Kwazulu-Natal (Haupt and Harinarain, 2016; UKZN, 2017).

The University of KwaZulu-Natal currently consists of five campuses, being, Howard College, Westville, Edgewood, Medical School and Pietermaritzburg. These campuses are responsible for four colleges which consists of 19 schools. The Construction Studies discipline is based at Howard College aand forms part of the school of Engineering (UKZN, 2017).

In the year 2014 the programme was relaunched. It is a three-year course which then branches into further areas of study for an Honours degree in either Quantity Surveying or Construction Management. Students can also pursue a Master's Degree by research and Doctoral degrees are further obtainable. (Haupt and Harinarain, 2016).

The undergraduate assessment in the Construction Studies discipline comprises of tests and/or assignments during the semester and a final examination. In the year 2017, the restructured Honours degrees in Construction Management and Quantity Surveying were offered. The Honours programme assesses learners through integrative assessments compromising of a number of assignments (dependent on the module) and a final assessment consisting of a portfolio and presentation. No formal examinations were conducted (UKZN, 2017). From a more broader perspective, the Univeristy as a whole implements an assessment policy to guide and enhance assessment design and application (UKZN, 2008).

2.4 Assessment at UKZN

The University of KwaZulu-Natal in the year 2008 produced the policy on teaching, learning and assessment with the aim "To enhance the quality of

learning, teaching and assessment practises and promote the autonomy of student learning". This stresses the importance the university holds with regards to assessment (UKZN, 2008).

UKZN ensures that assessment is designed to achieve learning outcomes of the relevant modules with the quality and standard appropriate at a tertiary level. Assessment must be provided in a way that is transparent, reliable, fair, consistent and practical and must be evaluated in a manner which is consistent (UKZN, 2008).

The university considers assessment in five forms being, mastery learning, criterion-referenced, norm-referenced, formative and summative assessments. These assessments must be utilized in an appropriate manner with sufficient and timely feedback from both educator and learner. Feedback given to learners can be given in a written format, orally, marking templates or in general to the whole class on a consensus established at the commencement of a course. (UKZN, 2008).

The university ensures that assessment enables students to engage in deep learning which is enquiry led as well as develop key competencies which promote the employability and responsibility of such students. In addition, assessment provided by the university must be established as reliable and viable in forming an integrated role of the learning process in a way which develops assessment. In support of providing assessment which promote these factors the university promotes staff development as well as the acquisition of exceptional course facilitators (UKZN, 2008).

Understanding of assessment criteria from a student's view point is vital and a tool that can be used to enforce this understanding is peer and self-assessment. This also promotes meta-cognitive development. Assessment must be applied in an integrated manner which is a vital part of maintaining exit level outcomes of a given qualification (UKZN, 2008).

3. RESEARCH METHODOLOGY

Taking upon a positivist approach which is one that is objective and quantitative, questionnaires were developed. Questionnaires provides a quick, simple and economical means to obtain data. questionnaires were utilised due to the large sample size being approximately 73 Construction Studies students. These qestionnaires utilised a 5-point Likert scale with response catergories of 1, 2, 3, 4 and 5, for "never", "sometimes", "often", "very often", "always" respectively.

The questionnaire begins to identify students understanding of assessment as well as the different types of assessment they were exposed to. It further goes on to establish the different approaches students undergo with regards to assessment. The questionnaire then seeks to establish the overall attitude of students with regards to assessment. The questionnaire developed obtained data regarding these aspects which was then analysed and interpreted.

4. DATA ANALYSIS

The data collected from the 72 students and analysed using SPSS version 24. Table 1 indicates the demographics of the students with the majority of the sample being male (61.6%) with a mean age of 20.

Table 1. Student profile

		No.	Percent
Year of study	4th	2	2.7
	3rd	26	35.6
	2nd	22	30.1
	1st	22	30.1
	Total	72	98.6
Gender	Female	27	38.4
	Male	45	61.6
	Total	72	100.0
Race	Coloured	1	1.4
	Indian	21	28.8
	White	4	5.5
	African	46	63.0
	Total	72	98.6
Age	Mean	20.12	

Cronbach's alpha was used to assess the internal reliability of the scale. The Cronbach Alpha was 0.845 indicating good internal reliability (Pallant, 2013). The questionnaire was therefore considered to be reliable and representative of what is to be measured.

Table 2 indicates that 77% of the students considered that the assessment within the discipline promotes self-learning (M=3.86, SD=1). Whereas only 58% of the students felt that assessments were designed with the sole purpose of measuring their learning. 75% of the students believe that assessment within the Contruction Studies discipline improves their future learning and is designed with the sole purpose of enhancing their learning. Only 64% of the students were able to identify the different types of assessment given to them, while 67% felt that the assessments mapped out all the learning outcomes they were meant to obtain in the module.

Table 2. Students understanding of assessment

Students understanding of assessment	Mean	Std. Dev.	Rank
Assessment within the Construction Studies discipline promotes self-learning	3.86	1.011	**1**
Assessment within the Contruction Studies discipline improves my future learning	3.83	0.949	2
Assessments are designed with the sole purpose of enhancing my learning	3.83	0.787	3
I am able to identify types of assessment when I am given them	3.69	0.944	4
Assessments map out all the learning outcomes I am meant to obtain for a module	3.61	0.943	5
Assessments are designed with the sole purpose of measuring my learning	3.54	1.061	6

Examinations are the main form of assessment for 69% of the students. This shows that the Construction Studies discpline uses examinations as their preferable method of assessment as opposed to assignments, tests and presentations. Only 22% of the students were required to produce a portfolio for assessment. This shows that portfolio is not extensively used among undergraduate students of the Construction Studies discipline. More emphasis placed on portfolio assessment will enhance self learning through students self-reflection of their work (De Valenzuela, 2002). Only 46% of the students acknowledged that their lecturers knew that they were not at the same level of knowledge in their learning.

86% of the students used feedback from their past asessments to improve their approach to future asessments. Majority of the students (83%) felt that feedback improved their approach to future assessment. This shows that feedback has a tremendous effect on the growth of a students learning, however, only 47% of the students discussed their feedback with their lecturers, whereas 67% discussed their feedback with their peers, this indicates that feedback given by peers plays a more active role. Fifty seven percent of the students did not believe that they received prompt feedback.

Table 3 discusses how self learning can be promoted through assessment. Ninety six percent of the students felt assessment within the Construction Studies discpline promotes the acquiring of additional information independently. Eighty seven percent of students had to conduct further research or go beyond the lectures given in order to expand on the material for the module. Further, 63.2% of the students felt they were required to undergo learning on their own without lectures. This indicates a strong support for the promotion of self-directed learning.

Table 3. Students understanding of assessment

Students understanding of assessment	Mean	Std. Dev.	Rank
Assessments require me to find additional knowledge and information on my own	3.93	0.852	**1**
Modules require me to go beyond the lectures given to expand on such material	3.74	0.987	2
I was required to learn on my own without lectures	3.12	1.299	3

5. SIGNIFICANCE OF STUDY

Since the reinstatement of the Construction Studies discipline of UKZN, traditional methods of assessment were originally implemented in its first year. This method had not been affective in the promotion of self-learning resulting in a studio-based methodology being implemented in the next year. This method did promote self-learning, however, was halted due to student protest among other reasons. Currently, an integrative approach is being implemented. The Construction Studies discipline has gone through numerous assessment methodology changes in the aim of seeking self-learning. In the light of such events, this study seeks to provide additional insight into achieving student self-learning.

6. CONLUSION

This study set out to provide additional insight into enhancing student self-learning through assessment. Considering that the Construction Studies discipline has gone through numerous assessment methodological changes over the past 4 years with the aim of promoting self-learning, this study aids in this objective through assessing the understanding that students have of assessment and its application witin the Construction Studies discipline.

This study showed that UKZN does provide assessment which promotes self-learning. Modules structure assessment in a way that encourages the learner to undergo learning on his/her own. There are however improvements left to be made in support of enhancing self-learning through assessment. Areas such as providing prompt feedback and the implementation of portfolio assessment being such improvements.

This study does have limitations. It lacks qualitative data to explain the quantitative data. This study only considers quantitative data obtained from first year to fourth year students in the UKZN Construction Studies discipline. Therefore, future studies should conduct a more in-depth study using qualitative methods as well on an expanded sample including postgraduate students and lecturers.

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Exploring Tertiary Education Trust Fund Projects Success Delivery in the Ahmadu Bello University, Zaria-Nigeria from Stakeholders Perspectives

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Abstract

Purpose of this paper
The triangle of cost, quality and time has traditionally been used to assess the success of construction project. Project stakeholders with varying influence and power, plays major roles in the success or failure of the projects. Hence, assessing project delivery success through stakeholders is essential to ensure the achievement of the project goal. This paper examined the success of TETfund projects executed in Ahmadu Bello University, Zaria between 2009 – 2011.

Methodology
This paper examined the success of TETfund projects executed in Ahmadu Bello University, Zaria between 2009 – 2011. Field survey was carried out by studying projects documents, distributing questionnaires to the project stakeholders and use of a checklist. Twenty-five (25) questionnaires were administered and twenty-two (22) questionnaires were appropriately filled having ninety- six percent (96%) response rate.

Findings
Research findings indicated that, factors such as the delay in progress payment, escalation in price of materials, insufficient supply of materials

and the technical skill of the project leader are ranked first among the militating against the success of the projects. Furniture, structural stability and ventilation were the highest ranked in terms of satisfaction by end users.

Value of paper
The paper identified potential areas for improvement to achieve the successful delivery of projects. The project stakeholders will be aware that the clients is not getting the full value for the investment made.

Keywords: End users, Project stakeholders, Project delivery.

1. INTRODUCTION

The construction industry is dynamic in nature due to the increasing uncertainties in technology budget and development processes (Muhammad *et. al.* 2008). Construction project development involves numerous parties, various process, the different phases and stages of construction and a great deal of input with the aim being to conclude the project successfully (Takim and Akintoye, 2002). The common assessment of the construction project is that, they are delivered on time, to budget and technical specification (Takim and Akintoye, 2002) ; (Wai, 2002). However, a project delivered on time, within budget and meets performance specification may not be well received by the client (user) for whom it is intended (Mohammed *et. al.,* 2008). This may be the reason why researchers are proposing for the introduction of new project success measures such as stakeholders and client satisfaction assessment (Samiaah *et. al.,* 2010). This aligns with (Roshana and Hamimah, 2008) opinion who noted that, the two possible criteria which could be used to measure the success of a project is customer and stakeholders satisfaction. Hence, for a project to be termed successful, end users input and satisfaction will be central to such assertion. A stakeholder is an individual or group inside or outside the construction project which can influence the project performance (Takim and Akintoye, 2002). For the purpose of this research, the stakeholders considered are: contractors, consultants and end users. The aim of this paper is to assess the success of project delivered from the stakeholders and users perspective in the Ahmadu Bello University, Zaria-Nigeria.

2. REVIEW

2.1 Project delivery

A project phase spans from the start and finish stages. Saidu (2016) noted that a project delivery phase includes: design, planning, construction and finishing phases. Assaf and AL-hejji (2006) submitted that challenges that might inhibit project delivery are not limited to inadequate planning and scheduling, insufficient experience, altering of the project scope, divergent views in the co-ordination and communication between stakeholders and time-consuming information flow pattern between the stakeholders. Yang and Peng (2008) puts forward that client's demand for a project to be delivered as scheduled, within stipulated time and required quality should be in line with contractual duties, obligations and responsibilities. Shehu and Akintoye (2010) found evidence in their study that the major challenges to project delivery in the construction industry are:

i. Non commitment from project management team
ii. Lack of proper coordination by relevant stakeholders
iii. Inadequate knowledge relating to portfolio and risks management techniques.
iv. Lack of cross-sectional communication
v. Lack of adequate techniques to measure project success and
vi. Financial constraints.

Mallak et al. (1991) explained that satisfying all the stakeholders in a project will be a herculean task due to varying influence each stakeholder exerts. They further submitted that the differences that exist between these groups will not guarantee a uniform satisfaction. The unique nature of a project makes it challenging to effectively evaluate the extent at which it is success (Anderson et al., 2006). A way out of these discrepancy was explained by Bandar (2011) that to ensure overall success in the projects delivered, relevant stakeholders should make sure the total project cost is completed within planned budget, time and required client`s satisfaction. Al-Sedairy (1994) noted that having a conflict between stakeholders is a norm when managing a project. Bandar (2011) agreed with Al-Sedairy (1994) but cautioned that the conflict should not have a negative impact on cost, time and quality of the project. The inability to deliver a project as planned might occur at any stage of the project life cycle. Chan and Kumaraswamy (1997) found evidence in their study that the project delay occurs at the construction phase of a project life cycle. Lim and Mohamed (2000) attributed this challenge to insufficient planning at the initial stage of the project. Koushki et al. (2005) offered an analysis on project delivery challenges in their study. They discovered that it is paramount to engage the services of knowledgeable and seasoned contractors, seek the services of competent supervisory team as consultants to plan, design and

monitor the project against over run for a client to derive satisfaction for funds invested in a project.

2.2 Project Stakeholders

PMI (2004) defined project stakeholders as "individuals and organisations that are actively involved in the project, or whose interest may be affected as a result of project completion". The stakeholders often wield influence over the project's objectives and success. González et al. (2014) submitted that project performance by the project team have been below satisfaction to clients and end-users. In their study on project delivery in Malaysia , Alaghbari et al. (2007) found out that improper coordination between relevant stakeholders can negatively affect a project success. Emuze (2012) offered an analysis of poor project performance in South Africa and concluded that to address the challenge poor performance, it will be paramount for the project stakeholders to deplore appropriate mechanism for making decision so as to achieve and improve on the project success. Randolph (2012) proposed the followings steps to adequately manage stakeholders:

- Building a strong and lasting relationship between the host, where their views, interest and aspiration are understood;
- Establishing of the robust mechanism which guarantees regular information flows across levels for effective communication between various stakeholders;
- Assessing situations holistically, where by information collected will be jointly viewed between relevant stakeholders.
- Hearing the various stakeholders to express their views, aspirations and challenges;
- Studying and understanding the groups dynamics that might exist in order to allow each stakeholders involved to express, dissatisfaction and other discomfort that can be resolved effectively.

2.3 End users

These are individuals who will put a project to use continually on a day to day basis. Anderson *et al.,* (2006) believed that one of the most important factors for a success is the user satisfaction since the project idea was conceived solely for them. Alinaitwe *et al.* (2007) emphasised that end users` quality satisfaction is a critical factor for examining construction project performance. Furthermore, they also highlighted that a number of projected hand over by contractors to clients often perform below expectation which was attributed to the poor project management delivery. However, Barrett and Baldry (2003) noted that only a very a small number of business cooperation's seek to understand if the projected delivered

meet up with their level of satisfaction. This assertion was further supported by Danny (2003) that major decisions regarding project success was handed over only to the project delivery team. Data and information that emerges from end users assessment will be very important for consecutive projects. Buys (2004) opined that end users feedback collection is important, since the users will be the closest to the building providing them with a firsthand information on the needs and required maintenance. The reason for the non utilisation of end users feedback was provided by Leaman (2004) as the defensive nature of project delivery team so as not to paint them in bad light or even determine their inefficiency. End users operational and maintenance result will enhance making important decisions that will be beneficial to enhance building performance data considering current times of high and increasing costs of operation, growing competition and increasing user-expectations (Emuze, 2012). Amaratunga and Baldry (2002) observed that the utilisation of users to evaluate project performance have often been used in America, Asia and European continent. They further stated that there is paucity of research from the African continents particularly relating to evaluation of projects in the higher education domain. Emuze (2012) highlighted the following as criteria for user satisfaction ;

- Functionality
- Accessibility
- Productivity
- Aesthetics
- Cost effectiveness
- Health safety and security
- Flexibility and adaptability

3.0 Research approach

Survey design was employed for the study using questionnaire as a tool for data collection form consultant, contractors and end users of the project. Purposive sampling was used to distribute questionnaires to various stakeholders of the projects due to time saving and cost efficiency advantages. The clients representative comprises of unit heads in architecture, quantity surveying and civil engineering departments. A cover letter was designed specifically for the research to guarantee respondents anonymity so that they will respond appropriately and candidly. A total number of twenty-five (25) questionnaires were administered and twenty-two (22) numbers filled appropriately and within the stipulated time having ninety six percent (96%) response rate was recorded. The project reviewed were project completed between 2009 – 2011. For the study, a 5-point Likert scale was adopted to seek information from respondents where:

1= Strongly disagree,
2= Disagree,
3= Neutral,
4= Agree and
5= Strongly agree.
The Likert scale was transformed to Mean Item Score (MIS)

3.0 Findings and discussion

3.1 Stakeholders Satisfaction

Table 1: Stakeholders Satisfaction

S/no	Project Stakeholders Satisfaction	(MIS)	Rank
1.	**Contractual Relationship**		
i.	Communication system between project participants	3.1	2nd
ii.	Communication between project stakeholders	3.6	1st
iii.	Control mechanism of project activities	2.8	3rd
2.	**Consultants Related Factors**		
i.	Consultants commitment to ensure construction works are done according to specification	3.2	2nd
ii.	Consultant co-operation to solve problem	3.6	1st
iii.	Consultant commitment to monitor project progress	2.8	3rd
3.	**Contractor Related Factors**		
i.	Project team leader commitment	3.2	2nd
ii.	Project team leader capability to adapt to changes in project	3.2	2nd
iii.	Project team leader early and continuous involvement in the project	3.0	4th
iv.	Motivating skills of the project team leader	2.8	5th
v.	Technical skills of the project team leader	3.4	1st
4.	**Client Related Factors**		
i.	Client emphasis on low construction cost	3.2	2nd
ii.	Client ability to make project decisions	2.8	4th
iii.	Client ability to brief the project objective	3.4	1st
iv.	Client interference during construction	3.2	2nd

Source: Field work (2016)

Table 1 depicts the level of stakeholders` satisfaction with the projects. It can be observed that in terms of contractual relationship there is proper communication between the project stakeholders ranked 1st with a mean score of 3.6. For consultant related factors, consultant cooperation to solve

problem and consultant commitment to ensure that, construction work are done according to specification were ranked 1st and 2nd respectively with a mean score of 3.6 and 3.2 respectively. In contractors related factors, technical skills of the project team leader was ranked first with a mean of 3.4 while motivating skills of the project team leader was ranked 5th with a mean of 2.8.For client related factors, client ability to brief project objective was ranked 1st with a mean of 3.4 while client ability to to make project decision was ranked 4th with a mean of 2.8.

3.2 User Satisfaction

Table 2: Client (End user's) Satisfaction on the Elements of Work in the Projects

S/no	Elements of Works in the Projects	(MIS)	Rank
1	Toilets facilities	4.4	4th
2	Floor tiling	4.4	4th
3	Painting	3.2	8th
4	Doors and windows	3.8	7th
5	Structural stability	4.6	1st
6	Ventilation	4.6	1st
7	Electrical fittings	4.4	4th
8	Furniture	4.6	1st
9	Spatial environment	2.2	9th

Source: Field Survey (2016)

Table 2 shows the level of user satisfaction on various elements of work in the projects executed. From the result it can be seen that, structural stability, ventilation and furnishing were ranked 1st with a mean score of 4.6. toilet facilities, floor tiling and electrical fittings ranked 4th with a mean score of 4.4. the element of works with the least ranking are panting, doors and windows with a mean score of 3.2 and 3.8 respectively. This means that, the users are mostly satisfied with the structural stability, ventilation and furnishing.

3.3 Factors Militating Against the Success of the Projects

Table 3: Factors Militating the success of the Projects

S/no	Factors	(MIS)	Rank
1.	Escalation of materials price	4.6	1st
2.	Insufficient supply of materials	4.6	1st
3	Quality control of materials	3.2	8th
4	Motivating skills of the project team leader	3.6	7th
5	Consultant commitment to ensure that construction work is done according to specification	3.8	6th
6	Delay in progress payment	4.6	1st
7.	Project team leader experience	4.4	5th
8	Technical skill of the project team leader	4.5	4th
9	Overall management actions	4.4	5th
10	Economic environment	4.4	5th

Source: Field Survey (2016)

Table 3 shows the factors that mitigate the success of the projects. From the result, delay in progress payment, escalation in materials price and insufficient supply of materials were ranked 1st with a mean of 4.6. Quality control of construction materials was ranked 8th.

4.0 Conclusions

i. Delay in progress payment, escalation of materials price and insufficient supply of materials are the factors mitigating the success of the projects
ii. Users are satisfied with structural stability, ventilation and furnishing in the projects.

5.0 Recommendation

i. Progress payment should be made to the contractors without delay at different stages of the projects in order to keep the project moving.
ii. Consultants should carefully monitor the progress of the projects in order to ensure that, the users are fully satisfied with all elements of work

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Good-To-Great Concept: A Novel Approach for Addressing the Skills Gap in Architectural Design Firms in Developing Countries

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ABSTRACT

Purpose

This paper aims to report on the role of Good-to-Great approach for addressing the skills gap in Architectural Design Firms (ADFS) in developing countries.

Design/methodology/approach

In order to achieve this aim, a research methodology is designed to accomplish three objectives.

- Building a comprehensive background about the topic through covering Skills gap in the construction industry and ADFs; including definition and complete background information, previous approaches used to address this issue, good-to-great as a concept to enhance ADFs performance.
- Presenting and analysing two case studies to investigate the role of adopting good-to-great concept as an approach to fill skills gap towards enhancing performance of the construction industry and ADFs.

- Investigating the perception and application of Good-to-Great concept for addressing problem of skills gap towards enhancing the performance of the construction industry and ADFs.
- Outlining research conclusion and recommendations useful for ADFs.

Findings
Skills gap issue threatens all types of industries, especially the construction industry. The demand of ADFs became greater than the supply of skilled employees which indicates a critical issue that encounters different ADFs. Therefore, good-to-great concept was proposed which has never been adopted in ADFs before which will be a unique approach to tackle this issue.

Research Limitations
This research focuses on tackling skills gap issue in ADFs and the construction industry, yet this issue has other impacts and causes that are not discussed in this research.

Practical Implications
Incorporating Good-to-Great concept to fill skills gap will enhance the performance of Architectural Design Firms.

Originality / Value
This research is targeting an important issue in ADFs in Egypt and other developing countries which is skills gap.

Keywords: Architectural Design Firms, Good-to-Great Skills Gap, Performance Management.

1 Introduction

The main approach of any organisation is to achieve its objectives, while maintaining the satisfaction of its employees and customers. However, there is a major shortage in skilled employees' due to lack of motivation, development, along with their need to have a stable income even if they are not satisfied in their jobs. The Construction industry as whole suffers from skills gap issue. As a result of this, the architectural department is suffering as well. Skills gap has a crucial impact on the organisation performance and competitiveness (Paauwe & Boon, 2009). Therefore, skills gap is an issue that needs to be clearly understood, as it is a reason for many organisations' failure and non-competitiveness in a business environment. Literature review showed that different approaches have

been discussed in this area by different researches; for instance, Callejia is discussing the skill shortage issue and is trying to solve this issue by increasing the supply of workers, but unfortunately the results are not as good as required (Calleja, 2016). The reason for the unsatisfying results should be understood, increasing the supply of workers is not difficult as the mission of attracting qualified employees who perfectly fit for the required position. Nonetheless, another study is trying to solve this issue by increasing employees training (Morris, et al., 2016). Training employees is a good idea; however, it has its drawbacks and in some cases forbidden employees from leaving work even if they found better opportunities, so that they do not use trained skills in any other place. Thus, another solution is argued to tackle skills gap issue which is Good-to-Great. Good-to-Great is applied in different fields in particular business, yet it is never argued within ADFs. It is new approach aiming to increase the competitiveness of ADFs in market place through bridging skills gap.

2 Research Objectives and Methodology

To achieve the above mentioned aim, a research methodology consisted of literature review, case studies and survey questionnaire is designed to accomplish four objectives:

a) Building a comprehensive background about the topic through covering: skills gap in the construction industry and ADFs; previous approaches used to address this issue, good-to-great as a concept to enhance ADFs performance and performance management.
b) Presenting and analysing two case studies to investigate the role of adopting good-to-great concept as an approach to fill skills gap towards enhancing performance of the construction industry and ADFs.
c) Investigating the perception and application of Good-to-Great concept for addressing the problem of skills gap towards enhancing the performance of the construction industry and ADFs.
d) Outlining research conclusion and recommendations useful for ADFs.

3 Literature Review

3.1.1 Overview of the construction industry

3.1.2 Definition

The Construction industry is mainly concerned with the development of projects and infrastructure facilities that fulfil the need of the community and

achieve the sustainable development objectives. In addition, it is linked to the maintenance and refurbishment of existing buildings. Moreover, it is one of the critical sectors in the economic development of any country (OECD, 2008). Nevertheless, unlike any other industries the construction industry does not adapt quickly to new technology (Castagnino, et al., 2014). As a result, the productivity level of the construction industry is poor if compared to other industries. The Construction industry is different from other types of industries (Szymanski, 2006). Each construction project has its own nature, scope, location, workers and parties (Oladinrin, et al., 2012).

3.1.3 Characteristics of the construction industry

The construction industry is not similar to any other type of industries. It has a major impact on the economic growth of all nations (OECD, 2008), and one of the economic pillars. The characteristics of the construction industries are divided as follows, output, size, client, nature of the construction work, the limitations of technology usage, complexity, safety, immobility (Nam & Tatum, 2006), costliness, and the human capital (Paauwe, 2009). The output of the construction industry such as houses, offices and roads must be long-lasting and durable. Moreover, studies showed that approximately 30% of people working in the construction industry across a nation. Unfortunately, 1 in 5 workers, die in the construction work (Sharpe, 2016).

3.1.4 Economic and Social Contribution of the construction industry

The Construction industry provides people with shelter, employment chances and infrastructure (Oladinrin, et al., 2012). Thus, it has an important role in accelerating the country's economic and social growth. However, this role varies from one country to the other (Shah, 2005). As for developing countries, the construction industry provides, new housings, schools, hospitals and infrastructure (Khan, 2008). Whereas, in the developed countries, the construction industry mainly provides repair and maintenance because the houses and other building construction is more developed than that of developing counties (Ruddock, 2009). Fox and Skitmore (2002) suggested that there are six factors tha*t* can be either drivers or barriers to the construction industry, such as, resources, culture, behaviours, policies, technology, and availability of human capital.

3.2 Overview of Developing countries

3.2.1 Definition

There is a major difference in social and economic development in developed and developing countries. Developing countries are defined differently, for instance, by United Nations (UN). According to the UN (2012), developing countries are countries with low living standards, undeveloped industry and low to moderate human development. Low and middle incomes economics are referred as instance, Libya and China. Libya has high income rate but it is considered as a developing country (Wells, 2006).

3.2.2 Characteristics of Developing Countries

As mention by Tri (2013), those countries are mainly characterised by being predominant in subsistence farming, unstable economic statues, inefficient infrastructure, and scarcity in skilled people, poor agriculture and costly transportation. Moreover, most of the developing countries suffer discrimination.

3.3 Skills gap in the construction industry

Skills gap is an issue that threatens the success of organizations (Sitek, 2012). Skills gap is the gap between what are the skills needed by the organizations and what are the available skills (JP Morgan Chase and Co, 2014). Some leaders understand the importance of bridging skills gap and consider it one of the top pressing concerns (Aring, 2012). Moreover, in both developed and developing countries skills gap is a barrier to industries growth, innovation, delivering service and product on time, meeting the quality standards and meeting economics and social requirement (Aring, 2012). Closing the skills gap has a direct connection with improving productivity, human development and economic growth (Aring, 2012). The latest studies reported that the construction industry needs to recruit an average of “44,690” workers yearly. (Scheme, 2016). In addition to, other studies reporting that 82% of managers believe that there is a remarkable skills gap in construction industry (Barnes, 2013). However, the construction industry is reliant on workers, which is increasing the issue (Martin, 2016). Mainly there are two types of skills gap skill shortage and skills mismatch.

3.4.1 Skills Shortage

Skill shortage mainly appears when there are not enough people with skills to meet construction industry demands; skill shortage makes it harder for a manager to find employees with suitable skills.

3.4.2 Skills mismatch

On the other hand, Skills mismatch is also an issue in the construction industry. Skills mismatch is the gap between the skill the employee has in his work and what the firm demands. Skills mismatch is when the employees have skill and do not use them but agree to work under any condition (Richardson, 2006).

3.5 Good-to-Great Concept

Good-to-great is concept trying to implement different techniques in order to solve ADFs skills gap problems. Good-to-Great mainly has seven different concepts that of applied will turn a company from. Good-to-Great covers all the issues that all different types of industries might suffer from. And applies 7 simple rules if followed all issues will be fixed especially skills gap. For this reason, only little can be great there are no great industries, schools or governments, there are just good ones.

1. “Level 5 leadership”: the good-to-great leaders has a sophisticated blend of a “professional will” and “humility”. Great leaders are humble.
2. “First who, then what”: the good-to-great leaders have the right people in the organization, the wrong people out. They put the right people in the right positions and then they figure out together where the organization needs.
3. “Confront the Brutal Facts and Never Lose Faith”: the good-to-great leaders face the real current situation, yet have faith they can achieve the best.
4. “The Hedgehog concept”: In this phase people are categorized into two groups:
    - Foxes
    - Hedgehogs

Foxes want to reach many things at the same time which makes things very complex. However, hedgehogs do not complicate things, but instead the organize their ideas in something basic that guides everything easily.

5. “Culture of Discipline”: combine ethics of starting work with discipline will help in having great performance.
6. “Technology Accelerators”: the good-to-great leaders do not use technology as a primary method of the industry, but they are the ones who choose the technology carefully.
7. “The Flywheel and the Doom Loop”: in this phase, good-to-great leader motivate people, enhance them and increase their passion towards work. Great leaders never kill the employee’s motivation (Collins, 2001).

3.6 The relationship between skills gap and good-to-great concept

Skills gap is an issue that mostly all organisations suffer from especially the construction industry and ADFs. There are two types of skills gap. Skills shortage and skills mismatch. Good-to-great concept has 7 main concepts

that work to solve the skills gap issue. Any industry begins with a leader the leader is the main key of any industry. When the leaders have the level 5 skills, then the employees' right employees should be chosen to fill the right places. When the right people are put in the right places the skills gap is automatically solve. Leaders must understand that if the job is empty and the doubt the skills of the employees it is better to leave this place empty. Nonetheless, leaders must be similar to hedgehogs have a clear plan to guide all people. They must also know what are the drivers for all employees and what are they passionate about. Moreover, they understand that technology is just an accelerator not the pioneer of the industry. Finally, leaders must follow the flywheel and keep moving the organisation forward. All the mentioned above concepts if applied in the correct way skills gap issue will be vanished.

4 Case Studies

4.1 Bethlehem Steel Company

4.1.1 Company background information

It is also known as Bethlehem Rolling Mill and Iron Company, or Saucona Iron Company, located in America. Bethlehem was the second largest steel producer in America. However, it decayed for 22 years due to the world bankrupt (Bethlehem-Steel-Mill, 2010).

4.1.2 Skills gap issues faced

- Limited skilled labour.
- Future Planning.
- Management Skills.

4.1.3 Techniques used to solve the skills gap issue

- Increasing benefits.
- Changing design.
- Replacing machines with people.

4.1.3.1 Increasing benefits

Bethlem company wanted to increase its production and remain one of the largest steel producers. However, unfortunately it decayed, although it provided its workers with different facilities such as paying their children college fees, having executive clubs renovated by Bethlehem, and elevating them to an elite status. Yet, the employees went to the company to fight for positions rather than working to achieve the plans of the company. Thus, the gap continued increasing.

4.1.3.2 Changing the design

The CEO of the company changed its design. He made the design in a complex way to accommodate a large number of vice presidents, along with two windows in each room, so they can have the desire to come with new design. Yet, they kept on concentrating on positions to gain more benefits without doing their jobs with the needed skills.

4.1.3.3 Replacing people with machines

Finally, the company started using technology. Technology had a major role in accelerating the production of mini-mills steel in the company. However, due to the labour issues, the company was not able to continue in its success, because the reason behind the success of any company was a good management system along with a great leader; moreover, workers are always the most valuable asset of a company and without having good workers, technology will not be able to improve the situation of any company without qualified workers.

4.1.4 Recommendations

- The manager must be able to lead correctly and make a team that will help him to lead.
- There must be future planning and red flag mechanism to reduce the rate of facing fatal issues.
- The leader must be able to align the organisation's need with the employees' needs, without putting anyone at the expense of the other.
- Leaders must understand that technology is only be an accelerator of the work not its creator.

4.2 Case Study two: Nucor Corporation

4.2.1 Company Background information

Nucor Corporation located in America was one of the contributors of the Good-to-Great concept. Ken Iverson is one of the 11 great leaders all over the world, he was able to make Nucor to turn the company from bankruptcy to be a great company (Nucor-Corporation, 2016).

4.2.1 Skills gap issues faced

- Limited skilled labour.

4.2.2 Techniques used to solve the gap

- Changing the place of the company.
- Apply the seven good-to-great concepts mentioned by Jim Collins.

4.2.2.1 Changing the place of the company

The leader changed the place of the company to be near to the farmers who wanted to work and had the ability to perform the work by the needed skills and work with passion.

4.2.2.2 Applying the seven good-to-great concepts mentioned by Jim Collins

The leader was able to turn the company from being good to being great by applying the seven techniques of success. Moreover, he was able to make it the largest steel production company.

4.2.3 Analysis

Nucor applied the seven concepts of the good-to-great concepts successfully. Nucor, as well, faced the same issue of “cheap imported steel”. Yet, in Nucor Iverson mentioned that the “first, second, and third reason was “Management”.

5 Data Analysis

Results of the survey questionnaire conducted by the authors of 28 architectural design firms in Egypt to investigate their perception and application of the good-to-great concept into the ADFs as an approach to bridge skills gap.

- The main driver of the good-to-great concept adaption is addressing the skills gap.
- Skills gap is an issue that most ADFs are suffering from.
- Good-to-Great concept is not widely applied in ADFs.
- Good-to-Great concept can be an innovative tool to tackle the skills gap issue.

The different specializations of the surveyed ADFs along with the different opinions and knowledge of the respondents helped in covering different aspects skills gap and the good-to-great concepts in different types of Architecture firms.

1. Skills gap
    - 62% Stated that they are aware of the skills gap issue.
    - 89.3% of the respondents stated that their firms suffer from skills gap.
    - 49.3% responded that degree of skills gap found in their firm is high.
    - 53.6% responded that the main reason for having of the skills gap is continuously changing the goals of the firm, or in other words not having a clear plan for what the firm wants.
    - 82.1% of the respondents argued that they apply training strategies as an approach to overcome skills gap, which is completely

opposite the proposed solution, yet it is mainly the most common approach.

2. Good-to-Great
   - 21.4% were aware of the good-to-great concept, which is a small percentage, therefore, this concept need to be taught.
   - 82.1 % responded that they are willing to know more about this concept which opens a door for learning and know more about this concept, for instance by providing lectures or learning sessions teaching how to start applying this concept.
   - As for the hypothesis, 78.6% responded that this hypothesis is highly effective, and that applying the Good-to-Great concept is an effective tool to addressing the skills gap in ADFs.

6 Conclusions and Recommendations

Having reviewed literature review and case studies and keeping in mind the results of the survey questionnaire, the research comes to the following recommendations.

6.1 Recommendations for Design Firms

- Skills gap must be properly identified and clearly understood.
- If skills gap issue is tackled, the performance of firms will be enhanced.
- Integrating the good-to-great concept in the ADFs from their start will help in not facing the skills gap issue.
- Good-to-great concept has several techniques if applied in the right sequence they will vanish the skills gap issue completely.
- The good-to-great concept must be spread widely among firms in the construction industry.

6.2 Recommendations for the Government

The government plays an important role in enhancing the adaption of unique and innovative techniques, which will help in addressing the skills gap issues and provide true work opportunities. Therefore, the government need to ease the process giving the upcoming generations different work opportunities to help them find what they can be the best at which will have a direct impact on decreasing the skills gap issues percentage.

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ICT in the Training of South African Bricklaying Operatives: A Pilot in the Greater Johannesburg Area

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ABSTRACT AND KEYWORDS

Purpose of this paper
To investigate the use of ICT in training bricklayers in South Africa.

Design/methodology/approach
In order to achieve this aim, a review of literature, complimented with a survey was undertaken. Participants were selected purposively, including managers of training organisations and trainers in the greater Johannesburg area. The survey was used to investigate the implementation of ICT in training bricklayers.

Findings
While literature shows that ICT is being successfully used in skills training in other fields and to some extent in the construction field, there seems to be very little effort towards the use of ICT in skills training for bricklayers in South Africa. Cost and other knowledge related factors seem to be more prevalent challenges.

Research limitations/implications (if applicable)
Major limitations were due to the difficulties in finding training organisations willing to participate and consequently the low numerical strength of trainees who were surveyed.

Practical implications (if applicable)
Considering the usefulness and potential in utilising recent technologies for training operatives, there needs to be more attention in that area, especially for areas of skills shortage such as bricklaying. It was worthwhile to explore ways of encouraging and incentivising the growth of ICT utilisation in training of operatives.

What is original/value of paper.
The study explores the use of ICT as a vehicle for much needed skills acquisition in the construction industry. The study provides a leap-board for additional research on issues concerning the use of potential in recent digital technologies and automation for training and upgrading the skills of operatives and management personnel in the construction industry.

Keywords: Bricklaying, ICT, skills, training, TVET, South Africa

1. INTRODUCTION

In South Africa there are historical factors that have led to an impediment in skills training and skills transfer to operatives and artisans (McGrath, 2011). As such currently skills-training in South Africa has yet to be delivered to a substantial level where operatives are being produced to meet the demand of the country (Construction Industry Development Board (CIDB), 2007). Currently the artisanal, technical and professional fields need to achieve 30 000 certified artisans per year by 2030 (Department of Higher Education and Training (DHET), 2013).

Attempts by the South African government to implement policies that encourage the construction sector with regard to skills training have not produced the desired results. This is regardless of the fact that potential employers can establish desirable requirements which become part of the qualifications in the National Qualifications Framework (NQF), for trades. Unfortunately the Sector Education and Training Authorities (SETA's) are perceived to have underperformed despite receiving rigorous auditing (Allais, 2012). This includes the Construction Education and Training Authority (CETA) (CIDB, 2007).

A common transferable skill such as bricklaying in South Africa seems to have been neglected to the point that it is stated as one of the scarce skills in the construction industry by CIDB (2007). Unlike other countries there is no clear and standardised formal training required by the private sector with regard to bricklaying.

In countries such as the UK, formal training methods have been adopted with the additional adoption information technologies to enhance the training of trade entrants. Such investments are credited with producing satisfactory results (Clayton, 2014). The implementation of Information and Communications Technologies (ICT) is not new to the world of education and training. They constitute versatile tools that are specifically important to

Technical & Vocational Education & Training (TVET) (Maclean & Lai, 2011).

However anecdotal evidence suggests that current training methods for bricklaying rely on the expertise of trainers, and their experience in the context of South Africa. This would pose a problem as various trainers will have different aptitudes, experiences and levels of understanding regarding their career. Learners will also be differentiated in their skills that are acquired.

The allegation stated above seems to be supported when considering the success rate of participants in South Africa's TVET college system. For example recently in Gauteng, success rate of participants was recorded as 28.7% for any course at (NC(V) level 2) (DHET, 2015). This suggests a need to improve processes for better outcomes. There is no clear evidence that the dismal results are largely due to training methods and lack of technology infusion. Nevertheless ICT enhancement of training delivery is one of the ways that improvements have been achieved elsewhere, as recorded in (Clayton, 2014).

2. LITERATURE BASIS FOR THE STUDY

In the construction industry there are several levels of skills, ranging from the highly specialised professionals level to site operatives (Kikwasi, 2011). Site operatives perform the physical work of construction and account for more than half of project cost, as labour (Fatonade, 2014).

TVET is a major channel for addressing the skills shortage with direct relevance to the construction sector. However in Africa, it has a number of challenges such as shortage in staff and inadequate trainers (Chimpololo, 2013); sustained population growth (UNESCO, 2015); and the need to decentralise responsibility for providing TVET education and incentivise the private sector to participate (McGrath, 2011). In addition e-Learning and its associated ICT tools have gained importance in the methods of skills training in all industries. The construction industry has been notably slow in the adoption of ICT in its skills training methods. Regardless there is an identified need to improve construction education and training by integrating the developments in digital simulation, modelling and other such technologies (Goedert et al., 2011).

In addressing challneges to trade and technical skills training delivery, several authors have highlighted the relevance of the adoption of information and communication technologies (ICT). Authors include (Chimpololo, 2013) on shortage of skilled labourers in Malawi; (Nitschke, 2013) on the need for better trained TVET instructors with the help of Open Distance Learning (ODL), on the backbone of ICT infrastructure; and (Nwajiobi, 2011) on the need for skilled trades men and technicians and the successful use of ICT in education in NIgeria.

With regard to South Africa, not much is known in terms of extant literature, on the use of ICTs to deliver training to brickwork trainees/learners/students.

3. THE STUDY

The South African government has attempted to address 'skills' in the country since the year 2000 with some success. In 2007, the CIDB identified two skills categories; scarce skills and critical skills. Scarce skills can be certified at a faster rate than critical ones due to the lower level requirements as they are short-term. Critical skills are those that require a higher skill level and are long-term thus requiring more time for accreditation. The major challenges identified in relation to TVET and scarce skills challenges are: Inputs, institutional issues, quality and relevance issues, and experiential learning and business issues (DHET, 2013; CIDB, 2007).

> "… the largest demand for skills is in the scarce skills categories, which can be met through short-term targeted training." (CIDB, 2007).

Considering bricklaying and the government implemented training programmes to address skills shortage; brickwork is still on the list of scarce skills (CIDB, 2007). Considering other countries such as the UK where some training colleges have successfully implemented ICT in training bricklayers (Clayton, 2014); There seems to be a gap in the use of alternative means, such as ICT tools, for training construction tradesmen in South Africa. Hogarth & Gambin (2014) identify a general gap in literature generally addressing the apprenticeship route to delivering training. It can be argued that the use of ICT in construction skills training will assist in achieving the rapid artisanal qualification rates; which is the need alluded to in CIDB (2007).

However there is paucity of information specifically addressing the use of ICT in training bricklaying operatives in South Africa. Therefore the current study aims to establish a baseline on the current status of ICT utilisation in skills training programmes for bricklaying operatives in South Africa, with the following objectives: To establish the current training offered to bricklayers; to determine the use of ICT in the trainings offered; to explore the stakeholder perceptions of the current training methods and outcomes; to establish awareness and knowledge of relevant ICT tools within training centres; and to identify challenges associated with the use of ICT in training bricklayers.

4. RESEARCH DESIGN FOR THE STUDY

The methodology followed a constructivist approach to knowledge claim, since knowledge here is developed by the participant's subjective views, and therefore understood from their perspective. These views could be influenced by participant's cultural background, history, experience and expectations (Saunders et al., 2012). Thus the strategy for inquiry was phenomenological, using qualitative approaches to collect and analyse data. The research methods employed were document content analysis,

survey by questionnaire and interviews. Schedules were utilised as administrative instruments for each method. The tools were applied physically with hard copies. Data was then captured electronically and analysed.

The population consisted of public and private-sector (for-profit and non-profit) training organisations. Purposive sampling was used and data was collected in phases; data collection and analysis of course outlines from the training organisations, benchmarked against the Quality Council for Trades and Occupations (QCTO) (Akojee, 2009) and the South African Qualifications Authority (SAQA) requirements (SAQA, 2015; Killen and Spady, 1999); questionnaires distribution to trainers/instructors; and semi-structured interview of managers of the training organisations. Out of 20 organisations identified, only 3 consented to participating in the study. The sample includes a non-profit organisation (NPO) and two private training centres, located in Boksburg, Kempton Park and Tembisa respectively.

Data was analysed for categories, themes, relationships, and patterns. Data from semi-structured interviews was compared data from the questionnaires to identify alignments and misalignments between the planning level and execution level of training for bricklayers by organisations.

4.1 Results of data analysis

Two organisations were CETA accredited while one did not require CETA accreditation since they provided only short courses. With regards to the current training, all three organisations offer both theoretical and practical training to learners. A number of languages are also used for instruction; English, Afrikaans, Zulu, Xhosa, Pedi, and Tswana. English being the predominantly used language is not always suitable in every case.

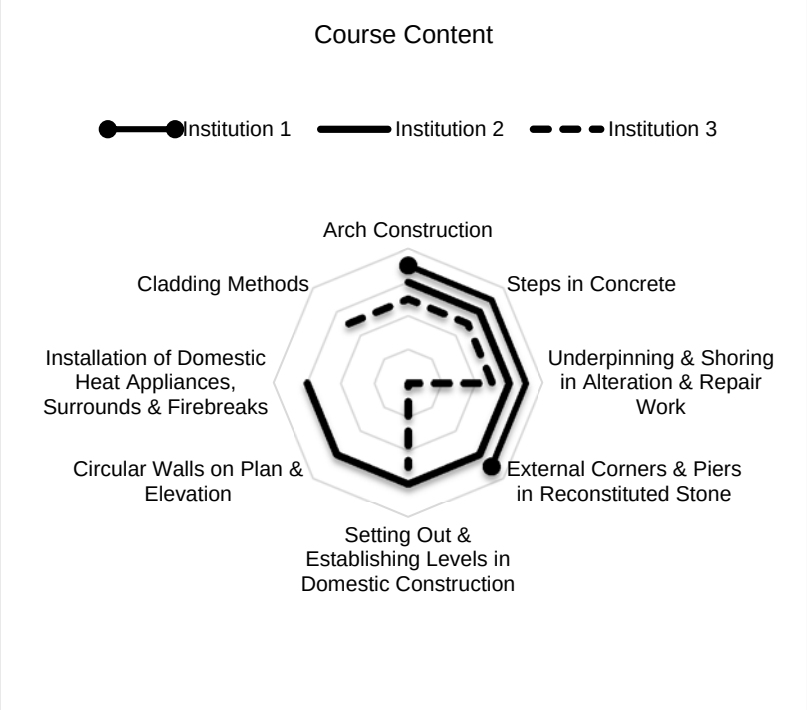
All Institutions offer the following outcomes: Read and interpret drawings and prepare the work area, tools, equipment and materials accordingly; Apply health and safety legislation to a work area in the form of standards and procedures, as well as the rendering of basic first aid; Set out and prepare construction masonry work areas; Set out, excavate, cast and build concrete strip foundations and foundation walling; Build masonry superstructures using both solid and hollow units of brick and block size; One organisation offers the additional outcome of; Demonstrate a basic understanding of the construction industry in terms of its composition, role players and the impact of the industry on the South African economy.

In terms of course content, Figure 4.1 below shows an analysis of course content for the three centres. Generally bricklayer trade theory only counts for 28.6% of a bricklayer's curriculum, which leaves considerable room to apply recent technologies for delivery of training modules. One organisation made remarks about students not enjoying the theory aspect of their learning. This provides an opportunity for use of ICT such as virtual reality (VR) and augmented reality (AR) to motivate the learners through

immersion. According to McGrath (2012) institutions can increase capacity to deliver more learning through the use of ICT.

Figure 4.1 Analysis of course content from the three centres.

There was an apparent discrepancy between the content analysis findings for organisation 2 and the questionnaire completed by their trainer. The content analysis revealed that there is no practical aspect to the training that they deliver. From the curriculum documentation it was apparent that the planner has an extensive knowledge of the bricklaying trade and the awareness of SAQA requirements for bricklayers. They also included many examples of plans for the interpretation of the students. Nevertheless, current training regimes in the other 2 organisations are heavily reliant on



the practical aspect of training as precluded in literature.
The most common ICT tool found to be in current use is video streaming and overhead projector illustration and can be considered basic currently. For the most part the only ICT tools that are used in training is that of Audio Visual aids in the form of health and safety videos that are shown to the trainees at the start of their course. See Table 4.1.

Table 4.1 Technologies utilised in training bricklaying operatives.

	Training Centre 1	Training Centre 2	Training Centre 3
Technologies used during training	Video Streaming	Mobile hand held	Mobile hand held
Skill level	Expert	Intermediate	Basic - Intermediate
Frequency	Frequent (Safety videos)	Occasionally	Rarely (Video Streaming - Safety videos)

According to responses most trainers are older (50 – 60) years of age and such not necessarily at pace with developments in information and automation technologies. Though there is some inclination to the use of ICT for training, there is a perceived mental distance from the inherent potential of such technologies. The trainers did not use the existing ICT to its full potential and they did not have the demonstrable skill levels. There is notable concern of managers at a strategic level over the capacity of trainers to deliver training using such technologies.

The main challenges identified through literature with regard to trade training in general are mainly language barriers, numeracy levels and literacy skills; with language barriers being the most prevalent. These challenges were also identified from the study. See Figure 4.2.

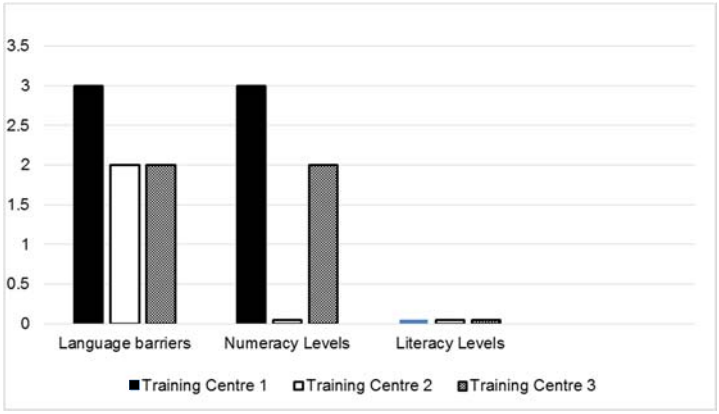


Figure 4.2 Analysis of general challenges to trade training

For the use of ICT in training operatives, the challenging factors identified are: cost of purchasing required equipment, set up and, maintenance; knowledge and awareness of the ICT technologies; complexity of use, among others. Cost was determined as the most severe challenge due to high capital investment cost. Language was also identified as a significant barrier in ICT use for training bricklayers. See Figure 4.3.

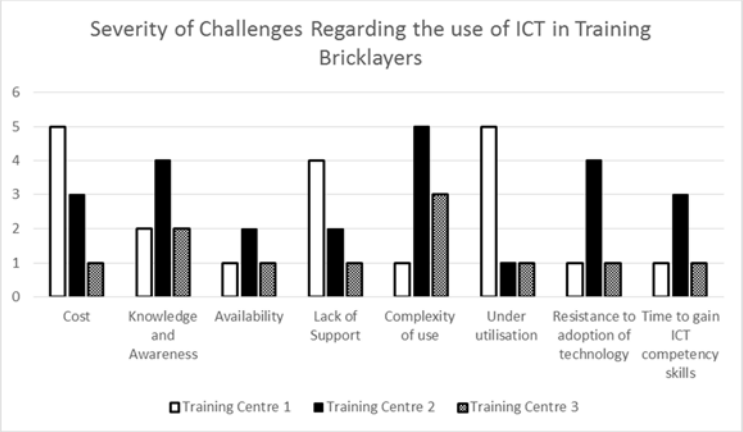


Figure 4.3 Analysis of challenges according to training the organisations

Overall the managers were optimistic about the use of ICT in training bricklayers, though they had concerns due to uncertainties, which were information related. There were also concerns about the capacity of trainers to utilise relevant technologies.

5. CONCLUSION

The aim of this study was to investigate the nature and extent of the use of ICT to train bricklayers in South Africa. This study was designed to provide baseline information on the state and ICT footprint of training currently offered to bricklayers in South Africa. Data was gathered from the greater Johannesburg area through purposive sampling. Though the organisations investigated were located in different areas of Johannesburg, the scope and size of sample provides baseline information as opposed to generalizable results.

Analysis of data shows that training programmes probably place f the emphasis on the practical component of training, to the detriment of theory, which could limit intellectual and conceptual development. This is an opportunity for ICT utilisation.

The knowledge and awareness of ICT tools seems to be limited to common instructional tools such as projectors used to stream videos. IT is

possible that ICT tools are not being marketed to bricklaying trainers. Furthermore, the bricklaying qualification requirements do not promote or encourage the use of ICT.

While cost is seen as a major challenge, training organisations may be failing to see long term benefits of initial investment costs. The issue complexity of relevant technologies to trainers and learners could be viewed as an opportunity to improve computer literacy skills of both stakeholders.

From responses in the current study, most trade training organisations probably have suggestions of possible ways to use ICT in improving their training delivery and experience. However it seems that motivation from policy makers, regulatory bodies, and other stakeholders would serve positively to improve the adoption of relevant technologies.

Considering the limitations of the current study, there is need to conduct this study at a national level. There is also need to update the study on available and relevant information and automation technologies for training bricklayers. It may be helpful to consider opportunities in policy and regulation that can be utilised to improve the current situation.

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ASOCSA2017- 102

Innovative Solutions for Lecture Venues: The Students Perspective

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Abstract

Purpose of this paper
Better facilities and venues are needed to deal with the ever-increasing number of students. There is a need for improved graduates and one of the main factors that could contribute to the 21st century construction professional is innovative lecture venues.

Methodology
This is a quantitative study that forms part of a bigger study and as part of the pilot study 50 questionnaires were randomly distributed to the undergraduate students of the Construction Studies Discipline to gain their outlook on current lecture venues and possible requirements for innovative lecture venues. Thirty-five questionnaires were returned (70% response rate). SPSS version 24 was the tool used to calculate the descriptive statistics.

Findings
The results indicated that there is a need for more lecture venues and recommendations were provided for innovative solutions. Student's preferences, which were obtained from questionnaires, showed that aspects such as improved spaces and new technology will improve their university life.

Limitations
This study was limited to students in the Construction Studies discipline at the University of KwaZulu-Natal.

Value
This study helps identify the need for new and improved lecture venues that could help to enhance the quality of education for students.

Keywords
Innovation, Lecture venues, Overcrowded classrooms, Students.

Response to the Conference
Theme Construction Education, Training and Skills Development

1. INTRODUCTION

Students come from all over the world to gain knowledge at universities (Boulton and Lucas, 2008). Universities are high-level educational institutions in which student's study for degrees and where academic research is conducted. There are 26 public universities in South Africa and there were 969,155 students enrolled in these universities (Department of Higher Education and Training, 2016).

Overcrowded classrooms lead to frustration where learners become discouraged and started to develop negative attitudes (Muthusamy, 2015). This effects a learner's performance and puts stress on the lecturer (Khan and Iqbal, 2012). Teachers face many problems when attempting to teach in overcrowded lecture rooms, especially disciplinary problems (Benbow, Mizrachi, Oliver & Moshiro, 2007).

The need for lecture venues is evident across South Africa, but these lecture venues need to meet other requirements and factors such as sustainability and innovation. Reducing the problem of overcrowding while ensuring that the students learning experiences are enhanced can be solved through innovative solutions such as new technology and innovative learning spaces. This study focuses on different and innovative construction solutions that can benefit the university as well as the students and other occupants that will occupy the lecture venues daily.

2. LITERATURE REVIEW

In South Africa, about 200,000 first year students were enrolled in 2015 but there were many unsuccessful students due to the institutions of learning being filled to capacity. First-year applicants tend to far outnumber the vacancies. This is despite the increase of almost 55,000 available spaces at the universities over the past decade (Savides, Pillay and Eggington, 2015). The highest demand and highest rejection rate was in KwaZulu-

Natal. At the University of KwaZulu-Natal only one in ten students were accepted (Savides, Pillay and Eggington, 2015).

Lecture venues at the University of KwaZulu-Natal are decades old as many of the buildings were constructed in the 20th century. These buildings were constructed to enrol a specified number of students. However, with an increase in population and the eradication of apartheid there has been an increase in the number of students attending university.

University buildings are well maintained and kept in a good condition for teaching. These buildings which are old, still operate with chalk boards and old projectors that need constant maintenance. With advancements in technology the lecture room has changed. Lecture venues need to be fitted with proper equipment to help achieve a quality education.

Some of the problems encountered in current lecture venues include:

- Overcrowded lecture venues. Teaching in an overcrowded classroom creates a challenge in producing productive learning. Large number of students in one classroom impacts the classrooms discipline (Benbow, Mizarachi, Oliver and Moshiro, 2007). Larger classrooms are noisier and lose valuable time by trying to control learners. Overcrowding has many disruptive consequences on a student's behaviour. An example of this is that students cannot payattention at the required level due to other classmates being noisy. The result is that academic achievement is negatively affected (Khan and Iqbal, 2012).

- Outdated technology. With today's modern technology lecture venues can no longer consist of just chairs, tables and a chalk board. Lecture venues should be equipped with projectors, air-conditioning, adequate lighting, Wi-Fi and computers that are quick and efficient. (Abravaya, 2015).

- Time management. Teaching in an overcrowded lecture room impacts on the lecturer's ability to manage time. Lecturers devote more time to check attendance lists and managing behaviour. Lecturers are required to do more work outside classroom times in order to assess work, prepare for the next lecture and help students with questions that could not have been done during the classroom times (Marais, 2016).

In the past two decades, the construction industry has seen many changes. From 3D imaging to smart construction software, construction has progressed to develop many innovative buildings (Team, 2015). As the

universities change due to factors such as digital technologies, global mobility, markets and funding (Young and Ernst, 2012), university buildings will also have to adapt to incorporate these changes.

New innovative construction solutions need to be studied to determine solutions for lecture venues that are modern, cheap, effective and sustainable.

2.1. Alternate Solutions employed both nationally and internationally

Considering the results and feedback of the students, the following are examples of innovative construction techniques done at universities both internationally and nationally.

2.1.1 *University of Kansas architecture*

The addition to the University of Kansas architecture school features double-layered glass skin. The new extension provides a 121-seat auditorium, a critic room and common space for the architecture department. The outer skin is made up of two separate layers of insulated glass, which are spaced a metre apart, this space creates a series of vertical cedar louvres. These louvres are mounted on motors and controlled by a rooftop weather station which is programmed to track the sun throughout the day (Howarth, 2017).

A green wall is installed at the back of the lecture venue to improve acoustics and air quality, while a displacement ventilation system supplies conditioned air at a higher level, which provides fresh air. The other elements that provides to the green credentials include LED lights, photovoltaic panels, water reclamation and the use of recycled materials (Howarth, 2017).

Figure 1: New University of Kansas architecture lecture venue (Howarth, 2017).

2.1.2 *University of WITS Science Stadium*

The University of the Witwatersrand opened a new Science Stadium in 2012. It consists of a former sports grandstand that has been converted into lecture theatres. The new building boasts a 435-seat lecture auditorium, two 330-seat lecture auditoria and a 240-seat lecture auditoria, all equipped with cameras and modern equipment.

The facility also has several different laboratories and tutorial rooms. Lectures are recorded as podcasts and there are cameras above the lecturers to enable them to project demonstrations, experiments and calculations of the big screen. Further, the lecture halls also have equipment that allows lecturers to use input from students, in the form of multiple-choice feedback, to determine whether students have understood key concepts.

The reuse of the grandstand structure saved significant resources and other green elements incorporated include water efficient fittings and an emphasis on acoustics and insulation, particularly within the auditoria. However, the primary green design elements became daylighting the spaces and using the large concrete structure to heat and cool the building.

2.1.3 *University of Stanford's Art and History Departments*

Stanford University opened McMurtry Building in 2015 that houses the school's art and art history department. The new building allows art history students to work alongside students practising fine arts for the first time in the university's history. The innovative design maximises collaboration between disciplines through the shape of two interlocking strands that connect around a central library (McKnight, 2015). It covers 9,290 metres and contains classrooms, galleries, and a flexible presentation space with 125 seats, studios, a digital darkroom, a print lab, a tinker lab and a sound recording studio.

The history department is made from cement plaster exterior. The other strand which houses the fine arts program, is clad in a custom-zinc finish. Between these strands is a volume containing the library, with a sheltered courtyard below and a roof garden above. The library is a glass box and enables views to every floor. Inside, the facility offices feature translucent walls between studios and classrooms, this ushers in natural light and enables views to different areas of the building (McKnight, 2015).

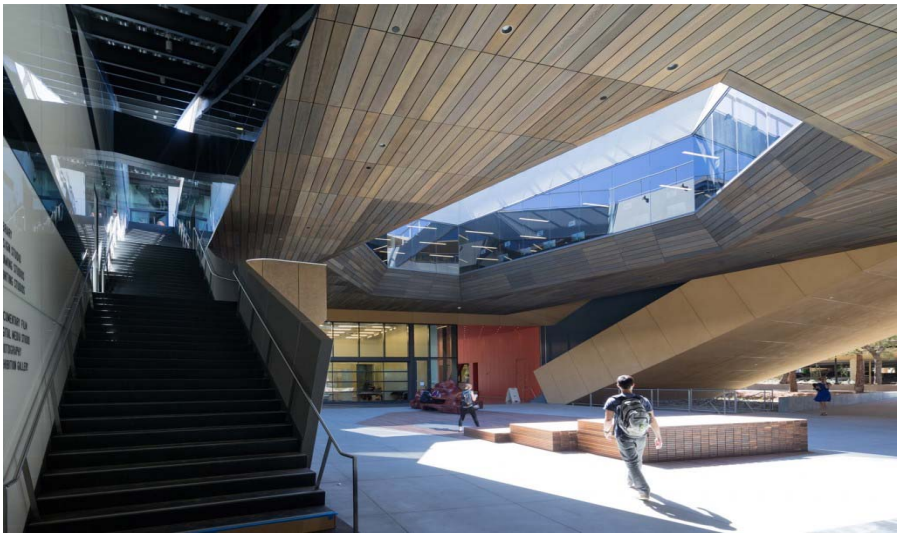

Figure 2: Interior Layout of Stanford University Art Department (McKnight, 2015).

2.1.4 University of Cape Town Chemical Engineering Building

Architects integrated offices, laboratories, teaching and research to promote interaction across disciplines. The latest design and technology were employed throughout the teaching and learning facilities, which provides high-tech audio-visual infrastructure and video-conferencing capabilities. Adequate, extended height space enhances the operation of scale pilot plants for both teaching and research purposes. The building is energy and resource efficient. It provides enough space to create a healthier and more productive environment for staff and students. Flexible design will make laboratories easy and inexpensive to reconfigure to meet changing needs.

2.1.5 Innovative materials that may be considered

Construction has many different types of materials that can be used as innovative solutions, some as common as light steel and prefabricated walls. Other materials not as common such as container buildings. A container structure is made up of many shipping containers to make a building. This is one of the eco-friendliest ways of constructing a new building. Not only is it sustainable but also cheaper than many of the typical construction materials (Paulsen, 2011). Many shipping companies have introduced container conversions as part of their job scope. Containers are like Lego blocks that can be combined to create a wide variety of structures (Kotnik, 2012).

Figure 3: Costa Mesa Waldorf School (Container World, 2017).

2.1.6 Other innovative solutions for universities constructed through green techniques:

- Saint Martin's University, which set out to construct a new building to house the engineering program. When the new building had opened in 2013 it received the highest-rated LEED (Green Standards) structure in the Western Hemisphere, and the third highest rated in the world (KahnJetter, 2013) with the lowest possible financial impact. The building was positioned to create a new campus quadrangle, providing a place for students to gather and optimizing solar orientation. A rain garden at the front of the building allows easy access for civil engineering classes to study the means of achieving storm water quality (Kahn-Jetter, 2013).
- Colorado State University is one of the first universities in the world to gain a Platinum in the STARS rating system. This campus is home to the first solar-heated/air-conditioned on-campus building. Colorado State worked with NASA to develop a cloud-profiling radar system, CloudStat, which monitors climate change and provides students with research opportunities concerning its own energy usages.
- Stanford University seeks to make sustainable living a part of the Stanford experience. The Stanford Energy Systems Innovation Program aims to reduce carbon emissions by 68% and cut potable water usage by 15% in the coming years. The waste-diversion rate at Stanford is rising steadily, 65% of solid waste produced on this campus is recycled or composted.

3. RESEARCH METHOD

This quantitative study involved the construction and distribution of questionnaires. A questionnaire that consisted of both yes/no response and 5-point Likert scale (categories ranging from 1= strongly disagree to 5= strongly agree) was developed to obtain information towards the improvement of lecture venues. The questionnaire also required the students to comment on the current state of lecture venues.

Fifty questionnaires were randomly distributed to students in the Construction Studies Discipline, of which 35 were returned, indicating a 70% response rate.

4. RESULTS AND DISCUSSIONS

4.1 Reliability analyses and Demographics

Cronbach alpha was used to calculate the internal consistency and reliability of the questionnaire. The alpha index was 0.801 as shown in table 1, which indicates good reliability (Pallant, 2013).

Table 1: Cronbach Alpha

Reliability Statistics	
Cronbach's Alpha	N of Items
.801	20

Table 2 indicates the demographics of this study, responses from 2nd year students will form part of the bigger study.

Table 2: Demographics of 1st and 3rd year students

		No.	Percent(%)
Year of study	1st	12	34.3
	2nd	0	0
	3rd	23	65.7
	Total	35	100
Gender	Male	20	57.1
	Female	15	42.9
	Total	35	100
Race	African	20	57.1
	White	3	8.6
	Indian	10	28.6
	Coloured	2	5.7
	Total	35	100
Age	Range	17 - 27	

4.2 Students experience

This study discovered that 43% of the students had sat on the floor at least once in their university life, with 49% of the students indicating that they have been affected by the lack of space in lecture venues.

If there were an allocated study room for each year of study, 89% of students would be more inclined to attend the university.

Sixty six percent of students indicated that they do have a preferred lecture venue. When questioned further question about why they preferred that lecture venue, the following responses were received:

- “Mode of circulation of air is fair and more space to do individual work”
- “Enough seating and available plug points”
- “More space than others making it easier to listen to the lecture"
- “It is cleaner”
- “Access to air-conditioning and lights”
- “Working projectors and bigger desks”
- “The environment is comfortable”

4.3 Data analysis

Table 3 indicates students believe more natural light needs to be provided in lecture venues (M=3.97, SD=0.890) and that lecture venues should look more attractive.

With a mean of 3.63 (SD=1.165) the students agreed that there should be break areas where students can relax between lectures. More students felt that lecture venues should be innovatively constructed (M=3.44, SD=0.927).

Students felt that UKZN lecture venues are up to standard with other universities with a reported mean of 3.15 (SD=0.939). However, 34.2% of students felt that they have been affected by overcrowding. The students who took part in the questionnaires felt that the lecture venues have an adequate amount of technology (M=3.02, SD=1.124).

Table 3: Students views/problems/opinions on current lecture venues

	Mean	Std. Dev.	Rank
More natural light needs to be provided inside a lecture venue.	3.97	0.890	1
The lecture venue is a good learning environment.	3.80	0.797	2
Lecture venues are able to be kept at good working temperatures (With natural air or air-conditioning).	3.66	0.998	3
Lecture venues should look more attractive.	3.65	1.011	4
The lecture venue is a healthy environment.	3.63	0.942	5
Lecture venues should have break areas, such as built in gardens.	3.63	1.165	6
Lecture venues are innovatively constructed to meet student's needs.	3.44	0.927	7
UKZN lecture venues are up to standard with other universities.	3.15	0.939	8
Overcrowding has affected your learning ability.	3.09	1.197	9
Lecture Venues are safe to work in at night.	3.08	0.900	10
Current lecture venues are overcrowded	3.03	1.087	11
Lecture venues have an adequate amount of technology (Eg. Wi-Fi and Computers).	3.02	1.124	12

Section C of the questionnaire consisted of yes and no answers which are indicated in table 4, these questions were used to get students opinions on what they would prefer in their ideal lecture venue. In their ideal lecture venue students felt the need for air-conditioning, fixed furniture and swivel seats, projectors in good working order, more space and more natural light. Ninety seven percent of the students indicated that new technology needs to be introduced into the lecture venues, such as smart boards or lecture capture which captures lectures for students to watch at a later stage.

Table 4: Students opinions on their ideal lecture venue

	Yes	No
New Technology	34	1
Fixed Furniture	21	13
Natural Light	24	11
Swivel Seats	33	2

5. CONCLUSION/ RECOMMENDATIONS

There is a need for more lecture venues due to the increase of students over the years. Through innovative solutions many problems with current lecture venues, such as students sitting on the floor, can be solved. The findings of this study indicate the desire and the need that the construction studies students have for facilities and lecture venues that suit the Quantity Surveying and Construction Management professions.

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Investigating the impact of Accreditation on Quantity surveying programmes and the professional preparedness of graduates

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ABSTRACT AND KEYWORDS

Purpose of this paper
In South Africa, higher education accreditation has promised numerous benefits with positive outcomes for universities and graduates. This has become increasingly debated over the past few decades. This study seeks to discover whether accredited SACQSP quantity surveying (QS) programmes from Higher Education Institutes (HEI's), produced quantity surveying graduates who were ready for the world of work and professional practice despite the theoretical benefits of accreditation.

Research Methodology
This is a quantitative study whereby questionnaires were distributed via email and hand delivered to 15 built environment employers and 150 QS graduates within the Kwazulu-Natal region. The data collected was analysed using SPSS version 24. Mean values, standard deviations and reliability values were computed.

Findings
Findings suggest that QS graduates in KZN claim to be ready for the world of work and possess the necessary skills and competencies; however, employers were not that convinced about the work readiness of graduates.

Response to Conference Theme
This study highlights the programme design of accredited QS programmes and identifies skills and competencies that are necessary for QS graduates to be successful at entry level positions. Therefore, if the Built Environment Industry wants to continue to succeed, a proactive approach is required in adequately skilling graduates.

Practical Implications
Suggestions are made for future research. These include; an increased involvement of the built environment industry with the development of HEI's programmes, collaboration between the SACQSP, HEI's and the built environment industry and future programme development.

Research Limitations
This study was limited to the Quantity Surveying programmes at higher education institutes within the Kwazulu-Natal region.

Value of the Paper
The findings provide guidance for the development of higher education qs programmes that are responsive to the needs of the qs profession.

KEYWORDS
Accreditation, Council for Higher Education, South African Qualifications Authority, The South African Council for the Quantity Surveying Profession, Skills and Competencies.

Conference Sub-Theme: Construction Education

1. INTRODUCTION

Over the decades there has been much debate about the state of accreditation within the education system. This debate has been a logical step forward in the evolution of the accreditation system, as it poses numerous opportunities and challenges that should be addressed. By addressing these opportunities and challenges, a meaningful understanding will be gained of what the future of accreditation holds. Accreditation within higher education institutes in South Africa, plays a vital role as a form of quality assurance tool and enhancement mechanism, for institutions and their academic programmes. However, in recent years, the Council for Higher Education Accreditation (2006) noted that accredited quantity surveying programmes were not providing industry with entry level graduates who possess the appropriate competencies and skillset to

perform efficiently within the built environment industry. The core factor of accreditation is that it is a type of self-regulation process that consists of an extensive internal and external review process that occur in relation to national and public standards pertaining to policies and procedures developed by accrediting bodies through consultation with higher education institutes and industry professionals (Ibid).

Specialized accreditation, such as quantity surveying academic programme accreditation, has been a long-standing debate throughout the history of higher education, and has therefore been a controversial topic in society (Glenn, 2011). The requirements of accreditation and its processes have been considered as an endeavour that is both tiresome and burdensome to academic programmes at educational institutions. The processes have additional cost implications and regulations that have a limited benefit. However, as the university environment has become more competitive and institutions search for every possible advantage, there has been a renewed interest in specialized accreditation (Ibid).

In South Africa, there are various types of accreditors, with each of them focusing on and regulating various constituents of the higher education system. The accreditation bodies are both national and nongovernmental organizations. National and regional accrediting bodies accredit higher education institutes in its entirety, while nongovernmental accrediting bodies accredit the programmes of the higher educational institutes. Both, national and regional accrediting bodies in South Africa are evident through organizations such as Department of Higher Education, Council for Higher Education and South African Quality Assurers. These bodies accredit higher education institutes and their processes. An overlap may exist among the various types of accreditors, both on a national and private level. For example, a university may hold institutional accreditation from one of the national bodies and have academic programmes that may hold dual accreditation from different nongovernmental accrediting bodies (Urofsky, 2013).

In deciphering whether accreditation is good or not, it is important to pursue accredited programmes for three primary reasons, namely

- to help establish a core curriculum for graduates that are trained in quantity surveying education,
- to ensure that a level of consistency is met across similar degree programmes at Higher Education Institutes and
- to improve employment opportunities for graduates which as a result enhances the relationship of employability between employers and graduates.

The initial challenge surrounds the question, “Do accredited programmes produce graduates that are equipped with the adequate skillset to work in industry?” and “What are quantity surveying education graduates trained to do?” Higher education institutes develop quantity surveying education

programmes that are accredited; to create a balanced curriculum, which is designed to provide theoretical education and/or practical experience to help graduates acquire that first job within the built environment industry (van Dussen, 2012).

1.1. The debate by professional accrediting bodies

Professional accreditation of higher education qualifications, has become increasingly debated over the past two decades in South Africa. The main characteristic of this debate is found by the desire of professional bodies to have an increased level of influence on the form, structure and intent of professional degree programmes in higher education institutes. This view is driven by a sense that universities are not rising adequately to the challenge of preparing graduates, in sufficient numbers or quality, for entry into the world of professional employment. Higher Education Institutes are resisting such influence, seeing it as being unreasonably directive; a conflict of mission and purpose; an affront to the independence of universities; and a frontal attack on the principles of academic freedom (Ballim, Mabizela and Mubangizi 2014).

2. ACCREDITATION AND HIGHER EDUCATION INSTITUTES

The Council of Higher Education (2016) suggests that along with themselves, higher education institutions, statutory professional councils and registered professional bodies have a combined responsibility to produce competent and extremely capable graduates that are instilled with the right values and attitudes to serve society at large. At the core of the work from of all these role players is a student who must be adequately equipped with the appropriate knowledge, attitudes and skills to develop as a competent and capable professional ready to enter the industry and workplace. The CHE, HEIs and PCs namely the SACQSP, play a vital role in the advancement of the teaching and learning process that would result in developing competent graduates fit for practice/specific working environment. This requires creating a relationship based on collaboration and cooperation between the role players, and the recognition of the importance of each role player's contribution to improve and enhance the quality of higher education (Council for Higher Education, 2016).

2.1. HEI'S and their accredited quantity surveying programmes

Built environment professionals are facing increasingly societal challenging expectations, and demanding job experiences (Walkington, 2002; Yeomans and Atrens, 2001; Yokomoto and Bostwick, 1999; Memon et al., 2009; Fitzpatrick et al., 2009). Therefore, built environment education must be carefully planned and executed so that the students not only attain the

necessary skills and competencies but also continue life-long learning to be successful professionals, who are capable to face such challenges. Built environment education programmes such as quantity surveying programmes, are mainly designed to provide the basic undergraduate education within the specific discipline. (Ibid).

The quantity surveyor in the current built environment industry uses their abilities to analyse cost components of a construction project in a scientific way and apply the results of his analysis to various of financial and economic problems confronting the developer and the designer. A great level of importance is placed on the fundamentals of building principles and design techniques which enables the students to identify and define problems and to develop construction concepts and solutions. The success of quantity surveying programmes is measured by the high levels of competency from its graduates in their professional career, and the full satisfaction of their employers and society. (Walther et al., 2011).

2.2. Quantity surveying programme accreditation

Quantity Surveying programmes in Southern Africa are accredited by the SACQSP. The fundamental criteria of the SACQSP for accrediting quantity surveying programmes are based upon knowledge, skills and the behaviour that students acquire through the curriculum of a programme. The criteria set out is intended to assure quality and to create the systematic pursuit of improvement in the quality of quantity surveying education that satisfies the needs of constituencies in a dynamic and competitive market. Programmes seeking accreditation need to keep track on the updating changes in its criteria, policy and procedures that can affect aspects as the programme educational objectives, student outcomes and programme criteria (Khan, Mourad and Waleed, 2014).

A higher education institute that provides quantity surveying education, should strive to provide a level of quality education that aims to prepare students for the various facets within the construction industry, commercial property industry and academia. Students should be trained to develop into multi-skilled professionals who possess mental, intellectual and emotional fortitude to succeed in the world of work (Faculty of Engineering and Built Environment, Malaysia, 2010).

2.3. The accreditation process

Specific criterion address areas which include student support services, finances, facilities, faculty, curricula and student learning outcomes. The SACQSP uses practices including a self-review by the institution and its

programme in comparison to standards and evaluation processes conducted by a team of experts through on-site visits. A review process is followed by a decision made by the accrediting body regarding the accredited status. This review process is repeated every three to ten years if the institution or programme is required to sustain its accreditation. The periodic examination is conducted by professional bodies based on a set of standards which is carried out by the Department of Higher Education or in the private sector, CHE (Ballim, Mabizela and Mubangizi 2014).

Advantages of The SACQSP accreditation system:

- The affirmation of the quality of education;
- The honour and prestige by the institution;
- The attractiveness of the institution to prospective students and their parents;
- International or national recognition of the degrees awarded by the institution;
- Incentives such as administrative and financial autonomy;
- The availability of funding and subsidies based on an objective study and data for performance;
- A culture of periodical evaluation and improvement;
- Peer recognition and ranking as a competitive institution.

2.4. The SACQSP accreditation benefits

Once a quantity surveying programme has an accredited status by the SACQSP, it means that students and the public can expect that the institute or programme lives up to its promises. It means that a student and the public can have confidence in the worth of an institution or programme and that the degree or credential has value. Accreditation provides real life value for students related to not only judging quality but also obtaining employment within industry (Council for Higher Education Accreditation, 2010).

The accredited programme assists with student mobility within institutions and signals to prospective employers that the educational programme offered to students has met acceptable standards and that they have graduated from an accredited programme. In the public's view, the accreditation process provides value by not only evaluating the quality of the programme/institute, but also ensuring consistent information about institutions and their programmes. Accreditation promotes liability and identifies successful improvements of an institute and its programmes (Ibid).

2.5. Framework of the SACQSP accreditation system at higher education institutions

The SACQSP has developed citeria that are used by HEI's. At all four academic qualification levels, the HEQC criteria for programme accreditation is applied. The purpose of criteria and its outcome of programme evaluation are intended to provide a framework. The framework aims at promoting the fundamental principles of academic development within higher education institutes that provide quantity surveying programmes (www.sacqsp.co.za).

SACQSP Accreditation Policy and Programme Accreditation Criterion:

- Criterion 1: Programme Design
- Criterion 2: Student Recruitment, Admission and Selection
- Criterion 3: Academic Staffing
- Criterion 4: Support Staffing
- Criterion 5: Teaching and Learning Strategy
- Criterion 6: Student Assessment Policies and Procedures
- Criterion 7: Infrastructure and Library Resources
- Criterion 8: Programme Administrative Services
- Criterion 9: Postgraduate Policies, Procedures and Regulations
- Criterion 10: Programme Co-ordination
- Criterion 11: Academic Development for Student Success
- Criterion 12: Teaching and Learning Interactions
- Criterion 13: Student Assessment Practices
- Criterion 14: The Assessment System
- Criterion 15: Coordination of Work-Based Learning
- Criterion 16: Delivery of Postgraduate Programmes
- Criterion 17: Student Retention and Throughput
- Criterion 18: Employability
- Criterion 19: Programme Effectiveness

2.6. Purpose of the SACQSP programme accreditation criterion

Criterion serves as a programme evaluation tool. A programme functions best if the HEI's able to actively monitor and promote quality quantity surveying programmes. Assessment tools can provide a structure for assessing the HEI's programme structure and for identifying areas that need development (ACCE, 2014). Therefore, these criterions have been developed to help programmes be reflective, to pinpoint strengths and weaknesses and to target areas for improvement (Ibid).

3. RESEARCH APPROACH

The data was collected by means of a quantitative survey questionnaire issued to quantity surveying graduates and construction industry employers. A final sample size of 15 employers that are actively practicing quantity surveying in the construction industry and 150 quantity surveying graduates from the various higher education institutes in Kwazulu-Natal were identified. A total of 11 employers and 43 quantity surveying graduates responded to the survey questionnaire. Descriptive statistics were derived using SPSS v24 and presented including measures of central tendency and dispersion. The internal validity of scaled responses was determined by the Cronbach's alpha co-efficient for validity.

4. RESEARCH FINDINGS

The objective of the research was to identify why accredited SACQSP quantity surveying programmes from HEI's, are not producing skilled quantity surveying graduates for entry level positions. The objective too was to determine whether the skills and competencies offered by accredited HEI's were considered by graduates to be adequate to be employed in the construction industry as junior quantity surveyors.

4.1. Profile of Respondents

Employer Survey

Less than a third (30%) of employers were quantity surveyors by profession and 20.0% each were directors, contracts managers and project managers. Further, 81.8% of organizations actively recruited graduates to work in their businesses while 54.5% employed students from non-accredited programs. These organisations employed a median of 11 employees in their workforce ranging from 4 to 24 employees. The organisations have been actively practicing quantity surveying for a median of 4 years ranging from 1 years to 17 years.

More than three-quarters (81%) actively recruited graduates from all the universities in KZN. Organisations also reported that a median of two quantity surveying graduates were recruited annually ranging from 0 graduates to 10 graduates per year. However, more than half (54.5%) of organisations did not only employ graduates from accredited quantity surveying programs.

Most organizations (72.7%) did not require graduate employees to be registered with the SACQSP. Just over a quarter of graduates recruited either had a Bachelor of Science degree in Quantity Surveying (30.0%) or an Honours degree in Quantity Surveying (30.0%), with the remaining graduates holding neither an undergraduate Diploma nor a Bachelor of Technology degree in Quantity Surveying. Just less than half (45.5%) of quantity surveying graduates were actively recruited and employed by

Quantity Surveying practices. Construction companies employed 27.3% quantity surveying graduates while other built environment organisations employed the rest.

Employers' Survey Responses Reliability

The Cronbach's alpha co-efficients for the various scaled responses indicate acceptable degrees of internal consistency for the all scales used, namely a Cronbach Alpha statistic which is greater than the rule-of-thumb 0.70 for acceptable internal scale consistency. Graduates Level of Work Readiness indicates a statistical value of 0.744 and Graduates Skills and Competencies 0.965.

Table 1: Employers views on the Work-Readiness of Graduates

Statement	Mean	SD	Scale	Rank
Students who achieved high levels on their academic records are not necessarily prepared for work at our organisation	4.27	0.786	Strongly Agree	1
Students employed at our organisation develop and maintain effective relationships with colleagues and superiors at work	4.09	0.539	Agree	2
The students employed at our organisation use physical resources, computer/printer, effectively at work	3.82	0.873	Agree	3
Students with work based learning experience enhanced their level of employment at our organisation	3.82	0.873	Agree	3
Organisations are not contacted by higher education institutes to provide input when constructing quantity surveying programs	3.82	0.981	Agree	5
Students employed at our organisation have excellent oral communication skills	3.55	0.687	Agree	6
The level of employee success is driven by their own efforts and self-motivation	3.55	1.128	Agree	7
Students employed at our organisation function effectively in a team, at work and on projects	3.45	0.687	Agree	8
Students employed at our organisation show commitment towards their tasks at work	3.45	0.820	Agree	9

Statement	Mean	SD	Scale	Rank
Students employed at our organisation have advanced numeracy skills to execute their tasks effectively	3.45	0.820	Agree	10
Students employed at our organisation have high levels of self-confidence	3.36	0.674	Neutral	11
The students employed at our organisation showed high levels of self-discipline at work	3.36	1.026	Neutral	12
Students employed at our organisation adapt to the constant changing circumstances of the quantity surveying industry	3.18	0.404	Neutral	13
Students employed at our organisation have efficient listening skills	3.18	0.750	Neutral	14
Students employed at our organisation have excellent written communication skills	3.09	0.700	Neutral	15
Students employed at our organisation effectively manage interpersonal conflict within the organisation	3.00	0.632	Neutral	16
Students employed at our organisation use quantity surveying computer software efficiently to execute daily tasks	3.00	1.095	Neutral	17
Students employed at our organisation are effective with their decision-making skills	2.90	0.539	Neutral	18
Students employed at our organisation show effective problem solving skills on projects	2.90	0.700	Neutral	19
Students employed at our organisation have high levels of innovation	2.82	0.603	Neutral	20
Students employed at our organisation understand the impact of economic influences on the organisation	2.73	0.904	Neutral	21
The students employed at our organisation independently plan their time at work	2.64	0.809	Neutral	22

Statement	Mean	SD	Scale	Rank
The students employed at our organisation have good leadership skills at work	2.63	0.809	Neutral	23
Students employed at our organisation demonstrate a good balance of theoretical, practical and experiential knowledge	2.45	0.934	Disagree	24
Only graduates with quantity surveying diplomas are employed at our organisation	2.00	1.000	Disagree	25
Only graduates with quantity surveying degrees are employed at our organisation	1.90	0.944	Disagree	26

Table 1 presents the responses of employers to 26 statements about the work readiness of graduates. Employers disagreed that students demonstrated a good balance of theoretical, practical and experiential knowledge and that not only graduates with quantity surveying diplomas or degrees were employed. The statistical mean across the 26 work readiness statements (composite mean) was 3.176 suggesting that overall employers were neutral about quantity surveying graduates and their work readiness.

The statistical mean across the 25 skills and competencies was 1.51 suggesting that employers regarded the skills and competencies that quantity surveying graduates should possess as extremely important.

Graduate Survey

The median age of a graduate quantity surveyor who participated in the study was 28 years old ranging from 23 years old to 53 years old. Just under three quarters (73.8%) of graduates were male. Almost all (97.7%) of graduates were actively employed and practicing quantity surveying in the construction industry in consulting or contracting firms. More than half of the graduates (52.5%) had attended a University of Technology and less than half (40.5%) had attended the University of KwaZulu-Natal. Almost all (95.0%) the graduates had graduated from an accredited quantity surveying programme.

Graduates Survey Responses Reliability

The Cronbach's alpha co-efficients for the various scaled responses indicate acceptable degrees of internal consistency for the all scales used, namely a Cronbach Alpha statistic which is greater than the rule-of-thumb 0.70 for acceptable internal scale consistency. Assessment of Academic Programme as per the SACQSP Programme Criteria indicates a statistical

value of 0.893, Graduates Level of Work Readiness indicates a statistical value of 0.857 and Graduates Skills and Competencies 0.926.

Table 2: SACQSP Programme Criteria for HEI – Academic Programme Assessment

Statement	Mean	SD	Scale	Rank
Criteria One: Programme Design	3.47	0.613	Agree	1
Criteria Two: Student Recruitment, Admission and Selection	3.45	0.754	Agree	2
Criteria Three: Academic Staffing	3.79	0.816	Agree	3
Criteria Four: Support Staffing	3.40	0.894	Neutral	4
Criteria Five: Teaching and Learning Strategy	3.30	0.809	Neutral	5
Criteria Six: Student Assessment Policies and Procedures	3.55	0.707	Agree	6
Criteria Seven: Infrastructure and Library Resources	3.11	0.941	Neutral	7
Criteria Eight: Programme Administrative Services	3.59	0.788	Agree	8
Criteria Nine: Postgraduate Policies, Procedures and Regulations	3.41	1.406	Agree	9
Criteria Ten: Programme Co-ordination	2.69	1.006	Neutral	10
Criteria Eleven: Academic Development for Student Success	3.37	0.833	Neutral	11
Criteria Twelve: Teaching and learning interactions	4.15	3.381	Agree	12
Criteria Thirteen: Student Assessment Practices	3.55	0.884	Agree	13
Criteria Fourteen: The Assessment System	3.19	0.876	Neutral	14
Criteria Fifteen: Co-ordination of Work-Based Learning	3.15	1.045	Neutral	15
Criteria Sixteen: Delivery of Postgraduate Programmes	3.32	1.392	Neutral	16
Criteria Seventeen: Student Retention and Throughput Rates	3.32	0.833	Neutral	17
Criteria Eighteen: Employability	3.75	0.915	Agree	18
Criteria Nineteen: Programme Effectiveness	3.21	1.006	Neutral	19

Quantity surveying graduates were presented with a list of SACQSP programme criteria that they had to respond to about their accredited

programmes. The findings are shown in Table 2. The statistical mean across the 55 statements of the 19 SACQSP Programme Criteria for HEI was 3.36, suggesting that overall quantity surveying graduates were neutral about the programme criteria and whether they adequately prepared them for the world of work and professional practice.

Table 3: Graduates views on their level of Work-Readiness

Statement	Mean	SD	Scale	Rank
I am expected to show commitment towards my work and towards tasks given to me	4.48	0.592	Strongly Agree	1
I am expected to have high levels of self-discipline at work	4.44	0.547	Strongly Agree	2
My success is driven by my own efforts and self-motivation	4.37	0.690	Strongly Agree	3
I am expected to develop and maintain effective relationships with colleagues and superiors	4.34	0.752	Strongly Agree	4
I am expected to have excellent written communication skills	4.32	0.565	Strongly Agree	5
I am expected to have advanced numeracy skills to execute my tasks effectively	4.32	0.565	Strongly Agree	6
I am expected to have excellent oral communication skills	4.30	0.604	Strongly Agree	7
I am expected to have high levels of self-confidence	4.30	0.772	Strongly Agree	8
I must be able to adapt to changing circumstances	4.25	0.693	Strongly Agree	9
I am expected to show effective problem solving skills	4.16	0.614	Agree	10
I am expected to be effective with my decision-making skills	4.16	0.659	Agree	11
When I started to work, I had efficient listening skills	4.16	0.614	Agree	12
I am expected to have good leadership skills	4.13	0.833	Agree	13
I am expected to have high levels of innovation	4.13	0.742	Agree	14
I was able to function effectively in a team when I started working	4.06	0.593	Agree	15
When I started to work, I was able to use physical resources; computer/printer, effectively in an organisation	4.04	0.950	Agree	16

Statement	Mean	SD	Scale	Rank
When I started to work, I was expected to independently plan my time at work	4.00	0.872	Agree	17
When I started to work, I was required to use quantity surveying computer software to execute daily tasks	3.79	1.059	Agree	18
I am expected to understand the impact of economic influences on the organisation	3.79	0.940	Agree	19
Having work based learning experience helped me to get a job	3.74	1.156	Agree	20
When I started to work I could effectively manage my time	3.62	1.000	Agree	21
When I started to work, I was able to effectively manage interpersonal conflict	3.60	0.954	Agree	22
Only graduates with quantity surveying diplomas are employed	2.58	1.179	Disagree	23
Only graduates with quantity surveying degrees are employed	2.51	1.202	Disagree	24

Quantity surveying graduates were presented with a list of work readiness statements that they had to respond to about their level of readiness. The findings are shown in Table 3. The statistical mean across the 24 work readiness statements was 3.98 suggesting that overall quantity surveying graduates agreed that they were ready for the world of work and professional practice.

Views on QS skills and competences

Quantity surveying organizations and graduates were presented with a list of skills and competencies that they had to respond to about the importance within the programme and for industry. The findings are shown in Table 4 where EI=Extremely Important and I=Important. The statistical mean across the 25 skills and competencies for organizations and for graduates was 1.51 suggesting, that both cohorts regarded the skills and competencies that they should possess as important to extremely important. It should be noted that graduates and employers ranked the skills and competencies in varying degrees of importance suggesting that the HEI's are not aligned with industry requirements. As a result, quantity surveying graduates have a warped perception of what industry requires

from them as entry level gradutes, who are actively seeking employment or are employed at built environment organisations.

Table 4: Views on QS Skills and Competencies

Skills and Competencies	Employers Response				Graduates Response			
	Mean	**SD**	**Scale**	**Rank**	**Mean**	**SD**	**Scale**	**Rank**
Traditional Skills and Competencies								
Personal and Interpersonal Skills	1.09	0.305	EI	1	1.30	0.557	EI	8
Design Appraisal and Measurement (Quantity Surveying)	1.18	0.603	EI	2	1.20	0.599	EI	3
Project Valuation and Payments	1.18	0.603	EI	3	1.28	0.635	EI	7
Ethics	1.27	0.646	EI	4	1.25	0.581	EI	6
Leadership and Management Skills	1.36	0.674	EI	5	1.42	0.630	EI	10
Professional Practice and Ethics	1.36	0.674	EI	6	1.21	0.519	EI	4
Financial Reporting	1.36	0.809	EI	7	1.34	0.686	EI	9
Interpretation of Data, Information and Information Technology	1.54	0.687	EI	8	1.18	0.500	EI	1
Drawing Interpretation (Architectural)	1.54	0.687	EI	9	1.20	0.558	EI	2
Drawing Interpretation (Structural)	1.54	0.687	EI	10	1.25	0.581	EI	5
Construction Technology and Environmental Services	1.81	0.750	I	11	1.46	0.702	EI	11
Evolved and Emerging Skills and Competencies								
Accounting	1.18	0.404	EI	1	1.51	0.668	EI	3
Construction Contract Practice (JBCC/GCC)	1.36	0.674	EI	2	1.23	0.570	EI	1
Procurement and Financial Management	1.45	0.687	EI	3	1.53	0.667	EI	4
Construction Law	1.63	0.809	EI	4	1.30	0.557	EI	2
Project Management	1.63	0.809	EI	5	1.65	0.612	EI	7
Health and Safety Acts and Procedures	1.63	0.924	EI	6	1.58	0.793	EI	5
Site Surveying	1.72	0.786	I	7	1.81	0.763	I	10
Marketing	1.90	0.700	I	8	2.06	0.632	I	13
Insolvency and Insurances	1.90	0.875	I	9	1.90	0.750	I	11
Construction Economics	1.90	0.943	I	10	1.64	0.655	EI	6
Property Law	2.00	0.774	I	11	1.67	0.565	I	8
Facilities Management	2.00	0.774	I	12	2.07	0.600	I	14
Dispute Resolution and Associated Procedures	2.00	0.894	I	13	1.73	0.664	I	9
Research Methodologies and Techniques	2.09	0.943	I	14	2.02	0.780	I	12

5. CONCLUSION

Employers felt that students did not demonstrate a good balance of theoretical, practical and experiential knowledge irrespective of which institution they graduated from. They were neutral about quantity surveying graduates and their level of work readiness after graduating from accredited quantity surveying programmes. They tended to agree that a combination of traditional, evolved and emerging skills and competencies were important to extremely important for quantity surveying graduates to possess.

Graduates were neutral about the SACQSP accredited 19-fundamental programme criterion and whether they adequately prepared them for the world of work and professional practice. The criteria are intended to assure quality and to create improvement in the quality of quantity surveying education that satisfies the needs of employers in the competitive construction market.

Graduates agreed that they were ready for the world of work and professional practice. They regarded traditional, evolved and emerging skills and competencies as being extremely important for quantity surveying graduates to possess and should be incorporated into HEI's QS programmes.

This study indicated that almost all graduates had graduated from accredited quantity surveying programmes. Most graduates had attended Universities of Technology. According to the SACQSP one of the requirements for professional registration is for students to graduate from an accredited quantity surveying program. Then only can graduates professionally register and practice as professionals in society.

However, it should be noted that more than half of built environment organisations employed graduates from non-accredited quantity surveying programs and did not require quantity surveying graduate employees to be registered with the SACQSP. Therefore, whether a graduate comes from an accredited program or not is inconsequential to employers. Similarly, graduates found no added advantage by having studied at an accredited SACQSP quantity surveying program as they were still not well-prepared for the world of work and professional practice.

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Monitoring and Evaluation of the Mentoring Programme for the Bachelor of technology students: A case study of Durban University of Technology

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ABSTRACT AND KEYWORDS

Purpose of this paper
Within the South African historical context of socio-economic inequalities and the efforts of transforming the higher education sector to engage with issues of redress, the implementation of the graduate mentoring programme is critical to improve student success in the workplace. Therefore, the aim of the study is to evaluate the outcomes, as perceived by the participating students, of the formal graduate mentoring programme for the Bachelor of Technology students in the Department of Construction Management and Quantity Surveying at Durban University of Technology.

Design/methodology/approach
The study used the quantitative research method where the registered cohort of Bachelor of Technology students was requested to complete the questionnaire. This article focusses on the responses to the open-ended questions dealing with the challenges experienced by the participating students, benefits of the mentoring programme to both the mentee and mentor and recommendations to enhance the effectiveness of the programme in the future.

Findings
The article argues that the postgraduate qualification should be more focussed to preparing the students as innovators and critical thinkers in the workplace through the implementation of a graduate mentoring programme. The major challenge of this programme was the time management by both the mentee and mentor. The students felt that the mentors were extremely busy to keep to their appointments, the sessions were short to complete the discussions. Students have benefitted by

acquiring greater industry knowledge, personal improvement in terms of self- confidence and communication skills and improved work performance. In addition, students perceive that the mentors benefitted as leaders, improving their communication skills and sharing of knowledge that was new to the mentor. Finally, majority of students recommended that the graduate mentoring programme continue, it should be implemented at a lower level of study, the duration of the programme be extended and the number of sessions with the mentor be increased.

Research limitations/implications
Mentoring in higher education usually refers to the supervision of masters and doctoral students undertaking their research resulting in there being a dearth of empirical studies highlighting the role of mentoring for graduate students in the construction sector in South Africa. The article proposes that future research be conducted to evaluate the outcomes and impacts of graduate mentoring in terms of the learning outcomes of the programme offering and graduate attributes. The limitation of the studies was that there was inadequate time to discuss individual issues in detail during the lectures.

Practical implications
The Department needs to develop a formalised mentoring programme, ensure its integration with the programmes teaching, learning and assessment strategies and the provision of additional administrative capacity to manage the programme. In addition, the introduction of the mentoring programme at the undergraduate level and/or extending the duration of the mentoring programme over the two years of study at the graduate level needs to be considered. To ensure the effectiveness of the mentoring process the Department needs to develop and maintain its industry and professional networks to encourage the practitioners and professionals to become mentors.

What is original/value of paper
This is an original study indicating that despite the challenges, the graduate mentoring programme could have significant positive value to the key stakeholders in the education and the construction industry. It is of value to academic developers, academics, employers and the professional associations interested in ensuring the continuous development of a sustainable pool of highly competent professionals.

KEYWORDS: Graduate. Mentoring. Construction. Challenges. Formal.

1. INTRODUCTION

South Arica needs to unravel itself from the complex socio-political and economic complexities that constraints its efforts to alleviate the high levels

of poverty, unemployment and income-inequalities. To this effect education, in particular higher education institutions, has a critical role to play through sustainable collaborations with key stakeholders to supply socially responsible citizens that could readily add value to the economy and society. Universities generally faltered to ensure their relevance through the lack of teaching and learning that is governed by experiential and emancipatory approaches to teaching and learning resulting in students not being adequately capacitated to engage in their workplace. Therefore, to prepare student to become critical citizens and value-adding employees, mentoring should be included within the broader domain of student learning and development (van Wyk and Daniels 2004: 359). It should be noted that while the positive outcomes of mentoring are emphasised, the "darker" side has not yet been fully researched.

The aim of graduate student mentorship is to enhance the academic development (research skills and disciplinary identity), professional (career) development and personal (psychosocial) development of graduate students (Lunsford et al.2017). The paper presents the literature review including education within the South African context, key issues relating to mentoring, the rationale for the study, research design. This is then followed by the discussion of the findings and concluding remarks.

2. LITERATURE BASIS FOR THE STUDY

The political imperative in post 1994 South Africa was to ensure the previously disadvantaged communities, mainly Blacks, gained access to higher education. The initial efforts focussed on "access as participation" and then shifted to "access as success" focussing on the new entrants becoming academically successful (Akoojee and Nkomo 2007: 390). This article argues that adequate effort has not been placed to evaluate the success of the new graduates in the workplace thereby diminishing the value of the previous redress initiatives. In this regard, higher education institutions have been criticised for their efforts to link academic study and the workplace resulting in the new entrants in the modern knowledge-based economy not being fully prepared (Eyler and Gyles 1999). Therefore, a synergistic and innovative approach, such as a graduate mentoring programme, that complements the constructivists learning approach should be considered to enhance the success of graduates in the workplace.

Transformation in higher education has led to the emergence of new perspectives on learning where learning is considered as a social process rather than an individual process. Within this social learning process, skills, dispositions and self-knowledge are evidenced in the particular institutional environments (Cristie 2014 citing Mcune 2013 and Wenger 1991). This has created an impetus for mentoring to become a developmental tool to enhance the professional and personal development of students into and through university. According to Knippelmeyer and Torraco (2007) mentoring is an interpersonal relationship that involves support between

the mentor and mentee. Mentoring is therefore seen as a process of building relationships involving student-academic, student-professional, student-student and tutor-student to positively influence both undergraduate and graduate students' academic, professional and personal development. The mentoring relationship is intentional (Hall 2000:147) and protected (Gibbons 2000:18) where learning and experimentation occur, personal and professional skills can be developed through dialogue and reflection between a qualified and experienced mentor and an unseasoned mentee. The original meaning of the word mentor, referring to a "father figure" who sponsors, guides and develops a younger person remains the foundation of the relationship.

Although a conundrum remains about the "best" form of mentoring both the informal and formal mentoring process could yield mutual benefits. In informal mentoring the mentor and mentee somehow find each other and continue to operate in many contexts. Formal mentoring programmes vary in nature, focus and outcomes (Ehrich, Hansford and Tennet 2004: 3). Despite the numerous formal mentoring programmes in education there is no uniform approach to training of mentors, allocation of mentors and mentees, location and frequency of meetings and the evaluation of the mentoring programme itself. Neglect of these issues could lead to unwarranted expectations and behaviours from both the mentor and mentee leading to a disruptive learning process and environment.

Mentoring leans towards informal learning and is aligned to the way adults learn, namely, "adults prefer meaning in their learning, adults rely of prior knowledge and experience, adults are oriented towards solving problems and directly applying their learning in an immediate fashion" (Knippelmeyer and Torracco 2007 citing Zemke and Zemke 1995). Due to many of the young graduates are unable to cope with their studies, work commitments and personal issues as evidenced by their absenteeism, late coming to lectures and non-submission of academic assessments, mentoring could be an ideal developmental intervention.

The success of the mentoring programme not only depends on the mentor but also on the mentee, the purpose of the mentoring programme, the degree of "correctly matching" the mentor and in the hope that a quality relationship develops during their interactions. These relationships could last for a short period or extend over a number of years (Eby and Allen 2008; Crisp and Cruz 2009). The complexity in mentoring is also highlighted by the many roles of the mentor in the mentoring relationship, namely friend, career guide, information source, confidant and leader while need needs to possess the following traits namely, authentic, nurturing, approachable, competent, inspirational, conscientious and hardworking (Mladenovic 2012 citing Darwin 2004). On the other hand, the mentee needs to have an eagerness to be mentored, willingness to assume responsibility, respect and commitment to the programme to enable the programme to be a success.

Colley (2002) suggest that while universities recognise mentoring as having a positive outcome since both the mentee and mentor benefits alike, it must be noted that mentoring may not always be effective or may

be less effective for certain groups. This could be attribute to the “uncritical acceptance” of the positive outcomes of the mentoring programme by the universities while little focus is given to the power and control within the mentoring relationships and social contexts at the university. In addition, the complexities in the mentoring process has much scope to move in the wrong direction due to the lack of commitment, trust, respect and personality differences Mladenovic (2012: 8). According to van Wyk and Daniels (2004: 363), when students are supported in the mentoring process for their own learning they would be able to evaluate the relevance of the course content to their workplace requirements. In some instance graduate mentoring programmes may not always result in positive outcomes as some students may experience a sense of self-doubt as a result of negative mentoring experiences including difficulties working with a quality mentor (Welton, Mansfield and Lee 2014). To avoid impediments in the mentoring process, Megginson and Clutterback (1995: 30) offer that the role of the mentor is to assist the mentee to progress in their professional and personal spaces by encouraging critical reflection, providing differing perspectives and supporting the mentee towards the achievement of their goals. Drake (2011) further adds that mentors should create a nurturing space for students to “reconnect” with the issues where they have been “disconnected”. For example, a student wishing to de-register from the academic programme could be advised to continue by providing encouragement and guidelines to manage the academic workload.

3. THE STUDY

The study introduced mentoring as a learning and teaching intervention to assist the current cohort of Building Entrepreneurship IV students be more prepared by engaging with practitioners and professionals in their respective disciplines. Each student was requested to identify a mentor and set up at least 4 sessions with the mentor. After each session with the mentor the student was requested to submit a report highlighting the key issues discussed and the way in which the session could be improved. At the end of the programme the mentor was given a questionnaire to complete relating to his/her perceptions about the mentoring programme. At the end of the mentoring programme each student was also given a separate questionnaire to assess their perceptions of the mentoring programme. This article focussed on the open-ended questions from the students’ final programme report dealing with their challenges, benefits to the mentor and mentee and any suggestions to improve the mentoring programme.

In the context of the Durban University of Technology student placements, many are from the previously disadvantaged communities with poor quality secondary schooling and limited opportunities for personal growth. Therefore, both the undergraduate and graduate students from these communities experience greater difficulty in adapting to the university and workplace environment respectively. There is a dearth of information

relating to the preparedness of graduates to adapt and add value in the workplace. Therefore, the current graduate mentoring programme aims to provide a space for the graduate student to enhance their chances of success in the workplace.

4. RESEARCH DESIGN FOR THE STUDY

4.1 Research design

The study used the quantitative approach and each student was given a questionnaire to complete. Eighty five questionnaires were given to students and 64 completed questionnaires were received thus achieving a response rate of seventy five percent. The study focussed on the open-ended questions from the students final mentoring programme report. These questions related to the benefits of the programme to both the mentee and mentor, challenges experienced by the mentee and suggestions to improve the mentoring programme in future. The primary data was captured on an excel spreadsheet and a thematic analysis was done.

The study was limited to Bachelor of Technology students in the DCMQS and not to other departments within the Faculty of Engineering and Built Environment. In addition to the time and cost constraints, discussions of specific issues affecting individual students was not pursued.

4.2 Results of data analysis

Challenges the student faced as a mentee

Many students found it a challenge to locate a mentor in their profession as there are insufficient number of registered quantity surveyors in their specific work environments. This has led to them accepting mentors from other disciplines which could have minimised their exposure to specific field. Similarly, unemployed students found it difficult to locate a mentor in the construction industry thus resulting in engaging a mentor from outside the industry. Some of the mentees had their contracts terminated and had to seek new mentors and start the mentoring process from the beginning. The above challenges and disruptions adversely affected the mentoring process as the programme operated over a short period.

Despite the continuous recognition of the benefits of mentoring many professionals decline to become mentors due to their work pressure and the additional time and energy demands introduced by the mentoring programme. In addition some practitioners believe that once they have mentored the protégé to the highest level, they may be replaced. Finally,

some mentors refuse to engage in a programme due to the development of counterproductive relationships.

The majority of the students found it a challenge to set meeting times as the mentor was not available due to business commitments or the mentor has forgotten about the appointment even after being reminded. In addition, the number of sessions and the duration of sessions was inadequate to fully explore the issues discussed and bring it to a closure. The quality of the mentoring process was a challenge since in some instances the discussions between the mentor and mentee took place in an open space with many distractions. Some students found that both the mentee and mentor were not fully prepared for the session as the agreed tasks from the previous session was not completed. The mentoring relationship could be different for the various participants as there is "huge academic demands, high levels of stress and anxiety and conflicts between various responsibilities" (Hadjioannou et al. 2007: 160). In the present programme, the mentors were volunteers and the mentor traits, mentoring skills and expectations were not assessed prior to the programme.

Where the mentor was the first-line manager of the mentee, the mentee felt that it would be offensive to discuss certain issues "with his boss". One mentee also feared to disclose his "visions and missions" to his mentor as the trust towards the mentor developed very slowly. While cross-racial mentoring can be effective there are benefits to matching students of similar demographic characteristics. Campbell and Campbell (2007) found that ethnically matched pairs remained enrolled for more semesters and accumulated more credits than did pairs who were not matched by ethnicity. This is important issue as the work environment as many graduates report to managers from another race group.

Benefits for the mentor participating in this programme

Mentees have identified that the mentor benefits as he/she has an opportunity to share information and knowledge, lead the younger professionals and think critically when providing feedback. In some instances, the queries by the mentees required the mentor to research the topic prior to the next session. Where the mentor was the manager of the mentee, the mentor got to know the mentee better by discussing both the work and personal issues thus improving the team work performance and productivity. The mentee also becomes a source of knowledge when the mentor is operating in another field where some mentees actually assisted the mentor in their technical obligations.

Ehrich et al. (2004) citing Levinson (1978) argues that the mentoring process is a reciprocal process and rejuvenates the mentors career since it enables them to assist and shape the profession and personal development of new entrants into the profession. The above findings are also supported by Dolan and Johnson(2009) who claim that mentors benefit from the mentoring programme through " improved cognitive and socio-emotional growth, teaching and communication skills". However,

Long (1997) cautions that the mentoring could be detrimental to the mentor due to time demands, poor planning of the mentoring process, unsuccessful matching of the mentees and mentors.

Benefits of the programme to the student

The majority of the students benefitted through the mentors' industry knowledge of the current challenges and trends in the construction industry. The mentees were exposed to accepting different perspectives, criticism and critical thinking as the various issues were discussed during the mentoring sessions. There were opportunities for the mentor and mentee to discuss work related issues which subsequently improved their understanding of each other and the mentees work performance. Many mentees discussed their personal issues and gained enhanced self-confidence, improved time-management and the ability to balance work and personal life.

The above findings are supported by Banu, Juma and Abas (2016: 523) who stated that their mentoring programme provided students with a critical support system, enhancing their professional and social development and creating opportunities for networking. Rawlings (2002) add that the mentoring programmes also provide the following benefits, namely, improved self-confidence, provision of advice, encouraged reflective thinking and improved effectiveness.

Improvement and continuation of the programme

All students responded that the programme should continue as they did not have sufficient time with the mentor to complete their discussions and have more challenges to be presented. There was a great demand for the programme to be started at the lower levels, extended to a longer duration and the frequency of the meetings to be increased. In addition, the mentees requested that guidelines for the programme be supplied to the mentors and a list of topics be presented for discussion. Finally, Durban University of Technology should contact the mentors and collect their details.

Mentoring improves students' transition from school to university and from university to the workplace. A study in the United Kingdom indicated that unmentored undergraduate students were four times likely to leave the university before graduating Lunsford et al. (2017). Mentoring also positively affects students' outcomes in creating a sense of belonging, capacity for socially responsible leadership, deep learning and thinking approaches and enhancing self-confidence in professional skills and abilities. Crisp and Cruz (2009) suggests that since the functions and roles of mentoring programmes may differ, students may benefit by having more than one mentor who provide different forms of support and perspectives. The issue of punctuality is a concern as power and control dynamics are central to the mentoring process, especially where the mentee directly

reports to the mentor at work. Small class size and effective administrative systems should enhance mentoring as a form of scaffolding in the private sector.

5. CONCLUSION

The study explored mentoring as an integral component into the broader programme offering with the hope of further developing the graduates' knowledge in the current trends and challenges in the construction industry. The above challenges and disruptions could have adversely affected the mentoring process as the programme operated over a short period. The mentees faced challenges to locate an appropriately qualified mentor, manage the times and durations of the meetings. They benefitted by improving their knowledge of the construction industry, to think reflectively and critically, improve work performance and interpersonal relationships. Mentors also benefited by sharing their knowledge, and reflecting on the mentees queries and their value systems. The majority of the students recommended that the mentoring programme continue in future with its duration and number of sessions be increased. Mentoring would continue to be a critical component for academic developers, programme co-ordinators, employers and the relevant professional associations to ensure that the new graduates are successful as socially responsible citizens and future professionals.

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Multilingualism in a Monolingual South African Built Environment

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ABSTRACT AND KEYWORDS

Purpose of this paper
A literature review and data analysis was conducted to objectively contemplate how constitutional and moral a monolingual built environment in South Africa might be. Consideration was furthermore given to the advantages of multilingualism as well as the challenges toward the recognition of all the eleven official languages in the South African built environment.

Design/methodology/approach
Historical literature resources coupled with current legislation and data analysis contributed to reaching conclusions and drawing of recommendations.

Findings
The South African constitution recognises eleven official languages and encourage the development of the same. English could be described as the *de facto* language used in the South African built environment in the current dispensation. The advantages of multilingualism could be motivated from a humanitarian as well as a financial perspective.
The linguistic landscape in South Africa could be described as a colourfully complex and sensitive heritage due to the intricate political history of the country and should therefore be treated with respect throughout all the spheres of the South African society, which include the respect for the language diversity in the built environment.

Practical implications
Transformation in the private sector remains a challenge. Lingual transformation might happen more naturally and more rapidly than traditionally pursued. True transformation should not be based on an imprecise visual observation like skin colour but rather on a practical

enhancing linguistic ability to the benefit of the service delivering business as well as the broader multilingual population.
In a South African context, the educational development of indigenous languages could teach mutual respect for each other in a rainbow nation where the spirit of Ubuntu could be strengthened to its rightful distinction.

Keywords: South African Built Environment, Language, Linguistics, Monolingual, Multilingual, Inequality.

1. INTRODUCTION

The South African Department of Public Works articulated its concern about the number of black built environment professionals, which, according to the 2015 / 2016 CBE annual performance plan still remains under 26% (CBE, 2015: 2). A revised methodology might be pertinent. This paper will deliberate multilingualism. The 2011 censes (Statistics South Africa (a), 2011) revealed that 22,7% of the South African Population (at that time more than 51 million), most frequently spoke isiZulu, followed by isiXhosa (16%) and Afrikaans (13,5%).
The following review investigates current South African legislation on language, its application and the recognition thereof in the built environment. It further exploits the relationship between language and cultural inequalities and how language impartiality could be applied to transform the built environment. National and international academic studies revealed various challenges, which should be considered. This paper questions the *status quo* and argues that cultural inequalities of the past could be addressed through a multi-linguist South African built environment. It will be argued that cultural equality in the South African built environment might be advanced through the recognition of the eleven official languages in South Africa.
Recent studies revealed that mother-tongue education towards bilingual proficiency development could be influenced by social and educational conditions. Jim Cummins and Merrill Swain (2014) however concluded that access to two languages during education and development could promote metalinguistic awareness and possibly also broader aspects of cognitive development. Birgit Brock-Utne (2005) addresses the same questions in his latest book “Language in Education Policies and Practices in Africa with a Special Focus on Tanzania and South Africa.
Although the advantages of a mono-linguistic built environment might seem obvious in terms of modern business operations, however this paper argues that the intercultural political, -social and -business advantages of a multi-linguistic built environment could not be ignored during the current political challenges in the South African built environment.
On a professional and business, operational level the current South African built environment could be described as linguistically unbalanced environment.

2. A MULTILINGUAL SOUTH AFRICA 1994 - 2016

Professor Kathleen Heugh, an international distinguished researcher who specialises in multilingualism from the University of South Australia was recently invited to share her knowledge on the matter of multilingualism and diversity at University of the Free State (Heugh, 2015).
She commenced her talk with the view that South Africa experienced an enlightened multilingual period twenty-one years ago with the transition to democracy. "*Multilingualism and language policies placed South Africa at the forefront of international innovation*", in Heugh's (2015) own words when she referred to the infant democracy and its constitution from twenty-one years ago.
The Constitution of the Republic of South Africa, chapter 1 makes provision for elven official languages of the Republic (The Constitution of South Africa, 1996, Section 1) and encourages the development of not only these official languages but also other minority languages. The Constitution of the Republic of South Africa was approved by the Constitutional Court on 4 December 1996 and took effect on 4 February 1997 (South African Government: online) and is the supreme law of the land.
A concerned Professor Heugh remarked that South Africa has stagnated with regard to its drive for multilingualism and that little progress has been made during the past twenty-one years. She remarked that she is afraid that South Africa might be left behind with regard to multilingualism (Heugh, 2015).
A comparison between the 2001 South African census and the 2011 South African census supports Heugh's apprehension as indicated in figure 1.
Figure 1 illustrates the comparison between the 2001 and the 2011 census for the population of South Africa by first language spoken at home.

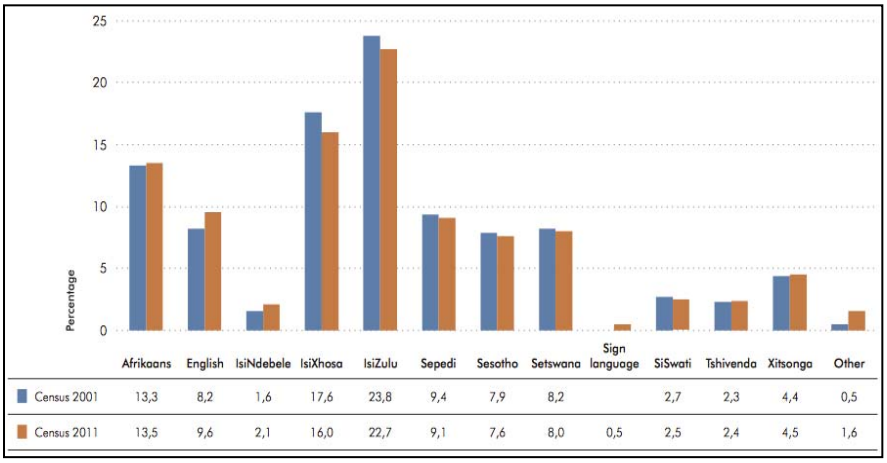

Figure 1 South Africa by first language spoken at home
(Statistics South Africa (b), 2011)

Figure 1 reveals that in 2001, the four most spoken languages among the eleven official languages in South Africa were;

1. isiZulu (23,8%)
2. isiXhosa (17,6%)
3. Afrikaans (13,3%)
4. Sepedi (9,4%)

From the perspective of a country encouraging multilingualism figure 1 does not indicate overwhelming growth in indigenous languages but rather decline to the clear advantage of English.

Table 1 compares the five most spoken languages among the eleven official languages in South Africa from the 2001 census to the four most spoken languages from the 2011 census.

Table 1: Growth / decline of the five most spoken languages in South African over 10 years

Language	2001 Census	2011 Censes	Growth/Decline
1. isiZulu	23,8%	22,7%	- 1,1% Decline
2. isiXhosa	17,6%	16,0%	- 1,6% Decline
3. Afrikaans	13,3%	13,5%	+ 0,2% Growth
4. English	8,2%	9,6%	+ 1,4% Growth
5. Sepedi	9,4%	9,1%	- 0,3% Decline

(Statistics South Africa (b), 2011) Own table

The results from the comparison between the 2001 and 2011 census revealed that English was the language that grew the most over the past ten years while most of the indigenous languages showed signs of decline.

2.1 South African languages: A World heritage

Professor Giliomee and Professor Mbenga began the first chapter of their book titled “New history of South Africa” with the notion that all people on earth today originated from Africa. Current fossil records proof that the “australopithecine” species, the ancestors from which “homo-sapiens (humans) developed lived in Southern Africa about 2 million years ago (Giliomee and Mbenga, 2007).

Discoveries of more recent stone artefacts and razor sharp arrow heads which dated about 18 000 years ago proofed that the people very similar to today’s San people occupied the area known today as the Western Cape (Giliomee and Mbenga, 2007). According to Giliomee and Mbenga (2007) it would be impossible to tell the language of these people 18 000 years ago but it was estimated that the “click” language of the San was already spoken 500 years ago. This language was used, among other uses, to transfer valuable knowledge from one generation to the next generation. The “click” language of the San was a treasured communication instrument.

On the 7th of June 2015, the South African Sunday Times reported on Katrina Esau, 80 years old, and her sister Hanna Koper, 95 years old, from the Upington area, who could allegedly be the last remaining speakers of the N|uu language, an ancient San language, one of the oldest languages spoken today (Sunday Times, 2015). When these two sisters die, they will take this ancient language, heritage treasure, with them to their grave.

Apart from the San languages, other Southern African indigenous language groups include the Sotho-, Tswana-, Nguni-, Venda-, Lobedu and the Tsonga people who roamed the fielded plateaus and rocky mountains of Southern Africa (Giliomee and Mbenga, 2007).

Appart form the indigenous languages, European decedents where introduced to the South African coastline in 1486 and brought with them a number of European languages among other, Portuguese, Spanish, Dutch, German, French, English, and Malayan (Giliomee and Mbenga, 2007). The youngest language spoken and used in South Africa today, baptized as “Afrikaans” derived from the name of the continent “Africa” and was only recognised as a true language in 1925 (Omniglot, 2015).

Archbishop Desmond Tutu accurately coined the term “Rainbow Nation” to describe the rich multi-cultural and multi-lingual South African nation after 1994.

Fifteen years prior to Archbishop Desmond Tutu’s well known description of the “Rainbow Nation” and fifty years after the Afrikaans language was firstly recognised, the indigenous population in South African, especially residents from Soweto, protested against the enforcement of the Afrikaans language onto schools by the former government (Giliomee and Mbenga, 2007). The protests had the intended global effect and fifteen years later South Africa recognised eleven official languages. This could have been seen as a step in the right direction towards a victory for multilingualism as Professor Kathleen Heugh referred to.

During July 2015, some students at the Stellenbosch University protested against a bilingual language policy and demanded a monolingual educational policy for the University (Petersen, News24, 2015). Quite the opposite of what happened during the 1960’s when protests demanded multilingualism.

From the aforementioned, the colourful linguistic landscape in South Africa could be described as complex and sensitive heritage due to the intricate political history. It should therefore be treated with respect throughout all the spheres of the South African society, including the built environment.

3. A MONOLINGUAL BUILT ENVIRONMENT IN A MULTILINGUAL COUNTRY

It appears that the *de facto* language used in the South African built environment in 2016/2017 to be English. Every Built Environment Council in South Africa communicates only through the English medium. The

South African built environment could therefore be described as a monolingual business environment dictated by the statutory bodies.
Section 4 (1) of Act 12 of 2012 also known as the "Use of Official Language Act" stipulates, "*every national department, national public entity and national public enterprise must adopt a language policy*". This policy complies with Section 6 (3) a of the SA constitution. The "Use of Official Language Act", does however not directly apply to the Built Environment Profession Councils (BEPC's) but could affect the BEPC's indirectly by recognising that national departments, national public entities and national public enterprises contribute collectively to the largest employer in the built environment (Khuzwayo, Bussiness Report, 2015). It could be argued that a monolingual built environment serves a multilingual client whose mandate stipulates the advancement of the eleven official languages of South Africa. The South African Built Environment Councils might however hypothetically argue that English could be seen as an international business language and therefore justify the monolingual built environment.

4. SOUTH AFRICA OPEN TO THE INTERNATIONAL BUSINESS ENVIRONMENT

4.1 English as the international lingua for business

It is a common belief that English is a global language of commerce, especially in the finance sector where it is not uncommon for countries where English is regarded as a second language that trading is normally done in English. According to an article written by Dublin City University, it is a pervading mind-set in the business sector in general, with multinational companies being the exception (Dublin City University, 2013). It stated that in a survey conducted by the British Chamber of Commerce in 2012, it was found that 96% of SME's (Small and Medium Enterprises) in the UK did not consider language skills when recruiting. The author of the article is of the opinion that English in terms of economic power has been declining and has been subsided towards upcoming economies and the economic power of the middle- and far East. The growing markets of Latin America mean that learning Spanish and Portuguese are far more advantageous than learning English, while learning Mandarin, Arabic and Japanese are obvious more beneficial than English for Asian and Middle-Eastern trade partners (Dublin City University, 2013).
Another article share the sentiment that businesses with multilingual capacity earn more than monolingual businesses (Nelson, 2013). The Dublin City University article goes further to imply that monolinguals could have a direct negative impact on businesses. It is estimated that about 11% or 945,000 of contracts in the UK are lost annually because SME's are unable to conduct business in a language other than English. Another benefit of being a multilingual business is intercultural awareness (Dublin

City University, 2013). An article in the Economist with the title "The disaster of monolingual Britain", confirmed this argument. In this article, the author made the point that the learning of foreign languages teaches humanity humility, empathy and respect for others (Charlemagne, The Economist, 2009).
Superimposing the aforementioned onto the South African community, the learning of indigenous languages could teach mutual respect for each other in a rainbow nation where the spirit of Ubuntu (the Nguni Bantu philosophy which means "humanity towards others") could be strengthened to its rightful distinction.

4.2 English as the *lingua franca* of business

English could be described as the 21st century lingua franca of the western world (Economist, 2002).
Lingua franca means bridge language, trade language, or common language that is used to make communication possible between people not sharing the same indigenous language, usually a second language to the native language (Oxford Dictionaries, 2015).
Fortunately, English has been recognised as one of the eleven official languages of South Africa. According to the 2011 census 9,6% of the South African population selected English as their home language. For many other South Africans, English could be and are being used as a lingua franca. It might be important to note that any of the other eleven official languages could also be used as a lingua franca.

4.3 The South African Department of Public Works

On 9 April 2014, the Minister of Public Works, Minister Thembelani Nxesi, signed a new policy document titled, "Policy Document on the Proposed Amendments of the Statutory Regulatory Framework of the Built Environment Professions". Among the challenges identified by the Minister was transformation of the built environment. The minister summarised it as follows:

> *"After 19 years of democracy, the number of previously disadvantaged individuals registered as professionals across the BEP's is dismally low – averaging under 25%. While this is a product of many factors, which Government is addressing, it is also the outcome of scarcity of innovation by respective BEPC's to address the impediments encountered by previously disadvantaged individuals to register as professionals."*
> (South Africa, 2014)

4.3.1. Council for the Built Environment

Minister Thembelani Nxesi accurately capture the communal responsibility of the built environment in the foreword to the 2013/2014 annual report issued by the Council for the Built Environment (CBE). He wrote the following:

> *"There is also a deeper dimension to the built environment and its relation to development. The built environment professionals, is the innermost mediator of the cultural, psychological and spiritual aspirations of a people, and is the core determinant within contemporary understanding of development which looks beyond meeting the material needs of a people to address their higher order needs of self-actualisation, psychological wellness and spiritual meaning."*

Accordingly, when the responsibilities of the built environment professions look past the material needs of the nation, to recognize the cultural, psychological and spiritual needs of the nation, then the built environment professions might recognize their responsibility as cultural mediator within the country. The built environment should be vigilant towards the various cultural identities within the South African community. Cultural identities consist of sensitive things like, symbols, customs, religion, values and languages among other things (Max-Neef, 1991).

The CBE chairperson for 2013/14, Ms Portia Tau-Sekati, highlighted two focus areas for the CBE in her foreword to the annual report. The one prospect of the CBE would be to redirect the focus of the CBE, with the aim of ensuring alignment to government priorities. The other closely associated with the previous prospect would be the acceleration of transformation in the built environment.

According to Mr Steven Lyons, the 2014 registrar of the South African Council for the Quantity Surveying Profession, transformation could be seen as a process that happens naturally within the quantity surveying profession but, according to the registrar, could be accelerated through funding (SACQSP, 2014).

4.3.2. Clients of the Built Environment a motivator for transformation and multilingualism

Although government funding might assist with transformation in the public sector, the private sector might be more challenging to transform. In the private sector the client would dictate the urgency for transformation.

> "*Today, more than ever before, business is about fulfilling client satisfaction.*" (Pries, et al, 2004 cited in Boyd and Chinyio, 2006).

A possible question to be addressed by the private sector could be; "*Should the focus of the South African construction industry be directed on the satisfaction of their clients; would the professionals consider addressing their clients in their clients' preferred languages?*" If so, this would mean that the professionals would have to transform along the lingual preferences of their clients. Lingual transformation might happen more naturally and more rapidly. Transformation would not be based on an imprecise visual observation like skin colour but rather on a practical enhancing linguistic ability to the benefit of the service delivering business as well as the broader non-English population.
Table 2 indicates the impracticality of the out-dated racial definitions, which attempt to box a wonderfully diverse population into only four partitions.

Table 2: BEPC's professionals & candidates per race

Council	African	White	Indian/ Asian	Coloured	**Total**
ECSA	13,233	26,291	3,394	1,021	**43,939**
SACAP	1,419	6,275	629	596	**8,919**
SACPVP	469	1,497	97	98	**2,161**
SACQSP	1,206	1,958	299	96	**3,559**
SACPCMP	1,128	2,011	151	98	**3,388**
SACLAP	11	211	4	4	**230**
Total	**17,521**	**38,334**	**4,585**	**1,928**	**62,368**

(CBE Annual Report, 2014)

Dividing people into racial categories reminds of a disturbing time in the South African history. According to the website of the Apartheid Museum, racial classification was the foundation of all apartheid laws (Apartheidmuseum, 2015). According to Gov. Bobby Jindal, a 2016 USA presidential candidate for the Republicans said on 9 February 2015, "One of the dumbest ways we divide people is by skin colour" (Washington Examiner, 2015). Skin colour could be seen as a divider while multilingualism could be seen as a means to unite.

4.3.3. Knowledge management through multilingualism

The United Nations Educational, Scientific and Cultural Organization (UNESCO) actively promote multilingualism and linguistic diversity. UNESCO believes that there might be a growing awareness about the role languages plays in ensuring cultural diversity and intercultural dialogue. UNESCO further advocate that knowledge and information impact peoples' lives significantly and that shared information and knowledge could transform economies and societies (UNESCO, 2015).
UNESCO believes that knowledge societies should be built onto four pillars, namely:

- Freedom of expression
- Universal access to information and knowledge
- Respect for cultural and linguistic diversity
- Quality education for all (UNESCO, 2015)

Knowledge transfer and knowledge management could be witnessed as a communication activity between parents and children in societies, which could be considered as the foundation of a moral society, but knowledge should also be similarly managed within a business or organisation.
David Bartholomew mentioned that the success of an organisation could be directly linked to the organisations ability to manage knowledge – "the basic economic resource" (Bartholomew, 2008). Employees join organisations with tacit knowledge, which could have been accumulated through learning, developing, training and experience. Employees grow and expand their knowledge further through the same process and the sharing and recording of high-valued explicit knowledge to create an organisational memory that is available to everyone should be priority for every organisation (Bartholomew, 2008).

4.3.4. Emotional intelligence through multilingualism

Accumulating quantitative and qualitative knowledge requires exploiting among other things emotional intelligence. Travis Bradberry wrote in 2014 an article on emotional intelligence on the forbes.com website that emotional intelligence consists of four core skills. One of the four core skills were identified as "social competence" which consist of among other attributes, communication skills (Bradberry, 2014). Interestingly enough, 58% of job performance depends on emotional intelligence according to talentsmart.com website (talentsmart, 2015).
Monolingual businesses could be limited to monolingual clients served by monolingual employees. The knowledge resource reserve for emotional intelligence might therefore be reduced to a single sector of the industry.

5. CONCLUSION

South Africa could truly be described as a wonderfully distinct country with a rich history with ample opportunities. The South African citizens could be seen as one of the natural resources among the abundance of other natural resources. The linguistic diversity of the country could similarly be described as an international heritage and asset (Giliomee and Mbenga, 2007). The South African constitution recognised eleven official languages and encourage the development of these.

The colourful linguistic landscape in South Africa could be described as complex and sensitive heritage due to the intricate political history and should therefore be treated with respect throughout all the spheres of the South African society, which include the built environment.
English as the *de facto* language used in the South African built environment might be to the disadvantage of the other ten official languages in South Africa. Although many arguments might support a monolingual built environment the scale might tip in favour of a multilingual built environment. This paper reached the conclusion that a monolingual built environment might be immoral and unconstitutional.

6. RECOMMENDATION

It is the authors' opinion that multilingualism might create a mutual cultural understanding and improve multi-cultural relations. This might contribute to the philosophy of "Unity in Diversity". This philosophy will enhance not only companies and industries but also countries.
Multilingualism could be applied to the mutual benefit of all parties involved. Multilingual communication as one of the tools of emotional intelligence makes business sense. Past president Nelson Mandela recognised this valuable negotiation tool and shared it in the following quotation.

> *"If you talk to a man in a language he understands that goes to his head. If you talk to him in his language, that goes to his hart."* Nelson Mandela

Dr Pamela Maseko (2015: Personal) from Rhodes University mentioned during the conversation on language policy issues at the University of the Free State, that, "a language develops as it is being used and used as it develops". This could be the essential ingredient missing from the South African built environment.
A simple solitary recommendation from this review would be that the South African built environment (participants, statutory and voluntary organisations) should attempt to make use of and develop the multilingual heritage of this country and encourage their members to do the same. The South African built environment should not only adhere to the national constitution but also has a humanitarian social responsibility towards country and its citizens.

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Perceptions and experiences regarding the use of alternative building technologies in school infrastructure in the Eastern Cape Province

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ABSTRACT AND KEYWORDS

Purpose of this paper

The aim is to improve conventional building methods and address infrastructural backlogs by exploring alternative building technologies. The study also seek to assess factors that contribute to school infrastructural backlogs in the Eastern Cape province.

Design/methodology/approach

An empirical study was conducted amongst Architects, Engineers and Quantity Surveyors and Department of Education officials within a case study using interviews and questionnaires. The study involved 4 Department of Education officials and 92 questionnaires sent randomly to Architects, Engineers and Quantity Surveyors obtained through the Department of Roads and Public Works database of professional service providers.

Findings

The key findings affirm backlogs in the provision of school infrastructure. Findings further indicate that alternative building technologies can be explored to address school infrastructure backlog; perceptions that

alternative building technologies are inferior to conventional technologies and lack of knowledge about them might be the underlying cause for their low acceptance and usage.

Research limitations/implications

The empirical study was limited to a single province and therefore further research is recommended to include other departments and other provinces and a larger sample.

Value

The study provides useful insights in to the potential of Alternative Building technologies in school infrastructure development.

Keywords: Alternative building technologies, alternative construction methods; school infrastructure backlog.

1. Introduction

Development Bank of Southern Africa (DBSA) (2012) reports that Eastern Cape Province is mainly constituted of rural areas. In addition, government is the largest employer and many people depend on social grants for their wellbeing (DBSA, 2012). DBSA (2012) states that education has increased potential to reduce people's dependency and increases their self-reliance. Kota (2013) claims that the state of infrastructure in the Eastern Cape deteriorates due to poor planning and limited investment in infrastructure reflecting both the historic and current trends. Office of the Premier (2004) reports that Eastern Cape Growth and Development Plan 2004 to 2014 identified infrastructure service delivery as a strategic long-term development. The 2013/14 Eastern Cape Department of Education (ECDoE) Annual Performance Plans highlighted school infrastructure as a major challenge in the province (Department of Education, 2013). ECDoE (2013) reports that an average of R50 billion is needed to eliminate school infrastructure backlogs in the province. ECDoE (2013) reports that infrastructure maintenance costs averaging R5 billion and R10 billion is insufficient and hinders efforts to eliminate school infrastructure backlogs

Fengu (2015) claims that an average budget of R52 billion is required for Eastern Cape to fix schools and comply with acceptable national regulations. Mr. Makhupula an MEC for education in the Eastern Cape Province, presented a detailed report to the Minister of Basic Education Mrs Motshega for maintenance and construction of new school infrastructure facilities averaging R122 billion (Fengu, 2015). The report reflected that more than 5500 schools servicing 1.8 million people in the Eastern Cape need adequate infrastructure (Fengu, 2015). Government Gazette (2013) states that norms and standards that were gazetted by the

minister during 2013 to regulate basic schools' required infrastructure for teaching and learning. Fengu (2015) claims that Eastern Cape Department of Education had three years to comply with the norms and standards. In addition, Fengu (2015) claims that it is impossible to achieve the targets sets for norms and standards because of inadequate budget and infrastructure backlogs. This means that backlogs could not be eradicated through the current school infrastructure construction techniques and funding norms. This study investigates the potential of alternative building technologies (ABT) in reducing backlogs and improving the funding mechanisms to bolster school infrastructure development and eliminate bottlenecks. This study contributes to an enhanced understanding of the use of alternative building technologies in school infrastructure.

2. LITERATURE REVIEW

2.1 Overview of Alternative Building Technologies

Verster (2006) claims that prosperity of any country is dependent on the level of investment in fixed property. Ganesan (1994) asserts that appropriate building systems through the construction industry requires to embrace various resources, procedures and techniques which promote countries' social and economic objectives and job creation. In addition, Ganesan (1994) claims that appropriate technology requires to address problems and positively respond to social and economic realities. Sanya (2010) adds on that alternative technology need to incorporate other available appropriate technology and promote sustainable development. Wells (1993) asserts that appropriate technology should encompass the amount of technology that can be produced, amount of capital involved in production process and amount of machinery needed versus available labour force. Mehta & Bridwell (2005) claim that affordability is an important aspect of alternative technology into infrastructure development. In addition, structural soundness of developed infrastructure cannot be compromised even when using environmentally appropriate technology (Mehta & Bridwell, 2005). For MacLeod (2002), it is essential that the product being built meets the potential beneficiary requirements.

Wienecke (2010) states that alternative technology means providing society with applied available local resources through alternative conventional materials. Akinwumi, Awoyera & Bello (2015) claim that despite conventional use of materials in infrastructural development, increased awareness of alternative construction materials and techniques can enhance environmental friendliness, affordability and reduce energy consumption. Odhiambo & Wekesa (2010) advocate that building technologies help improve or address socio-economic needs of the poor. Similarly, Steyn & Bosman (2010) claim that perceptions about what is viewed as not durable in building material is about what people are

accustomed to rather than quality assessment of observed material. Roets & Ramraj (2010) agree that challenges with alternative building technologies are mostly about perceptions. In addition, Roets & Ramraj (2010) claim that alternative building technologies existed over a long time but there is reluctance to accept them as adequate. Thus while some technologies have been licensed, beneficiaries perceive alternative material as comprised of inferior quality compared to conventional material. King (2005) asserts that alternative materials is a challenge for many built environment professions because of trusted conventional material accustomed to than the non-accustomed material.

2.2 South African Agrément certified building system

Alternative Building Technologies (ABT) is also referred to as Alternative Construction Methods (ACM) or Innovative Building Technologies (IBT) and these will be used interchangeably in the present study. Mphahlele (2014: 2) claims that ABT is defined as "the use of materials and technologies not covered by the building standards in the National Building Regulations (NBR) and Building Standards Act (Act 103 of 1977) where such materials and technologies require either rational design or an Agrément certificate." Conradie (2014) claims that ABT means a South African Agrément certified building system, but excludes masonry and is commonly used construction method in South Africa. ABT can be regarded as one form of innovation. Agrement South Africa states that innovations that are mostly readily implemented or adopted in the building and construction industry are those which:

- Improve productivity,
- Lower costs, or
- Enhance decorative products and finishes, with costs considerations being of secondary importance (Agrément South Africa, 1999: 8).

Agrément South Africa (1999) is a recognized statutory body that examines and approves ABT methods of construction against performance based criteria. Performance criteria and test methods are established in consultation with relevant experts in the field (Odhiambo, 2007). Odhiambo (2007) claims that evaluations include an assessment of applicant's quality system and implementation must be monitored regularly after the certificate has been issued. In cases where the ABT in question is assessed as fit for purpose, then the Board of Agrement South Africa grants the certificate. Agrement South Africa also provides assurance on fitness for purpose and quality of ABT methods of construction. It also provides technical information for interpretation and use during ABT implementation to end users (Van Wyk, 2014). This study deduces that Agrément SA supports and promotes innovation and technology development in the construction industry.

Most ABT methods are pre-fabricated. Pre-fabrication decreases the construction period because component production is not on site. This study argues that this approach improves quality control, reduces wastage and increases production speed. However, pre-fabricated structures negatively affects unskilled labour due to highly skilled needed labour and increased transportation costs (Botes, 2013). Conradie (2014) claims that ABT building systems can be classified into groups according to mass ranging from light weight to heavy weight building systems. This classification becomes an important piece of information especially in social infrastructure construction such as schools (Conradie, 2014). ABT buildings do not normally have air-conditioning installed in them and can be constructed in any part of South Africa (Conradie, 2014). The choice of suitable building systems that are compatible with prevailing climatic conditions is important (Conradie, 2014). Furthermore, Conradie (2014) explains that six building systems classification types were thermally examined in 38 cities and towns that represented various and different climatic conditions in South Africa. This revealed a favourable advantage of ABT in that they can be chosen to match prevailing local environmental conditions.

3. RESEARCH METHODOLOGY

3.1 Research approach

The empirical study used mixed methods with case study and applied interviews and questionnaires. The case study involved Physical Resources Management programme of the Eastern Cape Department of Education to establish the existence of school infrastructure backlog. Questionnaires and interviews were conducted to determine bottlenecks in the uptake of ABT in addressing school infrastructure backlogs and potential solutions. Respondents were requested to give an estimate of backlogs, to provide specific projects where ABT was used and generally what they thought needed to be done to increase uptake of ABT in solving school infrastructure backlogs. Ninety two (92) questionnaires were distributed to randomly selected professionals from a database of professional service providers sourced from the Department of Public Works (DPW) Supply Chain Management section, with a 57.61% response as indicated in Table 1. The findings are presented and discussed in the next section.

Table 1 Work Experience of the Questionnaire Respondents

Number of Years of experience in respective professions	Number of respondents	Percentage (%)	Rank
0 – 5	5	9.44%	5
6 – 10	11	24.53%	2
11 – 15	13	20.75%	3
16 – 20	15	28.30%	1
20+	9	16.98%	4
Total	53	100%	

4. RESULTS PRESENTATION AND DISCUSSION

4.1 Familiarity with ABT methods and Associated Perceptions

Respondents were asked about their knowledge of ABT, roles of certain institutions and their perceptions of ABT and had to indicate their level of agreement or disagreement to each statement posed from ranging from 1 strongly disagree to 5 strongly agree as ranked in Table 2.

Table 2 Familiarity with ABT Methods and Associated Perceptions

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Mean	Rank
	1	2	3	4	5		
I think communities (where schools are built) are not familiar with Alternative Building Technologies.	0.00%	7.55%	7.55%	33.96%	50.94%	4.28	1
I think that Alternative Building Technology can be constructed faster than the conventional brick and mortar in school infrastructure delivery.	7.55%	0.00%	7.55%	45.28%	39.62%	4.09	2
There are perceptions that Alternative Building Technologies are of inferior quality especially when compared to conventional brick and mortar.	3.77%	7.55%	13.21%	26.42%	49.05%	4.09	2
I am familiar with Alternative Building Technologies (ABT).	0.00%	7.55%	13.21%	52.83%	26.41%	3.98	3
I think one can rely on Agrement certification as an indication that Alternative Building Technologies are as good as the conventional brick and mortar when properly applied.	0.00%	16.98%	39.62%	30.19%	13.21%	3.40	4
I have been involved in a project where Alternative Building Technologies was employed as a method of infrastructure delivery.	7.55%	22.64%	7.55%	49.06%	13.21%	3.38	5
I think that Alternative Building Technologies can cost far less than the conventional brick and mortar in school infrastructure delivery.	7.55%	20.75%	20.75%	30.19%	20.76%	3.36	6
There is reasonable amount of information that is disseminated around Alternative Building Technologies developments.	0.00%	30.19%	30.19%	32.07%	7.55%	3.17	7
I am familiar with Agrement South Africa certified Alternative Building Technologies methods.	7.55%	30.19%	16.98%	30.19%	15.09%	3.15	8
There is reasonable amount of literature available around Alternative Building Technologies.	0.00%	26.42%	43.39%	22.64%	7.55%	3.11	9
There are government policies or strategies to promote the use of Alternative Building Technologies in school infrastructure in the Eastern Cape Province.	7.55%	30.19%	26.42%	35.84%	0.00%	2.91	10
Alternative Building Technologies is reasonably covered in Tertiary Institutions syllabuses.	9.43%	26.42%	52.83%	7.55%	3.77%	2.70	11

A noticeable finding in table 2 is the statement ranked 1st with a mean of 4.28 where respondents (about 84.90%) agree that “I think communities are not familiar with ABT”. The respondents also agree with the statement ranked 2nd with a mean 4.09 that the perception is that ABT is of inferior quality especially when compared to conventional brick and mortar. These findings are consistent with the literature review (King, 20015; Bosman 2010; Roets and Ramraj, 2010) regarding perceptions of ABT. It also emerged that the majority of respondents (about 84.90%) think that ABT can be constructed faster than the conventional method, with the statement ranking 2nd with a mean of 4.09. The statement ranking 4th with mean of 3.40 is worth noting as it indicates that the respondents think that the certification is critical component of ABT. About 62.27% of the respondents indicated that they have been involved in a project where ABT was employed as a method of infrastructure delivery; this is ranked 5 with the mean of 3.38.

Table 2 also shows a mixed reaction from the respondents on the questions posed to them as the means ranged from 2.70 to 4.28. The findings show that a reasonable percentage of the respondents (79.24%) with a mean of 3.98 and ranking of 3, indicated that they are familiar with ABT. However, the statement which ranked the least (11) (mean 2.70) indicates that the respondents are of the view that institutions of learning are not doing enough to promote ABT or disseminate information about ABT. This is closely followed by the statement ranking 10 with a mean of 2.91 where respondents believe that government is also not doing enough to promote use of ABT to address backlogs in the provision of school infrastructure.

The respondents were not entirely convinced about the cost effectiveness of ABT when compared to conventional brick and mortar method of delivery. This is the case because about 50.95% believe that ABT cost far less than conventional brick and mortar, while 28.3% disagree and a further 20.75% is undecided. There also seems to be doubt as to whether a reasonable amount of information is being disseminated around ABT developments as only 39.62% of respondents believe that is the case. About 30.19% disagree with the statement that “there is reasonable amount of information that is disseminated around ABT development”, while a further 30.19% is undecided. Less than half of respondents do not seem to be familiar with Agrément certified ABT methods as only 45.28% claims to be familiar. About 37.74% indicated that they are not familiar with Agrement certified ABT methods, while another 30.19% is undecided on this statement. Respondents are also not convinced that “there is reasonable amount of literature available around ABT” as only 30.19% believe that this is the case, 26.42% disagree and a further 43.39% is undecided. These findings seem to echo the literature that most professionals are accustomed to conventional technologies, suggesting that ABT are limited or not widely used (King, 2005).

4.2 Findings from the Interviews

All four interviewees agreed that there are challenges associated with applying conventional methods to school infrastructure development. Challenges cited ranged from difficulties in transportation due to the rural nature of the Province with increased costs implications, prolonged construction periods and delays and late completion of projects through conventional methods. Interviewee C mentioned that the benefit of conventional method is that it is labour intensive and therefore creates employment opportunities. This therefore indicates that although the conventional method is the most employed in school infrastructure development, it does have its own challenges. This is in line with questionnaires as well as the literature review findings as indicated by Ayowera *et al.* (2015). Two (2) of the four (4) interviewees were familiar with ABT through reading about it while the other two (2) were involved with ABT school projects. All interviewees agreed that the government did not have policies that promote ABT uptake and this was consistent with the findings of the questionnaire. Participants also indicated that they thought that ABT was not adequately covered in Tertiary curriculums. This was also consistent with questionnaire and literature review as King (2005) claims that most Engineers are accustomed with conventional building materials and are likely to be cautious and sceptical when applying alternative materials which they are not accustomed to.

There was consensus among the interviewees that ABT methods are perceived as having inferior quality. This finding is also in line with questionnaire and literature review because Roets *et al.* (2010) indicate that there are some challenges with implementation of ABT and the perceptions negatively affect ABT. Three (3) interviewees felt that good routine maintenance of the current school infrastructure should be the starting point as huge sums of money are spent rehabilitating buildings that are in advanced stages of dilapidation. Furthermore, three (3) interviewees advocated applying combined acceptable building methods as reliance on one option may not address the backlog. The finding is consistent with literature review as Van Wyk *et al.* (2012) believe that combination of environmentally friendly technologies that are in the construction sector contribute positively to infrastructure development.

All interviewees felt that consumer education should be a critical component of ABT employment and as such government and learning institutions should play an active role in ABT uptake, this is in line with questionnaire findings and this is consistent with literature review (South Africa. Department of Human Settlement, 2010). One (1) interviewee was of the view that establishment of local business enterprises is another step that needs to be taken towards addressing the backlog using ABT but these enterprises should be capacitated and make use of local resources. This finding is aligned with the literature review because Mehta *et al*. (2005) indicates that applied appropriate technology can be expected to afford the

builders affordable construction, less importing and more economic participation opportunities to local labour force. This has potential to promote economic growth as there will be more participants in the economic activities of the country and therefore creating a much broader tax base.

The study put forward the proposition that employment of Alternative Building Technologies may be limited due to perceptions associated with inferior quality of ABT. It was found that there are negative perceptions around ABT as a construction method and that communities are not familiar with these types of construction methods. Responses with 75.47% agree that there are perceptions that ABT is of inferior quality relative to conventional method. Of the respondents who agreed with the statement, 49.05% of the respondents strongly agree that there are perceptions that ABT is of inferior quality compared to conventional method and 26.42% agree, about 13.21% of respondents are not certain whether this is the case while a further 11.32% disagree with the statement. The above findings show that the above proposition is supported because more than 50% (75.47%) of the respondents agree that there are perceptions that ABT is of inferior quality especially when compared to conventional method, leaving 13.21% respondents uncertain and 11.32% disagreeing with that.

A second proposition made by the study was that employment of Alternative Building Technologies may be limited due to lack of awareness of ABT. Responses showed that majority of 50.94% of the respondents strongly agree that communities are not familiar with ABT, 33.96% agree with the statement and 7.55% are not certain while a further 7.55% believe that communities are familiar with ABT methods. Although the professionals in the study said are familiar with ABT methods, there is however a belief that learning institutions are not reasonably covering ABT in their curriculums (35.85%), while a majority of 52.83% is not certain about that. The view that the majority of respondents are not certain about the curriculums covering of ABT highlights areas of worth investigating by institutions. There is a further belief among the respondents that there is not enough information disseminated about ABT, 30.19% agree with this while another 30.19% is not certain, hence communities may not be familiar with ABT. Another critical belief is that government is not doing enough to promote ABT, 37.74% of respondents agree with this while a further 26.42% is uncertain. This therefore indicates 84.90% of the respondents agree that communities (where schools are built) are not familiar with ABT, with a further 7.55% of the respondents uncertain and another 7.55% disagreeing with the statement. These findings partially support the second proposition as no study has been conducted on the contents of curriculums in tertiary institutions.

5. CONCLUSION AND RECOMMENDATIONS

The findings of this study suggest that the respondents were aware that there are backlogs in the provision of school infrastructure in the province. The indication though was that ABT cannot be implemented in such a way that it replaces conventional method but the two must co-exist in order to effectively deal with the backlogs. The interviewees advocated for collaboration with innovative institutions. To this end the feeling was that research units within infrastructure departments be established in order to facilitate interactions with innovative institutions to keep abreast of developments in the built environment. There was a strong view that strategies around procurement of ABT needed to be developed, this was necessitated by the fact that government prefers open tendering and yet there might be limited number technologies of a particular type that is required at the time.

The results suggest that built environment role players would like to see construction industry moving forward towards the employment of ABT methods in addressing school infrastructure backlogs in the Province. This study concludes that while there is a backlog regarding the provision of school infrastructure, there is limited application of ABT as an alternative method in the Eastern School Building Programme.

The following recommendations are made to improve ABT application in school infrastructure development:

1. Further studies be undertaken to establish the extent to which ABT is covered in curriculums of tertiary institutions in the built environment.
2. Consumer education programs and change management on ABT be drawn up by implementing agents of school building programmes to raise awareness about ABT benefits.
3. Institutions for innovations be included in the planning process of infrastructure government departments to promote research projects that are likely to link ABT methods to available local resources.
4. Government should be encouraged to produce policies and strategies (especially around procurement) to promote the uptake of ABT construction methods.
5. Need to explore and increase awareness and usage of ABTs by industry stakeholders, both private and public sectors and criteria and best practices be developed.

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ASOCSA2017- 103

Technology for Instructors: A Pilot study

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ABSTRACT AND KEYWORDS

Purpose of this paper

This paper investigates the perceptions of instructors with regard to new technologies in the classroom and their possible effect on the student learning experience.

Design/methodology/approach

The qualitative research method was utilised. Two focus groups were conducted in the Built Environment Programmes in two Universities of Technology in KwaZulu-Natal. The results were analysed using thematic analysis were similar themes were grouped together and analysed.

Findings

it was found that instructors at these 2 institutions do not embrace technology as they should and therefore the effect on the student learning experience could not be investigated.

Research limitations/implications

This study is confined to two public Universities of Technology in the Province of KwaZulu-Natal in South Africa. Future research should be extended to the Gauteng and Western Cape Provinces of South Africa as

these Provinces have a five additional public universities where built environment programmes are offered.

Practical implications
This paper discusses how technological advances can be utilised by instructors with the aim of changing their teaching methodologies from a teacher-centred to student-centred teaching.

What is original/value of paper?
Limited research has been undertaken in built environment programmes in South Africa which has focussed on the instructor and their perceptions of technologies available in classrooms and the effect that these have on the student learning experience. This paper will be of value to instructors who are prepared to use technology in the classroom.

Response to the Conference Theme: **Construction Education, Training and Skills Development**

Keywords: Instructors, Built Environment, Classroom, Technology

1. Introduction

In order for technology to be an asset in teaching and learning, the instructor needs to be able to use that technology effectively and constructively (Webster, 2017, Glassett and Schrum, 2009). Technology allows teachers to connect students to each other and to new information, ideas and perspectives (McNight, *et al*. 2016, Neto, 2016, Ricoy and Feliz, 2016). Technology allows instructors and student's access to a wider range of learning resources to keep content current and to provide a greater depth and richness that is not available through textbooks. This paper investigates the perceptions of instructors with regard to the new technologies in the classroom and their possible effect on the student learning experience.

2. The Educator and Technology

In order for technology to be an asset in teaching and learning, the technology must not be the driving force, but it is the ability of the instructor to use that technology effectively and constructively (Webster, 2017; Glassett and Schrum, 2009). Technology provides efficiencies for teachers and students helping teachers focus their time on instructional planning and delivery. (McNight, *et al*. 2016; Ricoy and Feliz, 2016).
Educational goals and the curriculum should drive the use of technology in the classroom (Webster, 2017). Technology allowed students access to a

wider range of learning resources to keep content current and provide a greater depth and richness not available through textbooks only. Technology allowed teachers to connect students to each other and to new information, ideas and perspectives (McNight et al. 2016, Neto, 2016, Ricoy and, 2016).

However even allowing for the principle that technology is a tool, educators also need to be proactive as if they did not actively keep up with the use of technology in the classroom, they would be left behind, as technological change is inevitable (Webster, 2017). This results in students actively seeking their own information (Neto, 2016) and sharing this with the broader community of the classroom which in turn develops greater pride and responsibility in their work.

One of the results of the introduction of technology as a resource is that learning changes from teacher centred to student centred (McNight, *et al*. 2016; Glassett and Schrum 2009). Cognitive processes were improved (active enquiry versus memorisation) and teacher roles changed from content delivery to facilitator (Glassett and Schrum 2009). This results in students actively seeking their own information (Neto, 2016) which develops greater pride and responsibility in their work. In schools where technology implementation was successful teaching practice changed positively (McNight, *et al*. 2016; Ricoy and Feliz, 2016; Glassett and Schrum 2009). Technology in teaching is a tool which:

- Improves access to information (McNight et al. 2016, Ricoy and Feliz, 2016);
- Enhances communication and feedback (Webster, 2017, McNight et al. 2016).
- Restructures Teacher time (McNight et al. 2016).
- Extends purpose and audience for student work (McNight et al. 2016).
- Shifts teacher and student roles (McNight et al. 2016).

The different types of technology that can be utilised by instructors is discussed below.

3. Technology in the classroom

3.1 The Blackboard, Whiteboard and Interactive Whiteboard

The blackboard was developed when the headmaster of the Old High School in Edinburgh connected a number of plates together to show his class a large map. In 1801, George Baron a West Point Mathematics teacher also used this format to illustrate complex formulas to large audiences (Buzbee, 2014; Wojenski, 2002). The whiteboard was invented in the 1960s, although due to the cost, it was only began to be used in the 1970s. It was finally adopted in the 1990s when it became cheaper to

produce the writing surface (Callanan, 2014). In 2001, however Smart Boards came into the classroom (Wojenski, 2002). This allowed the teacher to use the draw, type, surf the internet from the board. The board also allows the teacher to print for the students (Wojenski, 2002). Interactive whiteboards are beneficial to both instructors and students (Smith, *et al*. 2005). The availability of Computers in the classroom however as well as the use of laptop computers, tablets and smartphones has surpassed even the smart board. With internet connection in most university classrooms and students being able to access the internet on their personal electronic devices most classroom now only use a common writing surface for a minimum of classroom interaction between instructor and students.

3.2 The Blog

A term that has come to the fore is the blogosphere. Miller and Ullmer (2013) refer to this phenomenon as providing students access to new and up to date thinking of authors that have not yet been captured in textbooks. The blog is an important method for students to share their own ideas as well (Jiugen and wen Kewen 2016; Yang, *et al*., 2016; Hyman, 2013; Dabbagh and Kitsantas 2012). Ideas on blogs boost the learning process (Pinya and Rosseló, 2016), are fresh (Kissinger, 2013) whereas those in textbooks may very well be dated. Blogs change constantly whereas text books only change when new editions are produced (Kissinger, 2013). Blogs are useful for communication between instructors and students (Lee and Bonk, 2016). The power of blogs however lies in the innovation and purpose of their use (Hyman, 2013).

Blogs allows information to be distributed quickly to a large number of users across the spectrum of education, business and government (Jiugen and wen Kewen 2016). Students consider that the blog is a learning tool that allows them to achieve professional competence, (Jiugen and wen Kewen 2016) that they find enjoyable (Pinya and Rosseló, 2016) flexible and convenient. Students are also able to learn from one another from what they post on their blog (Yang, *et al*, 2016).

3.3 eBooks

The emerging eBook revolution offers institutions many opportunities to enhance the academy and increase the standard of their libraries without increasing their library budgets (Loan & Un-nisa, 2015). eBooks upgrade the learning tools alongside other fast-paced technological advances in society at present (De Luna, 2015). Additional advantages of the eBooks are the ease of updates as well as being able to underline and highlight (Joseph, 2015, Isik, 2013). In addition, it has been found that the use of eBooks, has had a positive effect on attitudes towards reading (Isik, 2013). The production of the eBook also takes far less time than production of the

printed version (Joseph, 2015). Kissinger, (2013) was able to draw six conclusions into the student use of eBooks, which are:

- Students expressed competence in their use of mobile eBooks
- Students expressed feelings of high-efficacy when using mobile eBooks
- Students valued the use of the mobile eBooks for their learning
- Students were individualised and metacognitive in their learning
- with the eBooks
- Students enhance their learning socially and within situated
- learning opportunities, and
- The students and the instructors have divergent views on the value, and
- Utility of social interactive textbooks.

a. The Virtual Space and Mobile Learning Systems

Virtual worlds are environments where students are able to connect to one another or to instructors digitally (Saunders, *et al*., 2011). For the use of virtual space to be acceptable to students, students want to enjoy the experience of using the virtual space (Tokel and Isler 2015, Gibbins, et al. 2010). As many students are unable to attend classes on site many institutions have introduced distance learning programmes where students study via virtual space learning (Gibbings, *et al*., 2010). In addition, many institutions may have situations where multi-campuses are used by the institution and instead of a repeat of a lecture, video conferencing may be used instead (Szetto, 2014). Technical courses or problem based learning (PBL) can be delivered effectively in virtual space if the courses are appropriately developed, facilitated and managed (Gibbings, *et al*., 2010). Modular Object Oriented Development Learning Environment (MOODLE) is also an example of the use of the virtual space as a learning environment (Neto, 2017). Mobile learning systems (MLS) are also an integral part of the virtual space (Lin, *et al*. 2016).

3.5 Social Media

Student educational experiences will be substantially different in the 21st century because the significance played by social, economic and technological changes (Ricoy and Feliz, 2016; Neier and Zayer, 2015; Heavin and Neville, 2012). Social media has proven to enhance the student experience in Higher Education (Heavin and Neville, 2009). Students are

open to the use of social media in education as long as it focuses on the field of study (Neier and Zayer, 2015). It was also found, (Neier and Zayer, 2015), that students were careful to separate their leaning experiences from their personal life, as an example although they were knowledgeable about Facebook, they did not believe that it has a place in education in so far as sending out class messages (Neier and Zayer, 2015). Social media also allows students to communicate with one another outside the normal lunchtime, peer group sessions, class time (Dabbagh and Kitsantas 2012). In order that social media continues to be used successfully in higher education, the instructors use of social media in individual courses will result in its success or failure, therefore it is the instructor that has to adapt to the changing needs of society (Ricoy and Feliz, 2016; Heavin and Neville, 2012). Students found Twitter specifically to be of great use in higher education (Ricoy and Feliz, 2016). Students regarded universities that communicated to students via social media to be "*up to date and trendy*" (Neier and Zayer, 2015).

3.6 The Flipped Classroom

The flipped classroom is a technology supported innovation that many academics are using worldwide (Zhu and Chen, 2016; Meyers, 2016). The flipped classroom is when the higher level of Blooms Taxonomy, to develop higher order thinking skills is done in the classroom for interactive activities, such as lecturer student, student to student time, and the lower level of Bloom's taxonomy is taken up, out of classroom time when students interact with videos, audios, content-rich websites etc. (Jong, 2017; Meyers, 2016). Therefore, what would have previously been lecture time is undertaken by the students in their own time (Huang and Lin, 2017; Yong, *et al*. 2017). Therefore, in the flipped classroom what would previously have been student self-study is now interactive classroom time (Hwang and Lai, 2017, Yong, et al. 2017, Zhu and Chen, 2016, Meyers, 2016). A study by Çakıroğlu, & Öztürk, (2017) found that students watched the videoed class more than once to understand the contents. This is another advantage over the traditional class where the lecture is only available once. Hwang and Lai (2017) found that in a study with the flipped classroom and eBooks, not only did students learning improve, the eBooks allowed students' efficacy to improve as well. It was also found that the weaker students were the primary beneficiaries of the eBook and flipped classroom teaching method (Hwang and Lai (2017). The flipped classroom demands more time and are more demanding than the traditional teaching model in preparation, (Zhu and Chen, 2016), however it also uses classroom time more efficiently (Meyers, 2016).

4. Research Methodology

In qualitative research, data may be collected by various means, observations, analysis from text or videos, interviews and focus groups (Gill, et. al 2008). This research used focus groups as a preferred method, as it was decided that the interaction between the moderator and the group members and the group members amongst themselves gave an opportunity to collect rich deep data that would be of more value than questionnaires or interviews.
Focus groups are a participatory form of qualitative research and comprises group-based interviews which reveals opinions and perspectives (Winlow, *et. al.*, 2013). A focus group, although it shares some commonality with interviews, allows the moderator to guide the discussion and record it (Gill, *et. al*., 2008) as to not lose the essence of the discussion. It also allows the moderator to study the respondents in a natural setting.
In order for the focus group to be relevant, the size and mix of the group must satisfy the need. Interaction is the key (Gill, *et. al*, 2008). Thus a group of colleagues in this case was deemed best.
Two focus groups were conducted for this study, one at each University of Technology in KwaZulu-Natal. Each focus group consisted of four members and the facilitator followed a semi-structured set of questions.

5. Data Analysis

The focus groups combined consisted of four males and four four female academics. The qualifications ranged from Bachelor of Technology, four Masters Degrees and three staff members having a PhD, with only one instructor having a Post Graduate Diploma in Education.

The academics in institution A currently utilised laptops and PowerPoint. They connected the laptop to the internet so that they could google something such as videos to show the students. The academics from institution B stated that they used the overhead and data projectors. One instructor mentioned that Blackboard was also used.

All the members of focus group A knew what a smart board was but none of them knew how to use it. Some of the comments received were:

- '*By the time it was developed it was out of date. It has not taken off as it was thought it would'.*
- *'What was the point of the smartboard? So many other things that the smartboard has, has been bi-passed…'*
- *'Something is introduced and it rests upon the employee to figure out how the technology works.*

Blackboard was a case in point as an employee you were expected to learn to use it yourself…'

Focus group B was confused as to what exactly a smart board was. After much discussion, they stated that they have not used the smartboard as their department only has one venue with a smartboard.

None of the academics at either institution had blogs for private or academic use. One instructor however felt that blogging could be very powerful as a communication tool. However, blogging requires a talent as you need to be an articulate writer to use it. If students want to develop a blog the instructor would not mind being part of it to ensure what is being shared on the blog is actually correct. Another instructor raised the issue that the departments could develop a blog per subject stream. A further comment received was that a blog could perhaps have a '*frequently asked question*' section. The only concern raised about utilising blogs for academic purposes is that instructors felt that students would not keep to the discussion. They did not know however that the blog could be blocked so the students are restricted from commenting if they felt that the comments might be out of order.

With regard to eBooks, academics from focus group A did in fact use eBooks but raised the concern that they did not get much assistance from the library. The instructors from focus group B confirmed that eBooks were available and while '*they did not use them the students used them*'. They also stated that they did not prescribe the eBooks in any modules. One of the reasons given for this is that '*the hard copies were available*'. The major concern raised regarding eBooks were copyright and legality surrounding eBooks. While some books are available online, the legality of this is debatable and the copyright issues are unknown at the moment. Some of the instructors did point out that eBooks have certain advantages over the hardcopy, such as "*they are easier to carry and students have the books on their phones for ease of use*."

The participants in both focus groups did not know what virtual space meant. On Mobile Learning Systems (MLS) the instructors in focus group B knew of Blackboard but did not know that it was an MLS. The instructors confirmed that they knew Blackboard was available but did not know of any other MLS available at the institution. There was confirmation that the instructors knew some of the uses of Blackboard other than only posting information for students. This set of instructors also stated that they did not use WhatsApp or Facebook as a means of communication with their students.

Focus group A knew that both Blackboard and Moodle are available for use; however, the departmental instructors prefer using Blackboard as this was the system that they had learnt how to use. This group also stated that they did not use WhatsApp or Facebook as a means of communication with their

students. In fact, one instructor stated, "*she does not want to use social media as it infringes on academic/personal time…..The moment you use Facebook, Instagram, WhatsApp, it is personal*."

The instructors from institution A understood that a flipped classroom was "*giving students reading and the lecturer time was used for deep discussion*". The concerns raised were that the instructors "*did not believe that students will do the reading to do and they did not know how the students will react*." Focus group B did not know what a flipped classroom was.

When asked about the future of technology in academia the following responses were received:

- *"… a new idea is where you can record on Office 365 Mixit.*
- *"… I want to use Office 365 and skype as the travelling for some students in the evening is prohibitive, however this must still be investigated".*
- *"…students are more excited to use technology than staring at my face in the classroom".*
- *…technology is the way to go as students get lost in the talk for 2 hours which many instructors practice as they were brought up like that".*
- *"Students lose concentration as they start fiddling around so the concept of using more technology is for the benefit of the students as well the benefit of the instructor".*
- *"….technology is helping with problems such as attendance in the classroom by bringing the classroom to their homes…"*

6. Conclusion

This paper investigated the perceptions of instructors at two Universities of Technology in KwaZulu-Natal with regard to the new technologies in the classroom and their possible effect on the student learning experience. However, the effect on the student learning experience could not be investigated as it was found that academics in these two institutions do not effectively utilise technology. Consensus was that the smartboard was redundant and there was some resistance to blogging. Academics liked the concept of eBooks but at the moment there it stays as none of them prescribe any of these books in their courses.
This study was a pilot study, which forms part of a bigger study that looks to conduct further research at other public universities where built environment programmes are offered.

7. Recommendation

Based on the findings it is recommended that academics at these institutions embrace technology. The instructors need to be made aware that students do possess the mobile learning systems that will facilitate communication and learning by means other than just PowerPoint presentations in class.

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ASOCSA2017- 104

The Efficacy of introducing inquiry based learning in construction education to improve the skills of construction graduates in South Africa

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ABSTRACT AND KEYWORDS

Purpose
The purpose of the study was to investigate the possibility and practicality of implementing Inquiry Based Learning in construction education in South Africa's' higher education to foster the improvement of the critical skills needed by the 21th century construction graduates.

Methodology
The review of relevant literatures was carried out on the challenges that might hinder the implementation of Inquiry Based Learning approach in construction education in South Africa.

Findings
The study revealed that the implementation of IBL maybe beneficial to construction education in South Africa but its successful implementation might be hindered by some challenges identified in this study.

Research limitations/implications
This study presents findings from a review of literature and constitutes the first phase of an empirical research on the implementation of Inquiry Based Learning approach in South Africa.

Practical Implications
The outcomes of this study will guide the continued implementation of inquiry-based learning in construction education, and this will set an example for disciplines in engineering and the sciences. The research also identified challenges of implementing IBL in South African Universities.

What is original/value of paper?
The efficacy of introducing inquiry based learning in construction education is South Africa was identified.

Response to the conference Theme
This study speaks to Construction Education, Training and Skills Development.

KEYWORDS:
Construction; Education; Inquiry Based Learning Skills; Traditional lecture approach.

1. INTRODUCTION

All higher education institutions in South Africa have goals, missions and visions tailored around producing graduates with relevant skills. These skills should make them relevant and useful to themselves and the country in general. In a study conducted by Paramasivam and Muthusamy (2012), six critical methodologies that will aid the production of graduates that are innovative, creative, adaptable and of global workforce standard were identified. These approaches/ methodologies includes: theory of inventive problem solving (TRIZ); outcome based education (OBE); internship and continuous quality improvement (CQI); case based learning (CBL); project based learning (PBL); and Inquiry based learning (IBL). Likewise learners acquiring content knowledge is not enough for them to succeed in the 21st world of work especially in engineering and science related professions like Construction Studies. Learners are also expected to acquire competencies such as team work, professionalism, problem solving, critical thinking and so on. For these competencies to be obtained, there is need for a shift from teacher centred approach to a more learners centred approach as outlined by Paramasivam and Muthusamy (2012), and Zulu and Haupt (2015).

Therefore this study aim to exploit the possibility and practicality of implementing Inquiry Based Learning in construction education in South Africa.

2. INQUIRY BASED LEARNING

There are various types of approach to learning that takes place through inquiry (Prince and Felder 2006). In this study inquiry-based learning (IBL) refer to all pedagogical approaches where priority is given to learners' investigative work involve solving problem and addressing questions. Many authors have defined IBL in various. According to Levy *et al.* (2010:6) IBL can be defined as 'a cluster of strongly student-centred approaches to learning and teaching that are driven by inquiry or research' while Prince and Felder (2007:14) defined it as a teaching approach that starts by 'presenting students with a specific challenge, such as experimental data to interpret, a case study to analyse, or a complex real-world problem to solve'. Also IBL was described as any teaching method where 'some form of problem or task serves as a catalyst for student engagement and participation […], learning comes as a consequence of the information processing that occurs as students work to explore the problem setting and to seek a solution' by Oliver (2008:288). It is also to 'a range of instructional practices that promote student learning through student-driven and instructor-guided investigations of student-centred questions' (Justice *et al.* 2007:202).

The term 'inquiry-based learning' and its nature has a topic of debate for researchers in the literature. Learning through inquiry has been given several names such as 'research-based teaching', 'guided-inquiry', 'undergraduate research', 'problem based learning' and 'enquiry-based learning'. Despite the diversity of names, there is a similarity of belief of what constitutes inquiry-based learning. According to Kahn and O'Rourke (2004), Justice *et al.* (2007:202) and Spronken-Smith *et al.* (2007), the main components of an inquiry-based learning should include:

- Encouraging self-directed learning where learners are responsibility for their own learning.
- Encouraging learner-centred learning approach where teachers act as facilitators
- Learning is achieved by 'doing' using 'active' approach to learning.
- Learning is achieved through the process of constructing new understanding and knowledge
- The use of Problems and questions stimulate learning through inquiry.

Basically the learning outcomes of all IBL approach include the development of skills in critical thinking, in self-reflection, the capability to carry out independent inquiry (Lee 2012).The history of IBL is lengthy but the literature based is diffuse and patchy in disciplinary and educational

journals to encourage the use of the learning approach (Aulls *et al.* 2007, 2008; Lee 2012).

There have been increase in the call for the use of IBL in higher education worldwide. For instance in United Kingdom the use of IBL within different contexts have been examined to improve teaching and learning (Deignan 2009; Wood and Levy 2009; Blessinger and Carfora 2014). The IBL approach have been introduced into construction management programmes in two institutions in the United State of America - Mississippi State University and California Polytechnic State University at San Luis Obispo. The changes were necessary because both institutions noticed that the use of traditional lecture approach in construction education to produce thinking, problem-solve and integrative skills was too difficult. So new pedagogic approach was needed to respond to the changes occurring in construction practice. Upon implementation of IBL in both institutions, some challenges and problems were observed (Christopher and Allan 2012; Monson and Hauck 2012). In South Africa, a one day workshop was organised by the construction studies staff at University of KwaZulu-Natal. This workshop was organised to identify and design an appropriate learning outcomes needed to produce the of a profile construction studies graduate. It was observed that the current curriculum and learning approach is not well fitted to produce graduates that meet industry requirement (Zulu and Haupt 2015). So in 2016, the second year students were made to underdo eight weeks of studio based learning (Inquiry based learning). The student responses showed the experience made a difference in their learning even though the instructional space was not adequate. The study also highlighted some observations and challenges encountered while implementing IBL. These among others included: the students were not used to the new learning approach; the mode of transmission changed when the learning outcomes were mapped with the given project phases; the need to restructure the curriculum; and the need for suitable lecturers (Harinarain and Haupt 2016).

Literature has shown that the implementation of IBL Construction education and science related programmes is faced with various challenges and barriers both teachers and learners related. It was also identified that the lecturer plays a very vital role in the successful implementation of IBL. It is their responsibility to ensure that the six stages of the inquiry cycle are practised successfully. According to Llewellyn (2013) the inquiry involves the following stages of learning: 1. Inquisition, 2. Acquisition. 3. Supposition 4. Implementation 5. Summation 6. Exhibition. Both lecturers and learners must be actively involve from the beginning to the end of the inquiry cycle. The cycle is illustrated in figure 1 below. This study tends to verify these challenges by examining and investigating the possibility and practicality of implementing Inquiry Based Learning in construction education in South Africa's' higher education.

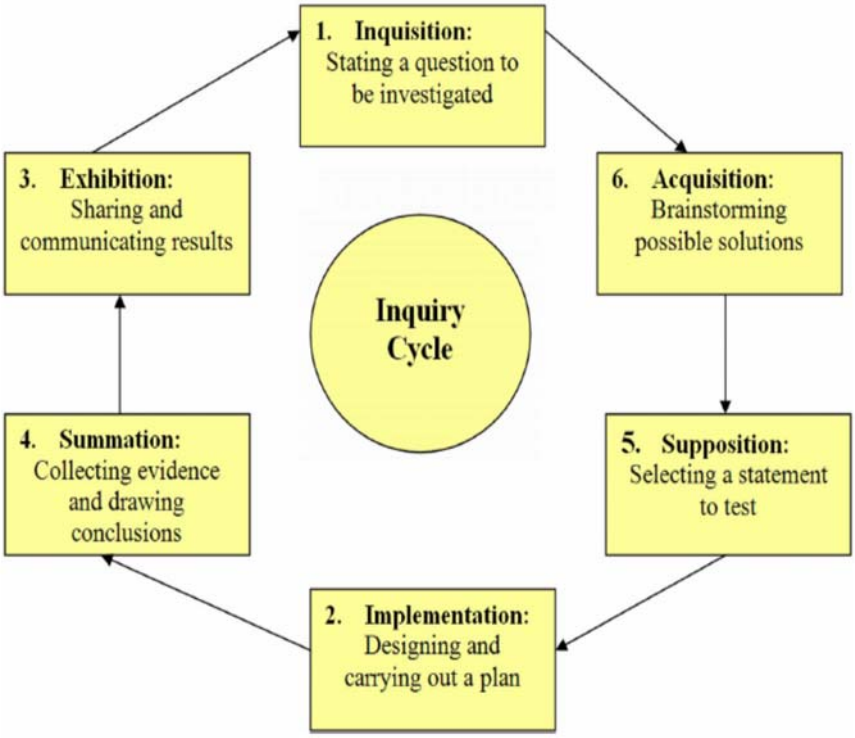

Fig 1: The inquiry cycle (Llewellyn 2013)

3. CHALLENGES IN IMPLEMENTING IBL

This section looks at the hurdles or barriers that might hinder the successful implementation of IBL in higher education in general and construction education in particular. It will also identify some challenges that might prevent learners from been actively involved in meaningful investigation which will undermine their learning. These challenges, hurdles, or barriers can generally be grouped into student related, teacher related and general.

3.1 STUDENTS RELATED ISSUES

There are five student related issues that need to be addressed successfully before IBL approach can be used to improve students' learning (Edelson *et al.* 1999). These include:

i, MOTIVATION. According to Savery (2015) motivation plays an important role in any student centred learning approach. The student needs to be motivated so that they can participate actively in the inquiry. IBL activities need more motivation of learners than most traditional educational activities. Student should be sufficiently motivated to make interested in the inquiry, its result and implications before learning can take place.

ii, ACCESS TO INVESTIGATION APPROACH. It is important that students have an idea of how a task is carried out before they can engage actively in the inquiry. The goals of the investigation must be clearly and the students must be able to understand the results. Science related inquiries might be complicated and needs precision so students are expected to master the techniques before proper learning can take place.
iii, BACKGROUND KNOWLEDGE. The processes of IBL investigations involves the use of science based content knowledge. So it is important that students apply and develop their scientific understanding. If this prior knowledge is missing and it cannot be developed then meaningful investigations will not be completed.
iv, EXTENDED ACTIVITIES MANAGEMENT. Students are expected to be able to manage and organise extended complex activities to achieve learning in BL.This is necessary because any investigation in IBL requires the coordination and planning of activities and the management of work products and resources.

v, LEARNING CONTEXT CONSTRAINTS. The activities and technology used in an inquiry based learning investigation should fit the learning environment constraints. So environmental constraints and learning needs should be considered when designing technology and curriculum in IBL.

3.2 TEACHERS RELATED ISSUES.

Some of the issues or challenges that might hinders learning or implementing IBL in construction education are related to the teacher. In a study conducted by Quigley *et al.* (2011) four challenges encountered by teachers that hinder successful implementation of IBL in a science oriented programme were itemise. These included:

i, How can the quality of the inquiry be measured? It was suggested by (Marshall *et al.* 2008) that the use of the Electronic Quality of Inquiry Protocol (EQUIP) can help teachers to improve the quality of the inquiry in their classrooms. EQUIP is an instrument developed to assess quality and quantity of inquiry taken place in IBL. It is based on four pedagogical concepts- assessment, instruction, discourse and curriculum and it gives a valid and reliable measure of the quality of inquiry that takes place in the classroom (Marshall *et al.* 2009). This barrier was also highlighted by Christopher and Allan (2012).

ii, How to use discussion and discourse to encourage learning in IBL? The quality of discourse in an IBL classroom is a substitute for the level of thinking. The quality of discourse can either encourage or discourage learning in IBL so teachers are encouraged to carefully examine their questioning methods and to always give feedback.

iii, How to think of inquiry and content as part of one goal? Teachers are often faced with the challenge of implementing inquiry in a module with so

much content. So teachers should develop strategies of teaching such that students can understand both content knowledge and the inquiry.

iv, How can teachers effective manage an inquiry classroom? Teachers are high concern with not losing control (control of the class, students and instruction) while teaching. So the teacher has to be in control before effective inquiry can take place. According to Barmby (2006) management issues discourages people from going into the teaching profession.

In another study conducted by Drabkin (2016), there are five teacher related issues that hinders effective implementation of IBL in a science-mathematical module. These includes:

i, Teacher anxiety – Teachers may not know how to effectively implement inquiry based learning approach in a classroom if they are not used to the role of a facilitator while teaching using constructivist methods (Tamim and Grant 2013). This may result to lack of confidence and discomfort to teach using constructivist methods.

ii, Teacher inexperience – Another major barrier to effective implementation of IBL from literature is the inability of teachers to use this approach to improve student learning (Burns 2007:5; Chapman 2011). It is expected that a teacher should be able to identify any conceptual misunderstand in a student and recommend appropriate interventions to improve knowledge. According to Burns (2007:5), “Teachers can’t teach for understanding if they don’t have a firm foundation of understanding themselves”.

iii, IBL is time consuming. The effective implementation of IBL pedagogy is time consuming as it is very difficult for a teacher how much time is needed for a concept or complex tasks. Time for the student to evaluate, question and develop solution to a task is often overlooked by the teacher (Zhaoxia and Qiding 2014). This argument was supported by Steffe and Thompson (2002), they stated that both teachers and students need time to revise, reflect and re-examine solutions.

iv, Diversity of response. Constructivist and inquiry pedagogy lay much emphasis on learning process. So students will give different responses and generate diverse ideas which the teacher has to consider and see how to help each student (Caspari *et al.* 2007). Teacher should be able to understand how each student understands, communicates and applies concepts and materials.

v, Minimizing challenges. Steffe and Wiegel (1992:17) stated that “The most basic responsibility of constructivist teachers is to learn the mathematical knowledge of their students and how to harmonize their teaching methods with the nature of that mathematical knowledge”. So teachers should be responsive to the need of the students to be able to guide them through the learning process (Pelfrey 2006).

However, there are other categorises of barriers that hinders engaging in and implementing IBL in construction programmes classrooms and modules. These barriers generally includes: (Trautmann *et al.* 2004; Christopher and Allan 2012; Harrison 2014).

i, The pedagogy of learning. There is the need to develop effective teaching strategies. These involve the development of suitable content, curricula (Christopher and Allan 2012), and assessment tools (Trautmann *et al.* 2004) that will produce the desired skill set required from a 21st century construction graduate in South Africa.

ii, Accreditation of Construction IBL programmes. The move of accreditation structure from prescription to performance will aid the acceptance of IBL in construction programmes. IBL evaluate performance as it encourages independence in learning. So there is need for more research in IBL to assist its acceptance by professional bodies.

Having identified the above mentioned challenges from literature, the implementation of IBL construction education and science related programmes in higher education needs to be researched further.

4. CONCLUSIONS AND RECOMMENDATIONS

The implementation of IBL in construction education in South Africa is a welcoming learning approach. It was successfully implemented in Mississippi State University and California Polytechnic State University in the United State of America. There is the need to challenge the traditional learning approach in construction education so that learners can face the realities of twenty-first century professional practice. The continuous building of the professional status and the challenges of integrating innovative practice in the construction profession has created the awareness for integrated, inquiry-based, and critical thinking curriculums. This paper therefore identified some challenges that might hinder IBL successful implementation in South Africa based on the experiences from other countries. It is expected that more research is carried to identify methods of incorporating more effective inquiry in classrooms and how the identified challenges can be addressed such that learners acquire the desired and relevant skills relevant in the 21st century construction workplace.

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The future of Universities, the possibility of the using social media and portable devices

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ABSTRACT AND KEYWORDS

Purpose of this paper
In higher education institutions, social media platforms are being used for marketing or some form of information distribution with updates on what is happening on their campuses or for advertising purposes. This study investigates the efficiency of social media applications and portable devices in enhancing teaching and learning at higher education institutions.

Design/methodology/approach
A quantitative questionnaire was randomly distributed fifty-seven undergraduate students in the Construction Studies discipline at the University of KwaZulu-Natal (UKZN).

Findings
This study found that students use social media for communicating with fellow classmates to discuss academic work and cell phones or tablets as a study tool. Students used portable devices for checking emails, accessing Moodle and using their device to view notes during lectures.

Research limitations/implications
The sample taken only included undergraduate students from the Construction Studies discipline at the UKZN.

What is original/value of paper
This information is beneficial in structuring the pedagogical format from the traditional system to newer systems, which students can relate to and be more participative.

Keywords: Higher Education, Mobile Learning, Portable devices Social Media

1. INTRODUCTION

Even with electronic technologies growing at a fast pace infringing into all aspects of life, the academic sector still proceeds with its long struggles to establish which role these technologies should play in teaching and learning (Roblyer, McDaniel, Webb, Herman and Witty, 2010). The use of social media networks can be considered for academic contexts, simply because students spend a lot of time on these networks (Mazman and Usluell, 2010). Social networks are an extremely informal setting which plays a significant role in the on-going communication outside the lecture room (Gillet El Helou, Yu and Salzmann, 2008). The current digital native students are calling for new ways for instruction and communication, and with the new innovations in technology this can be achieved (Banitt, Theis and Leeuwe, 2013). This study investigates the efficiency of social media applications and portable devices in enhancing teaching and learning at higher education institutions.

2. LITERATURE REVIEW

"*The future of learning is mobile, whether it is a simple delivery technology or something that enables a new method of instruction not yet possible*"
(Bowen and Pistilli 2012:1).

Students exist in a digital world where technology is used for sending instant messages, sharing videos and photos, social networking tools, podcasting, and blogging. Cell phones are no longer used just for making calls, but for other purposes as well such as taking photographs and uploading them into social media sites (Looi, Seow, Zhang, So, Chen, and Wong, 2010). With the increased presence of portable devices in higher education institutions, there is an opportunity for these technologies and social media applications to be used as part of the educational scheme (Gikas and Grant, 2013).

Portable devices provide students with the option to access educational material and interact with other students whenever and wherever they are (Looi, *et al*., 2010). This option of whenever and whenever access, allows for the potential for an evolution in technology-enhanced learning, which is described by Chan, *et al*. (2006), as '*seamless learning space*' and learning done in a different or any environment . With an increase in internet access it is certain that students are going to use their own devices to study outside the institution environment (Chan, *et al*., 2006).

'*The portability and versatility of mobile devices has significant potential in promoting a pedagogical shift from teacher-centred to participatory student-centred learning*' (Looi, *et al.*, 2010:156). Hence, education institutions and faculty are progressively using social media sites, such as Facebook to communicate with current and potential students and distribute academic information. Lecturers that have started to communicate with students on social media applications hope to positively influence outcomes of class discussion and teamwork on assignments and to better learning outcomes (Paul, Baker, and Cochran, 2012).

There are a number of devices that could be defined as portable devices but for the purpose of this study, portable devices are defined as those devices which can be carried around by a person with ease, which has access to the internet, can have applications installed or/and can be used to make calls and text messages (Gikas, and Grant, 2013) namely, smartphones, tablets and similar devices.

Social media applications are described as the online communication systems that can be used for communication, collaboration, interaction and information sharing, within a community of individuals (Joosten, 2012; Posted and Rouse, 2013). For this study, only Facebook and WhatsApp were considered.

A) Facebook

Facebook is an online communication platform for people, which has 900 million follows (Nations, 2016). Mark Zuckerberg who is a former student of Harvard University started Facebook and launched it 2004. This network was originally started as an education interaction platform for Harvard University, which later extended to other universities and before it was available to everyone (Phillips, 2007). Facebook draws the attention of many young adults, which means a potential for use as an academic tool, providing an opportunity of instruction outside the normal instruction time (Çoklar, 2012).

B) WhatsApp

The main intention of this application is to take the place of Short Message Service (SMS) with a cross platform mobile messenger allowing unlimited texts to be sent (Yeboah and Ewur, 2014). This application was co-founded by Jan Koum and Brian Acton in 2009. In February 2014, Facebook bought WhatsApp for $19 Billion (Deutsch, 2015). WhatsApp allows individuals to

transfer images, videos and audio messages using internet connectivity (Barhoumi, 2015).

There are advantages and disadvantages of using portable devices and social media applications as study tools. The advantages include accessing information quickly; communication and content collaboration; a variety of ways to learn and provides for situated learning (Gikas, and Grant, 2013). The disadvantages include the fact that there could be device challenges; anti-technology instructors and the devices could prove a distraction (Gikas, and Grant, 2013).

With the use of portable devices and social media as study tools there is a need to consider the different concepts of studying and how these technologies impact study techniques of students.

Study techniques are separated into formal and informal learning. Formal learning is conducted in a formal setting and structured by an institution (Organ, 2016). Course work (content and learning material) is usually delivered in classrooms through lectures, necessary readings and examinations (Cournoyer, Marketing, and Tags, 2012). Informal learning on the other hand is more flexible where the formalities are removed and content is created and consumed. Informal learning content work can be shared on social media applications and mobile devices, as it can be accessed anywhere at any time (Cournoyer, at al, 2012).

Online communities and networks systems are changing the way people think of knowledge, learning, and organise ideas. However, social networks have little to no incorporation into the formal learning environment. Course management systems such as Moodle and Blackboard are the most used technological networks in higher education institutions. Unfortunately these systems allow for limited chances for online discussions and chatting. These systems also provide a limitation, as they do not allow for external socialising and only allow a profile to be managed during a semester it is not continuous (Chen and Bryer, 2012).

Social media networks can provide the link between the formal learning and informal learning environment. Social media allows students to connect to experts in the field and individuals anywhere in the world. This provides the possibility for student-to-student, student to lecturer and student to content interactions. These platforms also allow the student to interact with educational contexts in new, modern and relevant ways apart from the traditional learning environment (Chen and Bryer, 2012).

Even though there has been an increase of the integration of technology and literacy to be paid attention to, a large number of lecturer are found to feel pressurised to integrate technology into their teaching, while the field of eloquence and composition is yet to give social networking enough recognition (Vie, 2008).

The study by Hrastinski-Naghmeh and Aghee (2012) found that students felt social media can be used to complement not a replacement to face-to-face teaching and group work meetings. Students used formal Learning Management System to get information and not to communicate

with other students, they preferred social media for communicating. Student perceptions on how social media can be used to support their studies; E-mailing, Instant messaging, connecting, exchanging documents, communicating with lecturers, reading Wikipedia, watching videos and project teamwork. The students regarded Facebook to be a platform to communicate with fellow students that they not familiar with. Student felt it was faster getting a reply on Facebook than the Learning Management System, as other students checked Facebook more often (Hrastinski-Naghmeh and Aghee, 2012).

3. RESEARCH METHOD

The quantitative method was used for this study. Data was collected via questionnaires that were randomly distributed to ninety undergraduate (1st to 3rd year) students in the Construction Studies Program at UKZN. The questionnaire was designed to test different variables about the use of portable devices and social media by studies. Fifty-six students completed the questionnaire, indicating a 62,22% response rate. The data was analysed using the statistical package for social sciences (SPSS) version 24.

4. ANALYSIS

4.1. Demographics of the population

Table 1 indicates the demographics of the population, with the different age groups and the number of females and males in the populations. The population included 26,0% students who were studying their 1st year, 37,5% students who are doing their 2nd year of study, 33,9% of the students in their 3rd year of study and 0,02% students who were doing their 4th year of study. The percentage is low for students who are in their 4th year as there are the only student who indicated that they repeated a year.

Table 1. Demographics of the population

Age	Gender		Total
	Male	Female	
17-20	16	16	32
1-25	13	10	23
≥27	1	0	1
Total	30	26	56

4.2. Social media applications used by students

Table 2 indicates that 96,4% of the students have smart phones, 71% of the students have Facebook accounts and 95% of the students have WhatsApp accounts on their phone.

Table 2. Accessibility to social media and portable devices.

	Number of respondents	% of respondents
I have a smartphone or tablet	54	96.4%
I have a Facebook account	40	71%
I have WhatsApp on my phone	53	95%

4.3. Social media and Portable devices as study tools

Ninety-three percent of the students use their cell phone or tablet as a study tool for studying and accessing course notes for studying purposes. Table 3 also indicates that the majority of the students often check email using their phones. Students use Moodle to access their course work.

Table 3. Accessibility to social media and portable devices.

	Mean	Std. Deviation
I consider WhatsApp and/or Facebook to be a good study tool	2.83	1.10
I consider my cell phone/tablet to be a good study tool	3.63	1.08
I check my email often using my phone	3.94	1.11
I use Moodle to access course work	4.35	0.90

4.4. Utilisation of portable devices and Social Media

Table 4 indicates that 95% of the students utilise their cell phones/tablets to study, view notes, record and take pictures of slides during a lecture. Students do not consider social media (WhatsApp and/or Facebook) as good study tools. A scale of 1-5 was used, where 1 meant strongly disagree and 5 meaning strongly agree.

Table 4. Accessibility to social media and portable devices.

	Mean	Std. Deviation
I use my cell phone/tablet to view record during a lecture	2.69	1.32
I consider WhatsApp and/or Facebook to be a good study tool	2.83	1.10
I take pictures of work on slides/on the board instead of writing it down	2.96	1.24
I use my cell phone/tablet to view notes during a lecture	3.00	1.14
I use my cell phone/tablet to study	3.49	1.09

Ninety eight percent (98%) of the students feel:

- WhatsApp and/or Facebook provides an effective mechanism for communicating about modules with peers;
- They will miss out on useful information if they do not engage in WhatsApp and/or Facebook communication with classmates and/or lecturers;
- Comfortable using WhatsApp and/or Facebook to communicate with my classmates.

Slightly fewer students (93%) felt that their classmates expect them to use WhatsApp and/or Facebook to communicate with them about my academic work. One can therefore conclude that as much as students do not find social media as a good study tool it is seen as a good communication medium for discussing academic work.

5. CONCLUSION

With the proliferation of social media and portable mobile devices, higher education institutions have to change and adapt in order to keep pace with these developments. This study investigated whether students could use social media applications and portable devices as a study tool.

The findings revealed that the majority of students have smart phones and/or tablets and utilise Facebook and WhatsApp. Students prefer to utilise their portable devices as a study and social media for communicating with fellow classmates to pass on academic information and to discuss academic work.

6. RECOMMEDATIONS

Therefore, this is a clear indication that students are moving away from discussing academic information using formal systems such as email to communicate and are now using informal systems such as WhatsApp to communicate. This information is beneficial in structuring the pedagogical format from the traditional lecture centred system to newer student centred systems in which students can be more participative.

Higher education institutions should consider how they can used these platforms to enhance student teaching and learning in a way which best works for their student to understand their chosen qualifications.

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ASOCSA2017- 106

The impact of housing quality on the studies of Construction Studies Students at the University of KwaZulu-Natal

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ABSTRACT

Purpose of this paper
This study aims to identify the experiences associated with student housing by students and the impact it has on their academic performance.

Methodology
Data was obtained through surveys of 60 randomly selected construction Studies students. Forty-eight completed questionnaires were received, indicating an 80% response rate. Data was analysed using Statistical Package for the Social Science (SPSS) version 24.

Findings
It was found that noise, lack of privacy and overcrowding were the key factors that affected the student's studies when living at residence.

Research limitations
This study is limited to the Construction Studies Discipline at the University of KwaZulu-Natal (UKZN).

Practical Implications
This paper is of value to students studying or planning to study construction studies at UKZN as it provides insight with regards to student accommodation in this institute.

Response to the Conference Theme:
Construction Education, Training and Skills Development.
This paper is relevant to the current situation at various Universities/Colleges and attention needs to given to this important aspect that can assist in improving student education so that construction can be made great again.

Keywords: Student residence, Construction studies, University, Private accommodation

1. INTRODUCTION

Education is one of the most important factors of economic growth in South Africa (Nkohla, 2014). The country will be able to increase its efficiency and labour productivity when investing in quality education. It is also very difficult for a person to get a job without education. Since the fall of apartheid in 1994, there has been a massive increase in the number of students entering higher education and this increase places a pressure on the universities infrastructure that includes the demand for student's accommodation (Higher Education Authority, 2015). The provision of student's accommodation that is suitable for students to study in, that is accessible to students and that is safe plays a very vital role in the quality of higher education and training system in South Africa and to the success of the students (Department of Higher Education and Training (DHET), 2011).

With the increasing number of students participating in higher education and training, it has become almost impossible for the universities to provide students with accommodation, let alone the issue of adequate suitable and safe environment of student accommodation (Student accommodation group, 2014). Twenty years ago, it was possible for universities to accommodate about 80% of students without any problem but now the universities can only accommodate approximately 20% of their students (Student accommodation group, 2014). This results in long waiting lists for university residences which causes students to lose hope and they end up trying to source other accommodation (Dibetle, 2009).

Student accommodation plays a vital role in the quality of higher education and training in South Africa (Department of Higher education and training, 2011) and it also plays a very important role in the pass rate of students. According to Student accommodation group (2014) a student residing in an adequate environment has a higher chance of doing better in university rather than a student who spends his/her entire time and energy worrying about how unsafe he/she is instead of focusing on her/his studies. A study conducted in 2014 by Student accommodation group shows that there is 80% pass rate for students living on campus residence, which drops to 40% when a student is not provided with an adequate and proper

environment and basic facilities for studies. This study showed that students who did not get accommodation at the university tend to rent sub-standard off campus accommodation, which are commonly known as communes (Dell, 2012). This type of accommodation lack facilities for students, they have a high crime rate and more often three or more students share a very small room and it is often far from campus (*Dell, 2012*).

According to Macfarlane (2012) students who are doing their first year at university are the ones that are commonly affected by the appallingly improper accommodation that universities provides for students.

2. LITERATURE REVIEW

2.1 *Student Housing Policy*

According to the Department of Higher Education and Training (2011) there are many challenges faced by the universities in providing students with accommodation and in some cases students are living in dreadful conditions because of these challenges. South African institutes are trying to provide accommodation without much success (Department of Higher Education and Training, 2011).

The South African Housing policy was established for the provision of housing in South African, it has nothing to do with the laws that regulate student housing or provision of student housing and even the South African Higher Education Act (No. 101 of 1997) does not include any regulations with regards to student housing (Tswai, 2013). Student Housing is more than just the place to sleep for students but it is also a place for living, learning and social communication (DHET, 2011). The policy on the minimum norms and standards for students at public/private universities was developed by the Government after the Ministers report on student accommodation (on-campus and off-campus residences) (Department of Higher Education and Training, 2015).

The use of this Student Housing Policy will ensure that students are provided with proper adequate accommodation and also accommodation that is suitable for academic learning and the policy will not only be applied to the residences that are already up and running but also to the residences that are still in the construction phase so that they will be constructed in accordance to the norms and standards of the policy (Department of Higher Education and Training, 2015).

2.2 Student Accommodation

The provision of decent, accessible, affordable and safe student housing is very important in order to ensure the quality of higher education (South African Human Rights Commission, 2015). According to the Department of

Higher Education and Training (2015) students housing is more than providing beds for students but it is also about creating the sense of belonging, especially for first year students. It is about establishing learning and social communities amongst students. Long distances that students travel all the time before getting to campus poses a security risk and limits the students from participating in the life at an institution (South African Human Rights Commission, 2015).

2.2.1 Demand for student accommodation

There has been an increase in the number of students entering tertiary education in South Africa and as the result of this increase, universities are unable to accommodate all students in residences (SA prop news, 2012; Tswai, 2013). With higher education enrolments, increasing approximately 7% annually this equates to approximately 30,000 additional students requiring student housing (Department of Education, 2005).

The shortage of student accommodation is a crisis that results in high student failure and first year dropouts (Majangaza, 2014). The lack of student accommodation in South African universities leads to students renting private accommodation, in some cases accommodation that they cannot afford.

2.2.2 Student enrolments in South African institutes

South Africa has 23 public universities with an enrolment of approximately 938,201 students (DHET, 2012). Higher education plays an important role in the training of qualified individuals who will be able use their knowledge to implement new technologies by using innovative methods (World Bank, 2010).

Table 1 shows the number of students that were registered at the University of KwaZulu-Natal in the year 2010 and the number of beds that were available at that time on each campus (Department of Higher Education and Training, 2011). Eighty percent of the students at UKZN were not accommodated by the university in 2010.

Table 1: Student Enrolment at UKZN and the number of beds available (DHET, 2011).

Institute	Campus	Registered students	Beds per Campus	Beds per university	2010 students enrolment Bed capacity
UKZN	UKZN Howard College	34 066	1743	6924	20.33%
	UKZN Medical school		165		
	UKZN Westville campus		2349		
	UKZN Edgewood		802		
	UKZN Pietermaritzburg		1865		

2.2.3 Funding for student accommodation

The Government through the Department of Higher Education and Training supports student accommodation in public universities and the universities manage the procurement of their residences (Infrastructure dialogue, 2015). The Department of Higher Education and Training provided an amount of R6 billion to public universities for a period of three years from 2012 until 2015 for infrastructure development. The R1.7 billion of this amount was allocated to student housing whereby to which universities added their own portion of money in order to have R2.3 billion for the developments. But the R2.3 billion was only able to produce 9,000 new beds (Infrastructure dialogue, 2015).

The lack of resources in South Africa is preventing the government's effort to provide student accommodation; the demand for student accommodation is more than the state capacity to fund it (Tswai and Netswera, 2013). Most of South African universities generate their own funds to finance infrastructure by for example utilising their residences during vacations (Tswai and Netswera, 2013). The cost of constructing student residences is about R240,000/residence but this cost excludes land acquisition. It will cost approximately R147 billion to overcome the lack of student accommodation (Kgosana, 2012).

The provision of financial support for student accommodation needs is only one aspect of the complex student housing equation; university residences and other forms of on and off-campus accommodation must also be maintained, staffed and managed (Department of Higher Education and Training, 2011). Traditional funding options are no longer viable for many institutions, and additional options are needed to address the gaps between what is required by university housing facilities, what is desired by students, and what is affordable for the university and the student resident (Department of Higher Education and Training, 2011).

3. RESEARCH METHODS

This research followed a quantitative data approach, which is defined by Nissaji (2017) as the research method that deals with numeric data collected from a quantitative measure and analyses the numeric data. The study population identified for this study was Construction studies students registered at the University of KwaZulu-Natal Howard college campus. Structured questionnaires were randomly distributed to sixty Construction Studies students. All participants in the research process remained anonymous. Forty-eight completed questionnaires were received, indicating an eighty percent response rate. The Statistical Package for Social Science (SPSS) was used to analyse the data.

4. ANALYSIS

Fifty six percent of the respondents were male students and 44% were female students.

There are 62.50% students living in private accommodation, 27.08% of students living in off-campus accommodation provided by the university and there is 10.42% of students living in on campus accommodation as shown in Figure 1.

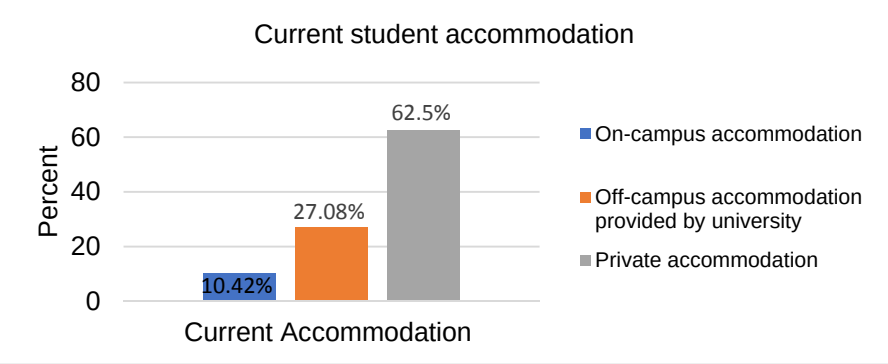

Figure 1: Current student accommodation

Figure 2 shows different types of private accommodation and reflects the imbalance of student accommodation in higher education.

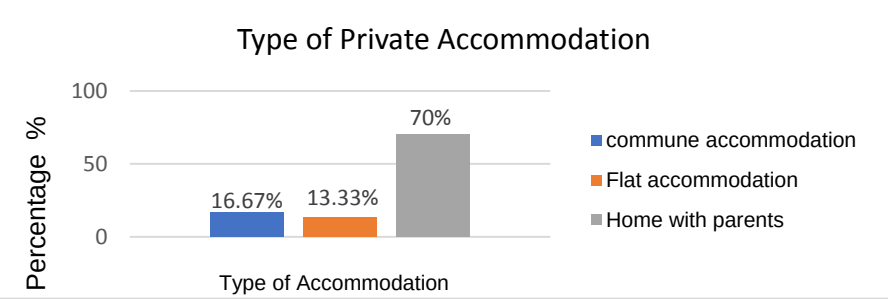

Figure 2: Private accommodation representation

Fifty two percent of the students preferred to live at residence. This implies that even though some students are currently living at home with their parents, they would prefer to live in residence. This indicates that the demand for on campus accommodation is bigger than the demand for private or off-campus accommodation. Female students in the Construction Studies discipline prefer on campus accommodation.

The students who live off-campus travel between 100m to 48km to campus every day.

Table 3 depicts the key factors that affect the student's studies when living at residence. Noise ranked first, as most students found it difficult to study when their accommodation was noisy. This was closely followed by the lack of privacy that can be found at residence. Ranked third, was overcrowding. Students felt it difficult to concentrate and learn due to overcrowding. The lack of security had the least impact on the student's ability to study.

Table 2. Students understanding of assessment

Factors	Mean	Std. Dev.	Rank
Noise	3.71	1.267	**1**
Lack of privacy	3.57	1.399	2
Overcrowding	3.07	1.439	4
Lack of hot water supply	2.93	1.439	5
Crime	2.93	1.492	6
Access to services	2.57	1.222	7
Lack of security	2.57	1.284	8

The university of KwaZulu-Natal should make the quality of accommodation a priority because the state of residence has a negative impact on students.

5. CONCLUSION

There are many challenges facing universities in providing students with accommodation and this lack of 'support' in this critical area of higher education is affecting the student's ability to study. With universities only able to accommodate between 20%-30% of their students on residences, accommodation becomes a daily battle for some students. This study found that noise, lack of privacy and overcrowding were the key factors that affected the student's studies when living at residence.

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A Decision Tree Framework for the Assessment of Construction Delays

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ABSTRACT AND KEYWORDS

Purpose of this paper
Delays to contractors' progress, often resulting in time and cost overruns, are a major source of claims and disputes in the construction industry. The assessment of extension of time (EOT) claims as part of a construction project can have far-reaching consequences for the financial success of the project. The proper and transparent assessment of EOT claims is therefore an essential component in the success of any project. The main objective of this study is to develop a framework with the use of a decision tree analysis to provide guidance for the assessment of delay claims. The framework would assist in providing a platform to standardize the assessment of delay claims.

Design/methodology/approach
In the study an action-research approach, a very specific qualitative approach, was followed to develop a user-friendly guideline, to assist practitioners to navigate this potential minefield of complexities in the process of the assessment of EOT claims. Focus groups, consisting of industry practitioners, with specialist knowledge in construction contracts, contributed to the development of the decision-support frameworks, and ultimately to the findings.

Findings
The iterative process followed assisted in producing a tool that can be used in practice as a guideline for the analysis of EOT claims.

Research limitations/implications
The main aim of this study is to focus on the evaluation of delay claims, but not on any other aspects of such delays.

Practical implications
According to the literature, one of the common causes of disputes in construction projects is the assessment of EOT claims. Very limited guidance is available for the assessment thereof. The main benefit of the decision-support framework is that it would provide a guideline with clear and easy to follow steps to assess any EOT claims. This could be of assistance to practitioners that are responsible for the assessment of EOT claims on projects.

What is original/value of paper.
One of the main contributions of the study to original knowledge was the development of a universal decision tree framework for the assessment of EOT. The decision tree framework is unique in that it would assist practitioners holistically in terms of all considerations in the assessment process. Other forms of guidance produce to date are mostly focussed on assessment of the criticality of the delay.

KEYWORDS
Construction Delays; Decision-Trees; Delays; Delay Analysis Methods, EOT.

1. INTRODUCTION

Delays and disruptions to contractors' progress, often resulting in time and cost overruns, are a major source of claims and disputes in the construction industry. Various analytical methodologies have been developed over the years as aids to determine the extent of the delay, but there is limited information on the extent of use of these methodologies in practice, and their impact on the construction process (Braimah, 2008).

Many problems are encountered in practice in the application, preparation and assessment of EOT claims. The lack of clear guidance on how to assess EOT claims can be seen as a major contributing factor to disputes (Danuri *et al*., 2006).

Limited information is available in terms of an overall framework or procedure to guide practitioners in the assessment of EOT claims. Previous research in terms of the various issues to be considered is fragmentary in nature and it would typically investigate one of the aspects in isolation of the others.

Moselhi and El-Rayes (2002) developed a computer-based system, named WEATHER, to quantify the impact of weather conditions on construction productivity, project schedule and associated delays. Although

this system will be helpful in the assessment of weather-related claims, it cannot be utilized as an overall decision-support system for claim evaluation because of its narrow focus on only one cause of delay.

Bubbers and Christian (1992) made use of a hypertext-information system to assist in the analysis of claims by informing contractors, owners, and their representatives of the contract provisions. The main purpose of the utilization of hypertext in this study was to organise the data; and thereby to enable users to focus quickly on only the relevant material. The hypertext-based system indeed acts as a decision-support system; but it does not provide a framework to guide practitioners through the claim-evaluation process.

Braimah (2008) developed a model for the selection of an appropriate EOT claim-assessment method. The aim of the model was to serve as a tool for assisting practitioners in justifying their choice of delay-analysis method. Scoring multi-attribute analysis, a multi-criteria decision-making method was utilized as the basis for the model. Although this model is a helpful tool in deciding on which of the many delay analytical methods should be utilized for a specific delay, it does not provide guidance on each step in the claim-assessment process.

The UK's Society of Construction Law is a body comprising highly experienced engineers, architects, quantity surveyors and lawyers. It has developed a Delay-and-Disruption Protocol. The purpose of the protocol is to provide good practice guidance for construction delays and disruptions. Section 3 of the protocol offers high level guidelines on dealing with EOT during the course of the project (SCL, 2002).

It is evident from the literature that there is a need for guidance to simplify the many complexities associated with the EOT claim-assessment process. However, a very limited number of guidance tools are available at this stage for practitioners.

The main objective of this study is to develop a framework with the use of a decision tree analysis to provide guidance for the assessment of delay claims. The framework would assist in providing a platform to standardize the assessment of delay claims. This approach will contribute to expediting the evaluation process; and it will limit the negative impacts associated with any prolonged process for concluding delay claims. As a result of the standardisation, it would also contribute to an improved perception of fairness in the evaluation of delay claims, which would, in turn, hopefully lead to the reduction in claims being subjected to dispute resolution.

2. LITERATURE REVIEW

It the heart of any claim for extension of the contract period is the presence of an event that could cause a delay. Therefore, an in-depth understanding of this primary building block of the claim-evaluation process is essential.

Types of delays

The evaluation of construction EOT claims is, to a large extent, influenced by the type of delay. A number of studies have attempted to categorise delays in terms of the impact, risk and cause of the delay. Figure 1 provides an overview of different types of delays and the impact each has on time and extra cost.

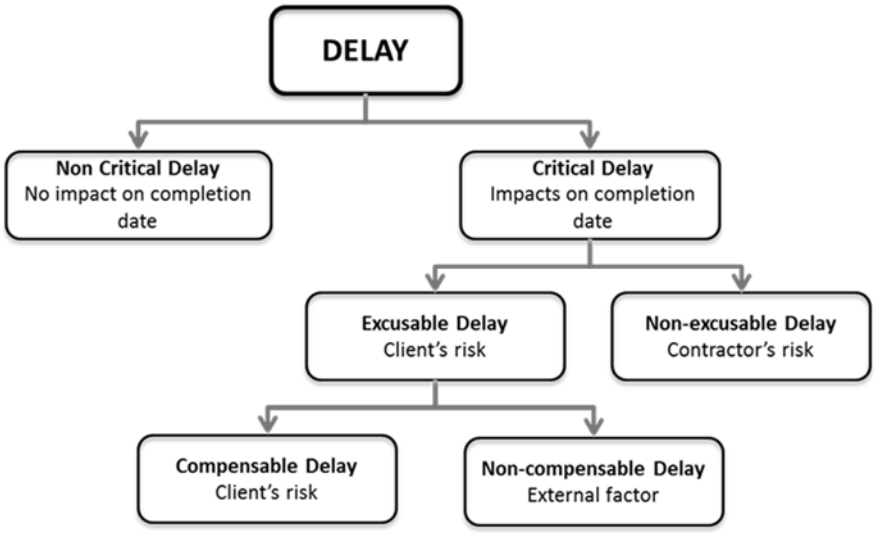

Figure 1 Types of delays

Critical delays

According to Pickavance (2000), a delay in progress is not the same as a delay in completion. A delay in progress is a significant shift in the planned timing of a specific activity or activities that could occur at any time.

Although the start and/or finish of the activity might differ from the original intent, it is irrelevant, unless it ultimately impacts on the completion date. On the other hand, a delay in the completion date occurs only when the completion date has passed; this can only be caused by a delay to the progress of an activity, which is in the critical path to completion.

The criticality of a delay can be defined as follows in terms of the ultimate impact on completion:

- Critical delay – a delay on the critical path of the project, resulting in the final completion date of the project being delayed, and
- Non-critical delay – a delay that is not on the critical path and that would, therefore, not impact on the overall completion date. (Ndekugri *et al*., 2008)

Excusable delays

A non-excusable delay is defined as a delay caused by the contractor, or any aspect that is within the contractor's sphere of control. The contractor would not be entitled to any additional time or compensation for this type of delay (Tumi *et al*., 2009).

An excusable delay, on the other hand, can be described as a delay caused by either of the following two factors:

- Third parties or incidents beyond the control of the client and the contractor, and
- The client or the client's agents. (Alaghbari *et al*., 2007).

Compensable delays

Compensation will have to be considered if a delay is found to be excusable, and it should be established whether the delay can be defined as follows:

- Non-compensable delay – an excusable delay caused by factors beyond the control of the client and the contractor. Although most forms of contract make provision for the extension of the contract-completion date, the contractor will not receive compensation from the client; and
- Compensable delay – an excusable delay caused by the client or the client's agents. The contractual completion date will be extended, and the contractor will receive compensation from the client (Tumi et al., 2009).

Contractual compliance in terms of delay claims

In order to assist contracting parties in dealing with claims that might arise during the execution of the construction contract, the majority of the standard construction contracts contain provisions, under which the contractor can recover compensation from the employer for various losses suffered – where the project is prolonged or disrupted by certain specified causes. However, the majority of contractual regimes, and even general conditions of contract, do not provide details of the principles governing the assessment of claims for EOT; this is left to the professionals involved in each project (Yogeswaran *et al*., 1998).

Delay-claim clauses in the majority of the standard construction contracts can be classified into the following two main categories:

- Clauses dealing with the notification of a possible delay, and
- Clauses dealing with the claim itself.

Compliance with all contract provisions in regard to claims is a prerequisite for the claim to be considered for approval.

Decision trees

A decision tree is a flowchart-like structure that shows the various outcomes from a series of decisions. It can be used as a decision-making tool, for research analysis, or for planning a strategy. A primary advantage of using a decision tree is that it is easy to follow and understand (Murthy, 1998). When formulating and configuring decision trees, the results of real-world factors are analysed and compiled, so that the specifics of the previous factors and the related results are used to predict the results of future factors (Smith and Tansley, 2003).

Decision trees would be of great assistance as a guidance tool for the evaluation of EOT claims for a number of reasons. Decision trees can guide decision-making during the EOT process by providing a simplistic tool to assess claims; since decision trees are simplistic in nature. When an EOT claim is being considered, sequential decision-making is required to ultimately decide if the claim should be awarded. Decision trees are conceptually structured in such a way as to allow for sequential decision-making. The diverse nature of delaying events would necessitate a high degree of flexibility in the assessment of EOT claims. One of the benefits of decision trees is that they provide for a high degree of flexibility. Another benefit of decision trees is that they provide for clarity and conciseness in decision-making – a critical requirement in the process of the assessment of EOT claims.

3. METHODOLOGY

In considering the choice of the research design, one should keep in mind that the research is undertaken in the built environment. Built-environment disciplines are primarily applied sciences, focusing on the application more than on the mere generation of knowledge (Klosterman, 1983; Knight and Ruddock, 2009). Several possible research designs were considered. Upon further investigation, it became evident that action research, a very specific qualitative approach, would be the most appropriate choice for the research design.

Action research is an approach to knowledge creation that results from a context of practice; and it requires researchers to work with practitioners, (Reason and Bradbury, 2001; Huang, 2010). The action research process required to develop a decision tree support framework for the assessment of EOT claims was executed as depicted in Figure 2:

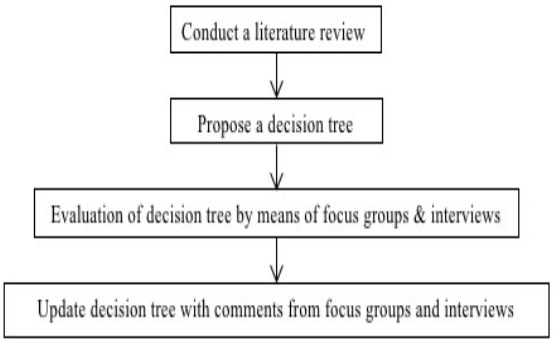

Figure 2: Action research process to develop a decision tree support framework

The focus-groups and interviews with industry specialists were deemed the most effective to gather the required data. The absence of a specific grouping structure of construction industry specialists knowledgeable and experienced in EOT claims has necessitated the use of non-probability sampling. Purposive sampling, one of the most common non-probability sampling strategies, was deemed to be the most appropriate approach.

Purposive sampling calls for the participants to be selected on the merits of their specific involvement and the experiences central to the phenomenon being studied (Greig *et al.*, 2012).

The level of knowledge required excluded some possible participants, who would only have a basic knowledge of contract clauses – as a result of the utilization of the specific contract in a project. As a result, it was decided to target those members serving on the technical committees of the organisations responsible for the compilation of the construction contracts.

To ensure that meaningful participation of all the group members was possible, it was decided to keep the number of participants as low as possible.

Table 1
Focus group participants

	Designation	Years of experience
1.	Architect; CEO JBCC technical committee	More than 40 years
2.	Contractor; Construction contract specialist	More than 30 years
3.	Contractor, Construction contract specialist	More than 30 years
4.	Construction contract consultant	More than 30 years
5.	Quantity Surveyor; Construction contract specialist	More than 40 years

6.	Architect; attorney; Construction contract specialist	More than 40 years
7.	Engineer; Construction contract specialist	More than 40 years
8.	Quantity surveyor; Senior government project manager	More than 40 years
9.	Quantity Surveyor; Construction contract specialist	More than 20 years
10.	Attorney; Claims consultant	More than 30 years
11.	Quantity Surveyor; Construction contract specialist	More than 40 years

4. FINDINGS – UNIVERSAL DECISION TREE FRAMEWORK

To be able to apply decision tree principles to EOT analysis it was necessary to identify the decisions taken as part of the evaluation process.

The literature, focus groups and interviews identified the following essential decisions required when an EOT claim is to be analyzed:

- Was the delay critical?
- Was the delay excusable?
- Were the contractual provisions complied with? and
- Was the delay compensable?

An important decision in the EOT assessment process would be to determine if the claim event delayed the contractual completion date; and therefore, it can be categorised as critical. An important consideration in the decision tree would therefore be whether the delay is critical.

Excusable delays are fairly well-defined concepts in the literature. However, although the notion of excusable delays is captured in some of the clauses of the construction contracts, the term ‘excusable delay’ is often not explicitly mentioned. Perhaps for this reason most of the focus-group participants found the term foreign. After highlighting the fact that, in essence, the term alludes to the process of determining whether the contractor is responsible for the delay, consensus was reached that it should be considered during the EOT assessment process.

One of the main considerations in the EOT-assessment process is to determine whether the contractual provisions were complied with. There are instances where contractual compliance to specific clauses does not lead to an outright rejection of the claim. These instances were highlighted in the focus groups and were considered in the decision trees for the different forms of contract. If it was established that an EOT should be awarded, an important consideration at that stage would be whether a compensation was payable to the contractor.

Decision trees address decisions in a sequential manner. As a result, it is necessary to determine the sequence in which the above decisions should be made. The decision on whether the delay is compensable can only be made once all the other decisions have had a positive outcome and it is established that an EOT should be awarded. Therefore, this decision

should be considered last. A logical approach would be to sequence decisions in terms of the consequence of the outcome of the decision. If a specific decision would lead to the rejection of the EOT, it would make sense to consider this decision first.

However, it is not possible to decide which of the three remaining decisions should be addressed first, by merely looking at the outcome of the decision; because a negative response to any of the first three decisions would result in the EOT not being awarded. The degree of effort required in making a decision in each of the three questions differs. In practical terms, it would make sense to consider the decision that would require the least amount of effort first. Should this first decision result in the claim not being awarded, time would not unnecessarily be spent on decisions that require more effort to consider.

To determine whether a delay is critical is normally the most complex and time-consuming part of an EOT claim analysis. A practitioner would not want to embark on this cumbersome process without knowing the contract provisions were complied with and the delay is indeed excusable. For this reason it is proposed that criticality should only be considered after contractual compliance was assessed and the question if the delay is excusable has been addressed. To determine whether a delay is excusable (beyond the contractor's reasonable control) can sometimes be complex. It is reliant on evidence presented by the contractor and the verification by the person responsible for the EOT claim analysis. This can become a time consuming process.

To determine whether the general contract clauses were complied with would normally not be a very involved process; as the facts presented in the EOT claim submission would be evaluated in terms of the relevant contract clauses. It is therefore proposed that the compliance with contract clauses should be considered before a determination is made on whether the delay is excusable. The following sequence of decision making is therefore proposed:

- Decision 1 – Were the contractual provisions complied with?
- Decision 2 – Was the delay excusable?
- Decision 3 – Was the delay critical?
- Decision 4 – Was the delay compensable?

If the decisions required in the EOT claim analysis process are translated into a decision tree, the decision tree can be formulated as follows (refer to Figure 3):

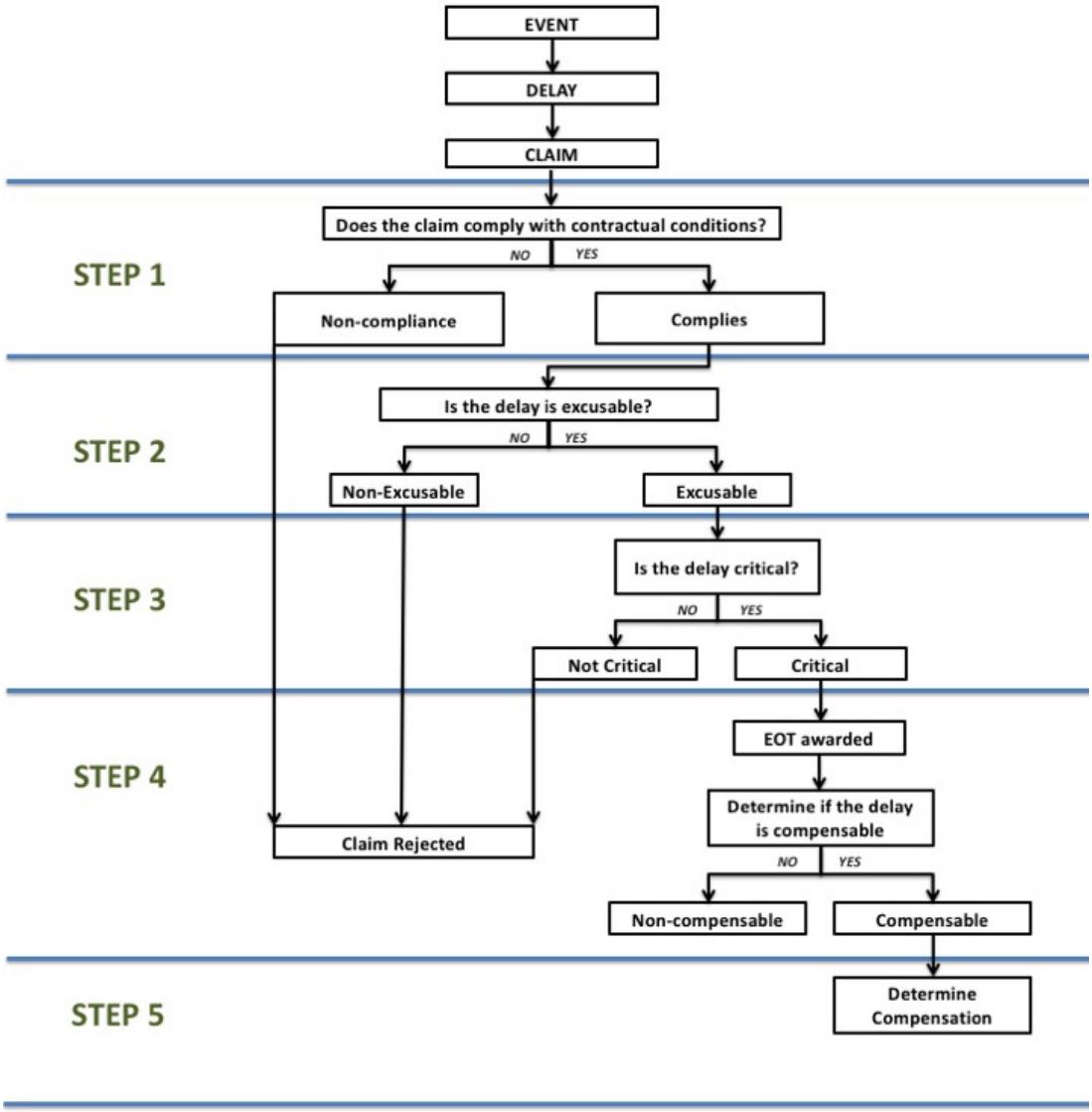

***Figure 3*:** Universal decision tree framework

The principles defined as part of the universal decision tree framework can be applied in the process of assessing EOT claims by developing decision trees for each step informed by the provisions of the construction contract utilized.

5. CONCLUSION

The main objective of this study is to develop a framework with the use of a decision tree analysis to provide guidance for the assessment of delay claims. The framework would assist in providing a platform to standardize the assessment of delay claims.

One of the main contributions of the study to original knowledge was the development of a universal decision tree framework for the assessment of EOT. The decision tree framework is unique in that it would assist practitioners holistically in terms of all considerations in the assessment process. Other forms of guidance produced to date are mostly focussed on assessment of the criticality of the delay.

The decision tree would assist in eliminating uncertainty in the assessment process of EOT claims by providing clear guidelines. It is possible that the decision trees could, to some extent, assist in the standardization of the assessment of EOT claims. Standardization would have a number of benefits. One of the significant benefits would be that this could possibly reduce the number of disputes in EOT claims. The main benefit of the decision-support framework is that it would provide a guideline with clear and easy to follow steps to assess any EOT claims.

This could be of assistance to practitioners that are responsible for the assessment of EOT claims on projects. The decision-support framework would also provide insight for contractors into the process of the assessment of EOT claims. This would lead to a better understanding of what is required to substantiate EOT claims, and to better quality claims being submitted.

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An investigation into the key factors causing construction waste in Polokwane, Capricorn Municipality District of South Africa

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ABSTRACT AND KEYWORDS

Purpose of this paper
Waste generated from construction activities, if not properly managed, constitutes a nuisance to the construction environment and could lead to a negative public impression of the construction industry as well as poor project performance. In order to effectively manage construction waste and to reduce its negative consequences, there is a need for a comprehensive understanding of construction waste causations. Therefore, this paper investigates the factors that lead to construction waste generation in the Polokwane Municipality District of South Africa.

Design/methodology
Data were collected using a questionnaire design. The targeted respondents were the contractors who are involved in various types of construction activities in Polokwane. The respondents were asked to rank the factors that lead to waste during construction projects and the sources of those construction waste. A total number of 44 questionnaires were obtained and the raw data were analysed using SPSS. Mean value was used to determine the level at which each identified factor cause waste

Findings
The study revealed that insufficient awareness about construction waste management was the highest factor leading to waste on construction sites in Polokwane. The second highest was the wasteful use of materials during construction activities. The lack of a well-developed waste recycling market was placed third as the highest factors leading to waste. In addition, poor skills of operatives, frequent demolition due to reworks and change of orders and insufficient regulations were also shown as factors leading to waste on construction sites in Polokwane.

Research limitations/implications
The study includes only participants in Polokwane municipality district of South Africa and this may affect its generalisation. A further study covering a wider areas with more participants is suggested.

Original/value of paper.
The study adds to the existing body of knowledge by providing information on wastes causations factors in Polokwane District of SA. The findings of this study will not only be beneficial to Polokwane community alone but will also sensitise the construction industry at large on how waste are generated and how construction players can minimise waste generation on construction site. This will enhance economic growth and protection of the construction environment. The study adds value to the conference theme in that it addresses the area of construction industry transformation.

Keywords
Construction waste, causes of waste, sources of construction waste, Polokwane.

1. INTRODUCTION

Waste generated from construction activities has become an issue of serious concern to researchers and construction professionals worldwide (Nagapan *et al.,* 2012). The construction waste constitutes a nuisance to the construction environment and also lead to a negative public impression of the construction industry (Adewuyi and Odesola, 2015). Aside, waste can affect the success of construction projects (Nagapan *et al.,* 2012). Inadequate control of these construction wastes lead to poor project outcome and poor project performance in the construction industry (Jayamathan and Rameezdeen, 2014). Nagapan *et al.,* (2012) noted that construction waste has significant effect on the time and cost of construction as well as on productivity and sustainability aspect. Thus, there has been serious concern about the volume of waste generated in the construction industry (McDonald and Smithers, 1998). Literature reveals that wastes generated from construction activities have direct impact on the environment (Nagapan *et el.,* 2011). Unfortunately, the manner at which the waste generated from the construction activities are being handled and disposed are not encouraging and thus lead to environmental difficulties (Ikau *et.al.,* 2016). Gauteng Department of Agriculture Conservation and Environment (GDACE, 2009) reports that construction waste generated in the Gauteng province of South Africa is mostly being disposed of either illegally or to landfill. This action have a serious consequential effects on the environmental, the country and all relevant stakeholders. Some notable consequences of illegal dumping and disposal to landfill include environmental degradation, poor public image of construction industry, increase demand for landfill, pollution, resources and material loss among others (GDACE, 2009). While it is true that, it is

impossible to completely avoid construction waste, proper control and effective management of these waste are very necessary (Teo and Loosemore, 2001). In order to achieve effective waste management, comprehensive understanding of waste causation is very important. It is on this background that this study investigates the key factors causing construction waste in Polokwane district of South Africa.

2. CAUSES AND EFFECTS OF CONSTRUCTION WASTE

Waste generated during different stages of construction activities is one of the serious problems in construction industry at large (Nagapan *et al.,* 2011). According to Pheng and Tan (1998), waste is "the difference between the value of mateials delivered and accepted on site and those used properly as specified and accurately measured in the work after deducting cost saving of substituted materials and those transferred elsewhere". Construction waste can result from material damage which cannot be utilized anymore, or through loss during construction activities and as a result of errors in construction works (Bossink and Brouwers, 1996). Globally, the construction industry is recognised an an important sector. Notwithstanding its importance, the industry has particularly been noted for its contribution to environmental degradation not only in South Africa but also in most other countries across the globe (Ali *et al*, 2014). The impact of the construction industry in terms of the resources it consumes and the waste it generates has been widely acknowledged (Tam, 2007, GDACE, 2009). Literature reveals that 50% of municipal solid waste in developing countries comes from construction (Lu and Yuan, 2011). In fact, more than 50% of waste entering land fill in the United Kingdom (UK) originates from construction (Ferguson *et al*., 1995). Similarly, research reports from Australia reveals that 44% of the total waste being deposited in landfilled annually is coming from the construction industry (McDonald, 1996; Craven *et al.,* 1994) In South Africa, although there is limited published information on the composition and volume of construction waste generated at different provincial level, the observations have shown that construction and demolition sites generate substantial commingled wastes (Purnell, 2009, GDACE, 2009). For instance, the reports of the Department of Agriculture Conservation and Environment on the waste generated in the Gauteng Province of South Africa shows that 20% of waste generated within the province arise from building demolition and construction waste. The report further indicates inter alia that approximately one quarter (25%) of waste entering landfills are building and demolition waste. Thus, the increase volume of construction waste generation has attracted considerable attention in the recent times (Lauritzen, 1998; Ali *et al,* 2014). Apart from the fact that the most of the waste generated from construction ends up in landfills or at times illegally dumped (GDACE, Gauteng Department of Agriculture Conservation and Environment, 2009), the increase in the amount of waste generated and the lack of appropriate waste control and management system has become

an issue of major concern in all countries including South Africa and Polokwane Municipality (Ikau *et al*., 2016; Jawad and Omar, 2016, SAEO, 2012). Literature reveals that construction waste have lot of consequences on the outcome of construction projects as well as on the environment. For instance, the official country problem statement according to the National Waste Management Strategy (NWMS) (Department of Environmental Affairs 2012) has noted that one of the major challenges faced by South Africa in the waste management field is the unpleasant unhealthy environment arising from waste generation. In addition, construction waste has significant effect on the construction time, construction cost and the construction industry productivity (Nagapan *et al.,* 2012). The increase in construction activities usually leads to increase in the waste generated from construction. Thus, it is expected that all effort should be put in place for effective management of the waste produced. Several consequences accompany ineffective waste management system notably are the fact that it leads to environmental degradation, encourages further dumping which aesthetically degrade the landscape, increase pollution, reduction in the amount of natural resources and increase burden on scarce land resources GDEAC, 2009). To reduce the negative consequences and impacts of Construction waste on the environment and to the general public, comprehensive understanding of the waste causation and waste management have becomes very necessary (Nagapan *et al*., 2011).

3. RESEARCH METHODOLOGY

This study employed a quantitative research approach. Data were collected using a questionnaire design. The questionnaire formulation started with a review of related literature to identify waste causation factors from similar studies conducted in other countries. From the literature review, 14 factors were extracted and presented in a questionnaire form for survey (Nagapan *et al,* 2011; Nagapan *et al.,* 2012; Ali *et al.,* 2014; Ikau *et al.,* 2016; Jawad and omar, 2016) . The respondents were to elucidate on the significance of the identified factors as the causes of waste on construction activities. The questionnaire design consists of two main sections. The first was the introductory section which was design to collect the demographic information of the respondents. The second section requested the respondents to appraise the significance level of each of the identified factors. The respondents were to judge the significance on a predefined 5 point Likert scale (1=Strongly Disagree, 2=Disagree. 3=Neutral, 4=Agree and 5= Strongly Agree). Based on the ranking given to each of the factors by the respondents, MIS score was obtained for each of the identified factors and were ranked from highest to lowest. An hypothesised mean of 3.0 was used as relevant level determinant as used in some earlier studies (Coakes and Steed, 2001). This was determined by adopting the mid-point value of the index (1+2+3+4+5/5=3). This implies that all scores above 3

are significant while scores below 3 are insignificant Thus, a factor is considered relevant if it has a mean item score of 3.0 or more.

Since the focus of this research is on waste causation factors from construction activities in the Polokwane municipality of SA, the sample for the study were collected using nonprobability purposive sampling approach. Consequently, only the construction professionals who are involved in various types of construction activities and their firms are duly registered in the Polokwane Capricorn Municipality District were contacted. The target respondents were contractors, builders, engineers, project managers and site agents who operates at the senior level in all categories of construction firms visited. The research survey attracted 44 responses and they were analysed using SPSS. The analysis shows that respondents are involved at both private and public construction sectors of the industry. Further, the analysis shows that 29.5% of the respondents were site agents/foreman, 31.9.4% were project managers, 22.7% were engineers, and 15.9% were Construction Managers. The years of experience of the participants varies, 79.5% had experience that ranged from 1-5 years, 18.2% had experience in the range 6-10 years and 2.3% had experience that ranged between 11-15 years. The analysis further revealed that 52.3% had worked in 4-10 projects, 36.4% had worked in 11-15 projects, 6.8% had worked in 16-25 projects, 2.3% had worked in 1-3 projects and 2.3% had worked in more than 25 projects. This demographic information implies that the respondents have involved in a number of projects within the province and are suitable for this type of project which make the data reliable.

4. RESULTS AND DISCUSSION

The mean item score (MIS) was used to elucidate the respondents perceptions of the relevance of each factor identified as waste causation factor on construction activities. For the purpose of clarity and better presentation of the agreement reached by the respondents on the level of influence of each factor, the mean item score and ranking of each waste causation factor were tabulated. A summary of the analysis results is shown in Table 1. In addition, the mean item score for each factor, including the associated standard deviation, is also reported In Table 1. Consequently, based on the five-point Likert scale, a factor was deemed very significant if it has a mean item score of 3.0 and above.

Table 1: Factors that lead to waste on construction sites

FACTORS	MIS	SD	RANK
Insufficient awareness about construction and demolition waste management	4.36	0.865	1
Wasteful use of materials in construction activities	4.27	0.872	2
Lack of a well-developed waste recycling market	4.23	0.937	3
Lack of skills and experience of construction workers	4.20	1.231	4
Poor skills of operatives	4.11	1.083	5
Frequent demolitions due to reworks and change of orders	4.09	1.117	6
Insufficient regulations	3.89	1.262	7
Low quality of building components and materials	3.77	1.138	8
Inappropriate methods for loading and shipment of building materials from suppliers to sites	3.66	1.160	9
Inadequate economic incentives	3.50	0.952	10
Prevalence of traditional methods of construction	3.48	1.000	11
Inappropriate methods for handling and shipment of building materials on site	3.45	1.190	12
Inappropriate packaging of building materials and components	3.30	1.145	13
Inappropriate inventory of building materials and components	3.09	1.030	14

According to Table 1, insufficient awareness about construction waste management ranked first with a mean score of 4.36; the waste of materials during construction activities ranked second with a mean score of 4.27; lack of well-developed waste recycling market ranked third with a mean score of 4.23; lack of skills and experience of construction workers ranked

fourth with a mean score of 4.20 and operative poor skills and frequent demolition due to reworks and change of orders ranked fifth and sixth with mean scores of 4.11 and 4.09. low quality of building components and materials, inappropriate methods for loading and shipment of building materials from suppliers to sites, inadequate economic incentives, prevalence of traditional methods of construction, inappropriate methods for handling and shipment of building materials on site, inappropriate packaging of building materials and components ranked seventh, eight, ninth, tenth, eleventh, twelveth and thirteen respectively. While inappropriate inventory of building materials and components ranked last with a mean score of 3.09.

A careful observation of the findings revealed that all the factors have mean scores that is greater than 3.0. This implies that all the factors contributes significantly to waste generation within the Polokwane district of SA. The study further revealed that the first six factors (as shown in Table 1 above) have a very high mean scores which are higher than 4.0. This is an indication that these six factors have a very high contribution to construction waste generation. According to the result, insufficient awareness about construction and demolition waste management ranked highest. This is similarly the issue with many other developing countries. Nikmehr *et al.* (2015) explained that the wasteful practices of construction workers in Iran mainly arise from their lack of awareness in implementing less wasteful construction methods. Beside, some of these construction workers are unfamiliar with appropriate methods of handling construction waste. In addition, some of the workers lack understanding of the value of building materials and have wrong views about waste management and as such affect the way in which they handle construction materials. Adequate information is very crucial for effective operation of construction activities. Thus, enhancing the level of awareness of construction participants of the value of materials and the necessity of reducing construction waste as well as effective supervision on construction site are very important.

It is further discovered from this study that wasteful use of materials in construction activities, frequent demolitions due to reworks and change of order, lack of skills and experience of construction workers and poor skills of operatives also have very high mean scores above 4.0 and contribute significantly to construction waste generation. Jawad and Omar (2016) have noted that material waste due to poor skill of workers usually arise from the fact that most of these workers are unskilled. In addition, majority of construction workers are employed temporarily on daily basis based on the available works on sites. These workers are later discarded once the contract period comes to an end and re-employed at the commencement of a new project. As such, most of these workers are not trained enough to build up their skills. This in turns affect the level of their knowledge, experience, understanding as well as the manner at which they handle construction materials. Consequently, the poor quality of work executed by

these unskilled/untrained labour can lead to serious error requiring demolition and rework resulting in construction waste.

Delving further to the findings of this study (as revealed in Table 1), insufficient regulations, low quality of building components and materials, inappropriate methods for loading and shipment of building materials from suppliers to sites as well as prevalence of traditional methods of construction are other factors which usually lead to the generation of large amount of waste in the SA construction industry. Having realised the negative consequencies associated with large volume of waste being generated in the construction industry, all hands must be on desk towards reduction of construction waste and adequate management and control should be encouraged.

5. CONCLUSION

The key factors causing construction waste in Polokwane Municipality District of SA has been investigated in this study. Fourteen factors were extracted from the review of literature and were presented to the professionals within the study area for the determination of the level of significant at which each of them generate waste during construction activities. The study reveals that all the variables identified from the literature are waste causative factors. The most prominent among these causations is insufficient awareness about construction waste management. Thus, it is important that the government should help in the creation of awareness on how waste are generated and how they can be minimised. This awareness will not only be beneficial to Polokwane community alone but will go a long way in sensitising the construction industry at large on how waste are generated and how construction players can minimise waste generation on construction site. This will enhance economic growth and protection of the construction environment.

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Analysing Hidden Lean Practices in Construction: An Eastern Cape Study

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ABSTRACT

Purpose
The study investigated the influence of hidden lean practice in the construction industry to develop methods, which can be used to lead lean practice in the South African construction industry. Lean practice is described as a production system used to minimize waste of materials, time, and effort to produce the maximum possible amount of value to benefit the client and other stakeholders.

Research Method
The qualitative research approach (phenomenology) was used in the study with the aim of understanding how lean could improve the conventional construction practice in a region where performance improvement is most needed. A semi-structured interview approach was adopted, and the collected textual data were analysed to produce the findings of the study.

Findings
The results show that Lean practices are not well known by the participants, and by extension by the companies where they current work. However, upon reflection of what lean practices represent, the participants elucidated if they apply the practices on projects, waste would be minimized, and more value would accrue to their clients.

Limitations
There are, however two limitations observed. One, the phenomenology study does not lean itself to statistical generalization, and two, the application of known lean tools was not assessed by the participants in practice.

Implementations
This study nevertheless provides insights into how to improve the construction practice regarding performance improvement through the adoption of lean practices.

Response to the Conference Theme
Construction Management

Keyword
Clients, Construction, Lean, Practice, Waste

1. INTRODUCTION

Construction projects are executed by the project team (project consultants and contractor) on behalf of the clients. However, construction managers are experiencing challenges, which require emergent knowledge, skills, and experience to overcome. The construction industry is a very competitive environment, and new knowledges are developed to encourage construction managers to improve the delivery of projects. However, Filho, Heineck, and Costa (2016) argued that it is important to understand the effectiveness of construction methods and to recognise the distinction between complex and complicated aspects of projects. The admonition from Filho et al. (2016) is premised on the idea that majority of projects are designed through modern engineering design, which is complex and complicated enough to incline managers to produce poor project delivery service for the clients (Kalsaas, Bonnier, and Ose, 2016). Furthermore, the study by Koskela (2000) argued that poor performance is often experienced in developing countries due to low productivity, insufficient quality, tremendous waste (both physical and process waste), and poor working conditions. The problem addressed in this research is that a lack of lean practice influences the delivery performance of projects in South Africa negatively. Although the adoption of lean practice in the developed countries such as the United States of America (USA) has been the revolution to the construction industry, it is surprising that contractors in the developing countries such as South Africa are still shy from implementing lean practice. The dilemma encountered by construction managers can, however, be improved through the adoption of the Toyota Production System (TPS) that is otherwise known as lean practice.

The TPS is benchmarked by two pillars: continues improvement, and respect for people (Korb, 2016). The application of TPS has helped the Japanese manufacturing industry to revive from the effect of World War II. During the implementation of TPS, the Japanese company called Toyota Corporation had a slogan, describing the two pillars of TPS *"We make people before we make cars"* points to a philosophy that should be emulated in construction (Korb, 2016). The slogan implies that the formula to achieve 'lean' is for the employer to have a constant relationship with workers and its supply chain (Korb, 2016). The construction managers should create a healthy working environment that motivates and support construction workers and the organization to promote the type of efficiency advocated by lean construction (Forbes, and Ahmed, 2011). Therefore, it is

necessary for researchers to undertake studies relating to lean practice to assess opportunities in South African construction. This paper thus aims to highlight lean practices that could be driven by 'people' in construction when conventional practices provide platforms for changes that produce higher productivity in a firm.

2. LEAN CONSTRUCTION PRACTICE

Lean practice can be described as the management system developed at the Toyota Corporation (Korb, 2016). Lean practice was developed in the early 1950's by Toyota engineer, '*Taiichi Ohno'*, with the purpose of finding alternatives methods to convert material waste into value while transforming craft production to mass production (Sarhan and Fox, 2013). It is necessary to recognise that Ohno's improvement of Toyota's production process was not necessarily a new technology, but rather the result of involving all existing knowledge in a new philosophy of avoiding waste of any type (Forbes, and Ahmed, 2011). Technically lean practice was designed to reduce waste while adding value in the automotive production industries, but researchers such as Koskela introduced this tool to the construction industry (Forbes, and Ahmed, 2011)

Lean practice in construction is described as a philosophical approach designed to complete complex and modest projects to clients' satisfaction (Howell, 1999). Forbes and Ahmed (2011) described lean as a production system which aims to minimize waste of materials, time, and effort to produce the maximum possible amount of value of the projects. Lean practice is based on the model of lean thinking and lean principles, which are adopted from the TPS to add value to the method of managing construction project (Al-Aomar, 2012). However, it is important to acknowledge that lean practice is grounded on lean thinking which focuses on how the project value is created rather than how the activities are being managed (Howell and Ballard, 1998). To enhance the value created for clients, Howell (2011) identified eight types of waste which are common in the construction industry. The waste types include; transportation, inventory, motion, waiting, overproduction, and over-processing, defects, and skills misuse.

In South Africa, Emuze and Ungerer (2014) argued that lean construction should be established in the minds of the clients, contractors, workers and all stakeholders for a better acceptance and implementation of projects. The suggestion by Emuze and Ungerer (2014) is the idea that it is the responsibility of the lean practitioner to identify and inform the clients about the importance, opportunity, and benefits of lean awareness and enlightenment campaigns within the construction industry (Suresh, Bashir, and Olomolaiye, 2012). Lean practice can be introduced in several ways. An example includes adopting lean thinking process which helps the lean

practitioner to manage the project based on the project principles and techniques (Forbes and Ahmed, 2011).

2.1. Lean practice concepts

This study was limited to six different types of lean concepts that affect the performance of projects. The six lean practice concepts include value stream mapping, lean principles, lean project delivery systems, last planner system, just-in-time, transformation flow value.

Value Stream Mapping (VSM)

The VSM is a lean practice tool, which examines the strength gained by providing vision and plan that connect all improvement activities together. The application of VSM allows lean practitioners to evaluate and eliminate waste in the construction process. The purpose of VSM is to provide optimum value to the clients through a complete value creation process with minimum waste in design (concept to the customer), build (order to delivery), and sustain (in-use through life cycle to service) (Rother and Shook, 2009).

Lean Principles

The application of lean principles is defined by Womack and Jones (2003), through the five principles of lean production. The five lean principles are highlighted in Figure 1 as termed by Forbes and Ahmed (2011):

- Value: The procedures to identify and describes the actual worth of the project required by the clients.
- Value stream: Is the procedures to determine the value stream of each product and expose waste, while facilitating its elimination, establishing cooperation between participants and stakeholder's results in the lean process.
- Flow: Is the principles of producing a value of the project while creating procedures to be followed.
- Pull: Represents the procedures which should be engaged by the lean practitioner in keeping a good relationship with the clients and the community and meeting their demands.
- Perfection: Represents methods of construction, which should be adopted by lean practitioners to produce and deliver a project of high standards and high quality without bad publicity and destroying the client's repetitions.

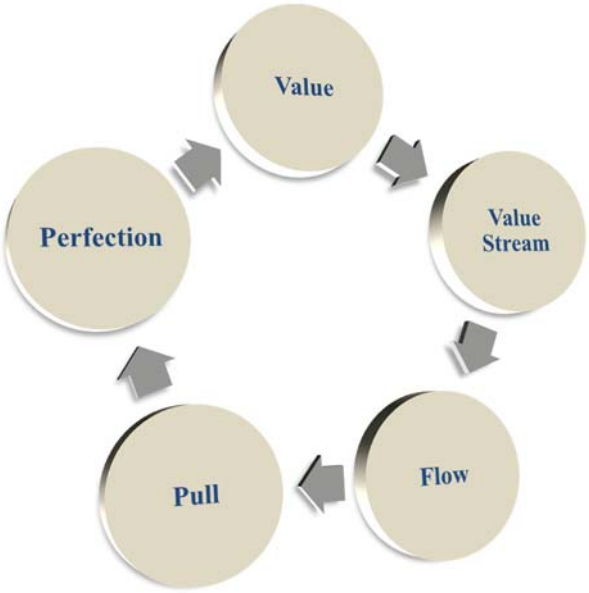

Figure 1: The five basic lean principles (Adapted from Rother and Shook, 2009).

Lean project delivery system (LPDS)

The LPDS is the lean tool, which defines the role of the project implementation team in that they are not responsible for putting the need of the clients first before the need of the project. It is important for the project delivery team to understand what the customer needs and what the project entails in the community (Womack and Jones, 2003). This process changes all the variables: ends, means, and constraints. Forbes and Ahmed (2011) listed the LPSD phases as follow:

- Define the project.
- Define lean practice for the project.
- Design lean practice for the project.
- Connect the supply chain process.
- Assemble or construct the project to the client's requirement.

Last planner system (LPS)

Mossman (2009) defined the last planner as a system for collaboratively managing the network of relationships and conversations required for programme coordination, production planning, and project delivery. The LPS uses lean practices to provide improved project control. The last planner is in the best position to match labour and material resources to accomplish assignments in response to downstream demand. Work planning may establish time frame but is not very effective in establishing that the tasks assigned are capable of completion (Hamzeh, Ballard, and Tommelein, 2012). The LPS originally was designed to address shortcomings of the critical path method, specifically, task continuity that was never addressed in the project schedule planning (Dave, Hämäläinen, Kemmer, Koskela, and Koskenvesa, 2015). The LPS is grounded on four levels of schedules and planning which include the master pull schedule, the look-ahead schedule, the weekly work plan, and a daily plan.

Just in time (JIT)

Forbes and Ahmed, (2011) described Just-in-Time (JIT) as a method, which allows a minimum number of units or items to be produced using fewer quantities of materials in an appropriate period to reduce waste and improve quality. The JIT method attempts to smooth the flow of materials from the suppliers to the customers (supply chain process), thereby increasing the speed of the production process. It could also change the production system gradually rather than a drastic change (Koskela, 2000).

Transformation, flow and value (TFV)

Koskela formulated the TFV theory of production to improve performance when applied in construction. The TFV exposes the need to evaluate construction production as a combination of conversion and flow process to remove waste. It is recommended that for achieving an internal position among other theories, two different understandings should be clear which are the ‘thing’-based theory of TFV and the process-based theory of TFV (Miron, Kaushik, and Koskela, 2015). Koskela differentiates the term transformation, flow, and value through the term ‘world views’. The Transformation view focuses on the actual problems relating to adding value to the activities; the flow view focuses on improving the value adding activity by reducing non-value adding activity; and value view focuses on the interest of the customer by improving value for the customer (Senior, and Nafe, 2016).

3. METHODOLOGY

The research study adopted qualitative research method. Thorne (2016) described qualitative research as the exploratory research where researchers are using it to gain an understanding of the underlying reasons, opinions, and motivations of the problem they are trying to solve. The problem of this study was grounded on the fact that the construction professions in South African construction are failing to adopt lean practice during the design and construction of projects. The aims of this study were to identify the impact of hidden lean practices in construction. The scope of this study was limited in the Eastern Cape Province.

A semi-structured interview guided the procedures for designing the methodology and for collecting the study data. The interviewees (participants) were selected based on their roles in their respective firms, and only participants involved in the project decision-making and management position were interviewed. The data were collected through In-depth interviews with project consultants (civil engineers and quantity surveyors) and contractors. Purposive sampling technique was used to select the member of the project consultants and contractor's team as recommended by Ritchie, Lewis, Nicholls, and Ormston, (2013). Purposive sampling technique is a type of non-probability sampling that is most effective when one needs to study a certain cultural domain with experts (Tongco, 2007).

The research data were collected between September and October 2016. The sample of this study resulted to 16 (9 contractors, 4 civil engineers, and 3 quantity surveyors) out of 20 participants who were proposed to be interviewed by the researcher. The demographic of this study shows that 56% (9 out of 16) were the member of the contractors, while 25% (4 out of 16) were the member of the civil engineers, and 19% (3 out of 16) were member of the quantity surveyors. The data were analysed by focussing on the research questions and eliminating responses, which did not answer the research questions.

4. FINDINGS AND DISCUSSION

This study was focussed on the central research question "*what are the hidden lean practices in the Eastern Cape construction industry?"* which guided 16 interviews. The interview procedures were unstructured so that the participants could express their knowledge and experience while answering each question. At the start of each interview, a detailed description of lean construction was introduced to the participants through aided presentation of five slides. The following sub-questions are used to present the analysed data of this study and to answer the central research question.

Question 1: Which construction delivery method did you use for your project?

This question focussed on the construction methods which were used by the participants to manage their project. The findings show that the majority of participants used traditional methods 'design–build concept' in their projects. The response from one of the participants was as follow:

> *"I follow the programme planning and instruct my foreman to carry out the construction according to the drawing plans and specifications as instructed by the engineers."*

A participant from the consulting engineers said that his responsibility is to design and make sure that the contractor follows his instruction and he is not concerned about the method of construction used by the contractor; he is concerned about construction production. Furthermore, some participants from the contractors explained that they design a programme planning for their project during the tendering stage and should they be awarded the project, they would then update the programme after the appointment letter has been issued by the clients. The programme planning helps the contractors to carry out the project according to the designed project period. A participant from the quantity surveying firm stated that it is the responsibility of the construction team to define the methods, which they are going to use after the client had issued an appointment letter for them because the correct methods will help the contractor to deliver the project and meet the client needs without disputes. Another quantity surveyor explained that majority of small and medium-sized contractors pay little attention to material supply on site and they end up increasing the period of the project due to this negligence. The participants emphasized that small and medium sized contractors often fail to negotiate and communicate with the material suppliers concerning payment of their accounts and the delivery schedule of materials to the site. These problems often force material suppliers to fail to honour their agreement regarding the delivery schedule of materials to the site.

Question 2: Identify the construction activities which are lean related

This question focused on how the construction activities are executed on site and whether they are lean related. The findings show that majority of the interviewed participants are not familiar with the term lean practice. Few participants from the contractor's team explained that the construction activities are determined in the programme planning, and the construction activities are revised and updated on a monthly basis. Furthermore, the participants explained that they are providing training for the construction workers (unskilled labours) with the aim of sharing knowledge and improving their work services. The unskilled labours are taught how to make a critical decision regarding bricklaying, casting of the concrete,

installation of plumbing, and how to reduce wastage of materials on site. The participants further explained that they never worry about the method of construction, and their company will start to adopt the lean practice to improve their methods of managing the project. The participants from the civil engineer's firm explained the importance of lean practice and expressed that the member of the contractor's team should adopt lean and reduce waste (especially waiting period) while adding value to the projects. Furthermore, the contractor's participant explained the situation they once had; they were advised to change the design of the roof truss from using timber to use steel due to high maintenance of the timber roof truss. The participant's responses are as follow:

> *"Even though steel roof truss is more expensive than timber truss but it is more durable and cost less on maintenance when compared to timber truss, which should be replaced after few years."*

Questions 3: What are the impacts of lean related activities on projects?

This question focused on the impact of lean related on the project and how the lean practice can be introduced to the project team. The participants explained that lean practice should be introduced to the project team during the design to the execution of the project by both the project consultants and the contractor to improve the project performance. The participants from the contractor's team explained that lean practice should be introduced to the construction workers because they are handling activities leading to major material wastage on site. The participants further explained that communication between the construction workers and the construction leader should be improved. In most cases, the construction workers are restricted from expressing their opinion on the site. However, the participants from the consultants disagreed with other participants on how to introduce lean practice by saying:

> "*The client will be compelled to pay the contractor for training the construction workers. Lean practice will just be a waste of money; the client does not have capital to train people to understand how to minimize waste and add value to the project. The current traditional method is working successfully even though it has its weakness; there are no methods which are perfect in the construction industry."*

4.1. Discussion

The Last Planner System (LPS) is a Lean tool designed to improve the performance of the project relating to programme planning by redesigning the production units, grouping activities per location and similarity of the tasks (Murguia, Brioso, and Pimentel, 2016). The findings show that it is standard practice for the construction team to develop the programme planning of the project. It would be an advantage for the construction team to adopt LPS and utilise it fully to improve their performance relating to revising and updating of the construction activities per their location and resemblance. This will help the construction manager to improve the construction period, reduces waste, and to establish the suitable team per task. The success of the Toyota philosophy of minimising waste while adding value to the production has inspired other industries to adopt this method, predominantly into the construction industry. Young, Hosseini, and Lædre, (2016) cited Howell (1999) who differentiate lean construction from traditional practice. In particular, lean construction*:*

- has a clear set of objectives for the delivery process;
- is aimed at maximising performance for the customer at the project level;
- designs concurrently product and process, and
- Applies production control throughout the life of the project.

The findings show that majority of the participants are relying on the traditional method. It would be in the best interest to differentiate traditional method from lean practice, to eliminate waste, meet the client's requirements, and add value to the project, while pursuing perfection. It can be concluded that the application of lean practice is not well used in South African construction. Therefore, Figure 2 constitute a proposal from an endeavour to introduce lean practice to South African construction. The diagram shows that training between the construction employers and employees is very important. It is advisable for the construction companies to invest in training to teach people working in construction the application of lean practices. Lean practices should be communicated during the design stage by the project consultants, and thereafter should be communicated by the contractors during the construction stage. The Lean training between the construction workers and the management would be addressed through open communication to accommodate everyone in a training. Appropriate lean training and open communication would lead to continuous working relationship on the construction site. Therefore, it is necessary to understand the importance of lean practice; the lean guideline would be the pillar of supporting the training, communications, and continuous working relationship for the lean practices.

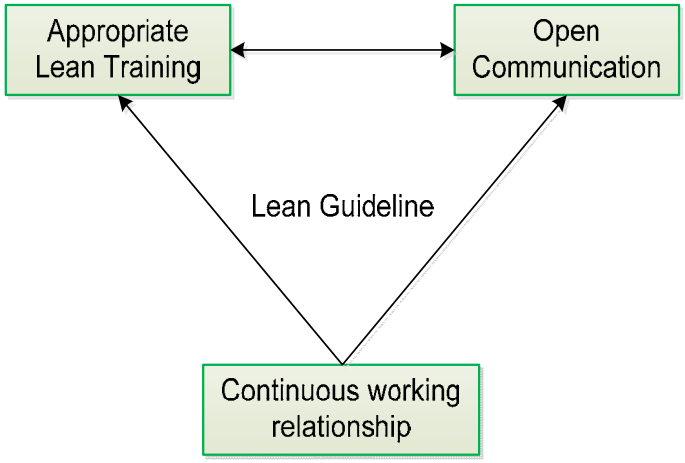

Figure 2: Lean Practice Guideline

5. CONCLUSIONS

This paper presented an outline of the common lean practice defined to improve the construction manager's decisions when managing the construction project. Lean practice is designed to improve the management of a project by minimizing waste to maximize value. The initial findings support the notion that it is the time the construction managers to adopt lean practice by using some of the concepts emphasized in this paper to improve planning and construction. It is important to report that a single lean practice was not discovered in the interviews. The non-discovery of a single lean practice implies that there is no 'hidden' lean practice in South Africa construction. In essence, construction managers together with the construction workers should be introduced to lean practice so that they can produce and deliver projects, which minimize delays and waste in construction. The project consultants should also adopt lean practice during the design stage; the project design (drawing plans and specifications) should allow contractors to carry out the project in a manner which would minimize waste and add value to the clients. The working relationship between the contractor and material suppliers should be technical adequate and transparent. The Lean practice can be adopted to improve the communication and create continues relationship between the contractor and material supplier. Lean researchers have developed a lean practice as described in the literature to help the construction members to reach the construction goals while adding value to their clients, and improving service to the customers. Therefore, the lean practice guideline is an attempt to close this bride of hidden lean practice in South African construction. This research established some of the advantages that lean construction practice can bring to improve the management of the

construction project and to reduce waste and construction period on site while adding value without reducing the project standard.

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Analysis of Factors Influencing Productivity in South African Construction

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ABSTRACT AND KEYWORDS

Purpose
The performance of a nations' economy can only be as good as the level of productivity of its constituent parts. Despite the significance of the construction industry to a thriving economy, it is almost impossible to deliver a construction project without overrunning its budget and schedule. This results in negative influences on construction project stakeholders, the business of construction, and a nations' economic performance. Based on this premise, this research project is focused on measuring the level of productivity in South African construction, and to identify the key productivity influences.

Methodology
A sample of contractors that are registered with the cidb (Grades 5-9) was surveyed. The sample of contractors was restricted to the Eastern Cape and Gauteng provinces, while the study population was obtained from the cidb database.

Findings
The study determined that inadequate workers' skills, defective workmanship, and inadequate contractors' experience in project planning are the preponderant construction productivity influencing factors.

Response to conference theme
The study relates to construction labour challenges in the form of productivity on construction projects

Practical implications
The study identified the need for contractors to measure productivity on their projects for performance assessment.

Value
The study provides the opportunity for construction stakeholders to develop an understanding and appreciation of construction productivity influencing factors for the appropriate intervention by the construction industry decision makers.

Keywords
Construction, Labour, Productivity, South Africa

Conference sub-theme
Construction labour challenges

1. INTRODUCTION

The construction industry is a significant contributor to the economy in most countries where the industry contributes 3-8% to the gross domestic product (GDP) (Arditi and Mochtar, 2000). Despite this significant contribution, the construction industry has long and widely been criticised for its underperformance, as the industry still grapples with the challenge of poor productivity. This has resulted in negative influences on construction project performance, project stakeholders, and the business of construction. To this effect, considerable research projects have been conducted with respect to construction labour productivity in developing countries such as Chile, India, Jordan, Nigeria, Oman, Palestine, Thailand, and Uganda (Enshassi *et al.,* 2007; Rivas *et al.,* 2011; Thomas and Sudhakumar, 2013; Odesola and Idoro, 2014; Jarkas and Bitar, 2012; Hiyassat *et al.,* 2016). Several studies have also been recorded in developed countries, such as New Zealand, the United Kingdom, and the United States of America (Dai *et al.,* 2009; Durdyev and Mbachu, 2011). However, in the construction industry, poor productivity with its attendant detrimental effects have continued to be a recurring issue, especially in developing countries. There is an indication that the existing studies have not largely benefited emerging economies (Enshassi *et al.,* 2007). Coka (2013) reports the decline of both capital and multi-factor productivity (MFP) as -1.6 % and - 0.7 % respectively in the South African construction industry. The author recommends further research to focus on identifying key influences that impede productivity of SA construction which this study addresses.

2. PRODUCTIVITY IN PERSPECTIVES

Productivity is a multi-dimensional concept that could be understood in different contexts depending on the objectives involved; the objective, in turn, defines the parameters involved in its assessment in relation to the benchmark used (Durdyev and Mbachu, 2011). Production methods are usually non-standardised as different organisations measure workers performance at different levels (cidb, 2015). Many authors have provided succinct and elaborate definitions of productivity relative to their studies. Economists and accountants define productivity as the ratio between the total input of resources and total output of product (Enshassi *et al.,* 2007). The American Association of Cost Engineers (AACE) defines productivity in construction as a relative measure of labour efficiency, either good or bad, when compared to an established base or norm. Nasirzadeh and Nojedehi (2013) define construction labour productivity as the ratio between completed work and expended work hours to execute the project. Consequently, the effort to benchmark construction productivity in the global construction industry is almost impossible.

2.1 Single factor productivity (SFP)

Single factor productivity only considers labour as the input resource (Park, 2006). In economics, labour productivity represents one of the most widely used metrics. This is because there is a relationship between economic growth and labour productivity. The change in labour productivity multiplied by the rise (or decline) in total hours worked in an economy equals the national output. Park (2006) posit that SFP is frequently adopted in the construction industry, where the actual work hours (input) is divided by the quantity installed (output).

2.2 Multi-factor productivity (MFP)

A multi-factor productivity is determined by dividing the index of actual output by the index of the combined units of labour input, capital services, and intermediate inputs. MFP is used for measuring the combined effects of technological change, efficiency improvements, reallocation of resources, and other factors relative to economic growth. Chau (2009) defines MFP as "*the ratio of the total gross output of the construction industry to* ***all the resources*** *required to produce the output within the same time interval*". MFP is commonly expressed as the combined efficiency of labour inputs and capital inputs relative to the growth in GDP or value added. This concept involves multi-factors such as labour, equipment, materials, and capital as the inputs. MFP is commonly employed in economics studies (Park, 2006), and has been widely recognised as the only sustainable source of long-term economic growth.

3. SALIENT CONSTRUCTION PRODUCTIVITY INFLUENCING FACTORS

This section presents a review of previous studies with respect to factors influencing construction productivity. An understanding of the factors influencing labour productivity would enable site management teams to allocate their limited resources more effectively (Nasirzadeh and Nojedehi, 2013).

To determine the factors responsible for unproductive time on construction projects, Olomolaiye *et al.* (1987) investigated the factors that negatively influence craftsmen productivity. It was determined that lack of material, lack of tools, rework, instruction delay, and delay of inspection are the underlying factors resulting in poor productivity on construction sites. Josephson and Chao (2014) note that non-value adding time (waste) constitutes approximately 35% of the available time between activities, while the time spent on value adding activities is significantly less. Rivas *et al.* (2011) attribute the fundamental causes of material-related challenges to late delivery from the central storehouse, lack of material before the commencement of operation, and long distance of material from work area.

Lim and Alum (1995) explored productivity challenges encountered by contractors on construction projects. The study determined that difficulty in supervisors' recruitment, difficulty in recruitment of workers, high rate of labour turnover, absenteeism at worksite and communication problem with foreign workers are the critical factors that negatively influence construction productivity. It is further stated that a shortage of well trained and competent site supervisors contributes to less efficient deployment of labour. The difficulty in supervisor recruitment can be attributed to the scarcity of competent supervisors as construction organisations strive to employ the available competent supervisors which are not easily found. Communication challenges in the construction cycle can be attributed to low literacy level of labour. Thomas and Sudhakumar (2013) maintain that poor communication systems between supervisors and craftsmen can affect workers' motivation and escalate the chances of mistakes in the construction process with its attendant detrimental effects to project success.

Durdyev and Mbachu (2011) investigated the key constraints and improvement measures to on-site labour productivity in the construction sector. Project management, project finance, workforce, projects' characteristics, and technology process were identified as the critical variables influencing construction productivity. Livesey (2016) states that the geographical location of project team especially those involved in design, procurement, and construction increases the challenges of project management process.

Jarkas *et al.* (2012) investigated the relative importance of factors influencing labour productivity. Labour skills, shortage of materials, labour

supervision, shortage of experienced labour, communication between site management and labour, and lack of construction management leadership were determined to be the critical factors resulting in reduced construction productivity. Poor labour supervision engenders unscheduled breaks, idleness, unproductive activities, or even workers leaving the site during work hours to attend to personal matters (Jarkas *et al.,* 2012). According to Daveri and Parisi (2015), the productivity of workers is largely dependent on the skills and experience of workers. Tabassi *et al.* (2016) maintain that project managers should acquire the necessary leadership competencies, intellectual competence, skills, and knowledge to achieve sustainable project delivery.

The key factors influencing construction labour productivity were investigated by Thomas and Sudhakumar (2013). The findings include (1) Tools and equipment issues resulting from lack of maintenance, poor quality of tools and unavailability of equipment; (2) Poor labour motivation – resulting from lack of monetary incentives, lack of recognition of efficient workers and disregard of craft worker suggestions; (3) Supervisor absenteeism – resulting from lack of experienced supervisors, and inadequate instructions provided by supervisors, and (4) Poor material planning – resulting from the unavailability of materials on time in the workplace and material delivery delays courtesy of suppliers.

Hafez *et al.* (2014) investigated the critical factors affecting construction labour productivity. The study determined payment delay, the skill of labour, shortage of experienced labour, lack of labour supervision, the motivation of labour, working overtime and lack of leadership of construction managers as the critical factors affecting the performance of construction. Skill shortages were identified by Enshassi *et al.* (2007), Jarkas *et al.* (2012), and Hafez *et al.* (2014), which constitute studies undertaken in developing countries. Delay in employee payment is related to motivation of construction workers and could affect their morale for optimum performance. Productivity is directly related to motivation, while motivation is also dependent on productivity. Hiyassat *et al.* (2016) determined that the factors that influence construction productivity are workers' experience, financial incentives, trust and communication between management and workers, scheduling, and team spirit.

4. RESEARCH METHODOLOGY

The data related to this enquiry was collected by a structured, closed-ended questionnaire survey. The questionnaire survey comprised an ordinal measurement scale ranking the extent at which the identified factors influence productivity on construction projects. The scale adopted was 1 (Minor) to 5 (Major), while respondents were also provided with an option of selecting 'unsure' should respondents be uncertain with respect to a factor. The numbers assigned to the scale, however, do not indicate

equal intervals or absolute quantities, rather, the effect of each factor, from the respondents' perceptions regarding labour productivity. Based on previous labour productivity related studies, seventy-two construction productivity influencing factors were identified. These factors were categorised under ten different themes, namely rework related, resources related, constructability related, political related, socio-economic related, working environment related, dispute related, welfare conditions related, planning related and training related factors. To ensure a reasonable validity of the results obtained by this study, that is, to ensure that the questions do measure what they are supposed to measure, a pilot test was conducted on a small sample of the prospective respondents. The purpose of this test was three-fold: (1) To detect possible mistakes in research instruments; (2) To identify the ambiguities involved in research instruments, and (3) To detect any non-verbal behaviour relative to contents or wordings of research instruments. Subsequently, a few changes were made to the research instrument considering the input of construction practitioners in the pilot test conducted. The study population is contractors that are registered with the cidb within the categories of grade five to grade nine. The population of the contractors was obtained from the cidb official page, while the sample represented in the study was randomly drawn except for a few conveniently sampled contractors. The reality of productivity in South African construction would be provided by contractors in these categories, as the tender value for grade five contractors is R 6 500 000, while grade nine contractors have no limit as to the value of projects they can tender for. Data for the study was primarily collected through an internet survey, while a few questionnaires were administered on construction projects to supplement the low response rate achieved during the internet survey. Eastern Cape, Gauteng, Kwazulu-Natal, and Western Cape provinces of South Africa predominate in terms of construction capital outlay (cidb, 2015). This is a direct indication of significant construction operations in these regions. Hence, the survey was conducted with contractors in two of these geographical regions (Eastern Cape and Gauteng). The data collected was analysed with Microsoft excel while a measure of central tendency in the form of a mean score (MS) to rank factors. 367 Contractors constituted the sample stratum, and 38 questionnaires were retrieved, and included in the analysis of the data. This represents a 10.4% response rate. The average length of time participants' organisations have been involved in construction is approximately 21 years, while the average length of time that the respondents have worked in construction is 20 years. Both represent a considerable length of time, which indicates that respondents are likely to understand the factors that influence construction productivity.

5. RESULTS AND DISCUSSION

The extent at which construction productivity is affected by the identified seventy-two factors was determined. Study respondents indicated that factors that are related to project contractors are the most significant factors that affect the performance of construction projects. As indicated in Table 1, inadequate workers' skills (MS = 4.20), defective workmanship (MS = 4.17), inadequate contractors' experience in project planning (MS = 4.13) and payment delay by contractors are the factors that mostly influence productivity on construction projects. Inadequate skills of construction workers have been a major issue that has been repeatedly identified on most construction projects during pilot and primary surveys. An employee with poor skills would contribute to rework and quality related problems on projects. The absence of the requisite skills is also detrimental to delivering timeous construction projects with its attendant impact on project cost, which results in clients' dissatisfaction. During their study, Jarkas *et al.* (2012), Chingara and Moyo (2014), and Jarkas (2015) also identified the problem of skilled workers as a critical factor affecting onsite productivity. Defective workmanship indicated as the second critical factor influencing construction productivity, could be largely attributed to workers' skill. Defective workmanship will inevitably engender the rate of rework on construction projects. Time and cost as some of the essential resources of construction projects will unavoidably be wasted with the occurrence of construction defects. Defective workmanship can result from poor information management in the form of instruction from supervisors to their subordinates. Jarkas (2015) identifies the major causes of defective workmanship as poor supervision, buildability problems, errors from labour, over-inspection, change orders, inadequate coordination, physical fatigue of workers because of overtime and poor communication. Several studies conducted by Olomolaiye *et al.* (1987), Rivas *et al.* (2011), Odesola and Idoro (2014) have identified defective workmanship as a major factor that marginalises construction productivity. As indicated by respondents, inadequate contractors' experience in project planning is a fundamental factor with respect to construction productivity. Planning is essential, as effective planning can avert some of the undesired eventualities that ensue during project delivery. Planning has an overarching effect on most of the factors that engender overruns in the construction industry. For example, the construction industry working environment has been widely recognised to be inherently dangerous with incidences of injuries and even death. These occurrences and more others that could negatively influence project productivity can be mitigated through effective and adequate planning. Payment delays by contractors as one of the highly ranked factors influencing construction productivity has also been identified in previous studies conducted by Hafez (2014), Chingara and Moyo (2014), and Enshassi *et al.* (2007). Timely payment of employees can be a form of motivation to engender employee commitment to their assignments, thus they should be considered significant in terms of project delivery.

Excessive bureaucracy (MS = 4.02) as identified by respondents is essential, as this can affect the progress of construction project. Essentially, this factor has not been widely recognised in literature as a factor influencing construction productivity. The practice of awarding contracts to lowest bidders (MS = 4.02) is also a major concern in addressing productivity. Desperate contractors who do not have the technical-know-how and resources to execute construction projects can take advantage of this practice to the detriment of project performance. Political activities resulting in industrial action (MS = 3.98) as identified by respondents has been a major issue over the years, especially in the South African construction industry. Inappropriate planning techniques (MS = 3.96), late delivery of materials (MS = 3.91), and poor financial management by contractors (MS = 3.91), are also among the ten top ranked factors influencing construction productivity.

Table 1: Construction productivity influencing factors

Factor	**MS**	**Rank**
Inadequate workers' skills	4.20	1
Defective workmanship	4.17	2
Inadequate contractors' experience in project planning	4.13	3
Payment delays by contractor	4.11	4
Excessive bureaucracy	4.02	5
The practice of awarding contracts to lowest bidders	4.02	5
Political activities resulting in industrial action	3.98	7
Inappropriate planning techniques	3.96	8
Late delivery of materials	3.91	9
Poor financial management by contractors	3.91	9
Corruption	3.91	9
Poor communication management	3.89	12
Poor leadership	3.85	13
Scarcity of competent workers	3.82	14
Inadequate constructability awareness of designers	3.81	15
Poor supervision	3.78	16
Workers' lack of concern for training	3.76	17
Undiscovered anomalous conditions during site investigations	3.74	18
Inadequate time for designs	3.73	19
Inadequate commitment to existing plans	3.73	19
Late payment of wages	3.72	21
Job dissatisfaction	3.63	22

Table 1 continued

Inclement weather conditions	3.63	22
Insufficient initial cost estimates	3.62	24
Cost of training	3.61	25
Inappropriate construction methods	3.60	26
Poor motivational system	3.59	27
Inadequate clients' briefs	3.58	28
Design errors	3.57	29
Wastage of materials	3.57	29
Inadequate training facilities	3.57	29
Workers' absenteeism	3.52	32
Low education level of workers	3.50	33
Unforseen conditions	3.49	34
Non-involvement of contractors in the design phase	3.48	35

Among the identified seventy-two productivity influencing factors, Table 2 presents the factors that have a MS ≤ 3.00.

Table 2: Lowest ranked factors influencing construction productivity

Factors	**MS**	**Rank**
Cultural differences	2.80	68
Poor storage of materials	2.74	69
Ageing workers	2.63	70
Working overtime	2.50	71
Religious differences	2.02	72

The results of single factor and multi-factor productivity determined is presented in Table 3. The average labour productivity, material productivity, and plant productivity are 40.0%, 45.7%, and 31.6% respectively. Considering these three resources, average multi-factor productivity is thus 39.1%.

Table 3: Measuring productivity on construction projects

Measure	**Resource (%)**		
	Labour	**Materials**	**Plant**
Availability	80.8	75.3	64.6
Utilisation	72.9	77.5	70.9
Efficiency	67.9	78.3	69.1

Average	**40.0**	**45.7**	**31.6**
Average multi-factor productivity	**39.1 %**		

A fundamental question to ask is 'Do contractors measure productivity on their projects?' This is essential, because project decision makers can determine the level of productivity, and ascertain the extent of productivity improvement or decline. Among the surveyed contractors, as indicated in Table 4, 10.5% of respondents were not sure whether they measure productivity on their projects, or not. 42.1% indicated that they do not measure productivity on their projects, while 47.4% indicated that they do measure productivity on their projects.

Table 4: Do contractors measure productivity on their projects?

Parameter	**No.**	**%**
Unsure	4	10.5
No	16	42.1
Yes	18	47.4
Total	**38**	**100.0**

6. CONCLUSIONS AND RECOMMENDATIONS

This study concludes that the major factors that negatively influence construction productivity include inadequate workers' skills, defective workmanship, inadequate contractors' experience in project planning, payment delays by contractors, excessive bureaucracy, the practice of awarding contracts to lowest bidders, political activities resulting in industrial action, inappropriate planning techniques, late delivery of materials, and poor financial management by contractors. To improve construction productivity requires interventions relative to these factors. Based on these findings, this study therefore advocates the reinstatement of the apprentice system and proper training of construction workers. This will address the issue of skills shortages, and contribute to improving construction productivity, thus engendering stakeholder satisfaction and economic improvement. Also essential is adequate training of white collar managers with respect to managerial skills especially with respect to effective project planning throughout the project delivery process. When construction organisations trivialise the essence of developing their managers, the organisations would unavoidably be less productive as opposed to organisations with a well laid out and comprehensive plan that considers the intrinsic and extrinsic project parameters that undermine project performance. Productivity is directly related to motivation, while motivation is also related to productivity. One of the essential interventions

for improving project productivity is ensuring a consistent and timely payment of wages and salaries, as payment delays could affect workers' morale for optimum performance. The study further recommends a non-excessive bureaucratic procedure in project procurement, while clients should create adequate mechanisms that are devoid of prejudice in selecting competent contractors for the kind of proposed project. To contribute to construction project productivity, political factors resulting in industrial action should be addressed by extensive engagement of construction stakeholders with labour unions. The study has revealed that 42.1% of the surveyed contractors do not measure productivity on their projects, while 10.5% of the contractors are not sure whether their organisation measures site productivity or not. It can be predicted that, more than 50.0% of the unsure contractors are likely not to measure productivity on their projects, which generally implies that the contractors that do not measure productivity on their projects are likely to be higher than those that measure productivity. On this premise, the study recommends that contractors should view productivity measurement as a value, as measuring productivity will provide a true indication of their performance and aid the evolvement of improvement strategies when and where necessary. Further research is recommended to determine the most effective employee training system in terms of improving productivity in the South African construction industry.

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Assessment of alternative building systems available in South Africa based on sustainability indicators

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ABSTRACT AND KEYWORDS

Purpose of this paper
This paper investigates and assesses the rating of South African Agrément certified alternative walling systems based upon sustainability indicators, providing meaningful data for construction organisations and personnel. This provides a platform for further research.

Design/methodology/approach
A sample of active South African Agrément certified alternative residential building systems were assessed using sustainable indicators, considering Social, Economic and Environmental factors, using surveys including documentary analysis and questionnaires, providing an index of systems and assessing the sustainability of each through an assigned rating scale.

Findings
Findings indicated various factors in the sample group that could be further explored, such as local value creation and environmental pollution. Alternative building systems were categorised based upon materials/construction and sustainability rating is provided.

Practical implications
Although a multitude of alternative building systems are certified for use, the South African low-cost housing market remains dominated by concrete

block and mortar construction. This paper strengthens the awareness of alternative building technologies and could foster their wider application based upon sustainability targets.

What is original/value of paper.
The paper contributes to knowledge by providing an assessment of alternative building technologies available in the South African construction industry which are analysed through the lens of sustainability criteria.

KEYWORDS
Alternative Building Technologies, Sustainable Construction, Low-Cost Housing.

1. INTRODUCTION

Considering low cost sustainable housing for the African city of the future, a myriad of building materials, construction techniques and combinations thereof have been proposed over recent years. Housing developers are often constrained by tried and tested materials and traditional construction methods, being cautious of new concepts. De Villiers (2009) states that It is essential to find a balance between achieving reliability and consistency but not hampering innovation and further development of alternative building systems. Furthermore, he states that identified drawbacks to performance-based regulation need to be addressed and a critical assessment conducted of the performance requirements and the system of accountability. The introduction of the Agrément certification of alternative building systems has created a guideline for the acceptability of the performance of each system based upon the benchmark of the 'standard brick house' however it has not provided a meaningful reference for the merits of each system in terms of sustainability. The present paper endeavours to initiate a path of research which may ultimately guide policy makers, designers and constructors in the direction of long term sustainable construction solutions for low cost homes in South Africa.

The paper aims to analyse the suitability of alternative building systems, active in terms of the Agrément Certification (Agrément) for low cost housing in terms of sustainability, in the context of South Africa and its sub regions. An 'Indicator-based sustainability assessment tool' was developed to analyse available systems through a questionnaire based survey. This paper presents the preliminary findings of the analysis, which is oriented to provide a platform for further research and development of the South African construction industry and local built environment towards a sustainability culture.

The following section provides a review of the literature about the concept of sustainable construction, and relevant building systems.

Then the methodology of the study is explained in detail, followed by the discussion of the preliminary results achieved. Finally, conclusions and recommendations for further development of the research and similar studies are outlined.

2. AFFORDABLE AND SUSTAINABLE ALTERNATIVE BUILDING SYSTEMS

Initial research concluded that the number of alternative building systems worldwide is vast and that the materials and processes used for construction vary greatly dependant on the global region (Wallbaum, 2012). For example, in many eastern countries the use of bamboo has proven to be a very satisfactory building system as it is strong, light and durable and has gained widespread social acceptance, however in other parts of the world there may not be the local bamboo raw material or the required construction skills and the climate may not favour type of structure.

The attention to the building sector arises from its energy consumption and greenhouse gas emissions which, in developed countries, represent 30 and 40% of the total quantities respectively (UNEP-SBCI, 2009). However, when addressing sustainability, the “green” aspect is often over emphasised at the expense of the social and economic factors (Berardi, 2013). Following an in-depth review of the definition of sustainability in the built environment, Berardi (2013: 76) stated that “the social aspects of a sustainable building are still rarely investigated”.

Initial review of work carried out on the sustainability of low cost housing revealed an extensive global study conducted by Wallbaum et al. (2012) where 46 affordable building systems were evaluated in terms of sustainability. The paper concluded that “After screening, assessing, and ranking 46 different construction technologies against 10 sustainability indicators, it is possible to conclude that the most promising technologies are closely connected to local production of materials” (ibid.: 363). Furthermore, the research concluded that there were a diverse range of top ranking building systems and that there is no perfect solution to the sustainable affordable housing problem, but that combining multiple top-ranking technologies can provide an optimized solution.

The topic of sustainability although initially seeming quite simple in terms of being able to continue functioning or in this context to continue to be built became more complex and ambiguous as the subject was researched. The generally accepted concept of sustainable development means that “Sustainable development seeks to meet the needs and aspirations of the present without compromising the ability to meet those of the future” (WCED, 1987: 49). Moving forward, the concept of sustainability now links the three aspects of ecological, economic and social wellbeing (Tessema *et al.,* 2009).

There are many published papers with more complex and differing concepts. A study from Berardi (2013) concludes that sustainability implies a consistent rate of uncertainty and suggests that it is more a transition path than the label given to a building. He also proposed that a greater importance should be given to both the social and economic context of a building.

Another challenge to sustainability that is particularly relevant to housing is the competitiveness of consumption markets. While this results in low prices for consumers, the high amount of competition reduces incentive to develop sustainable products different to the societal norm. Indeed, a key component of sustainability is social acceptability, which means that for an activity or development to be successful in terms of purchases being made, it must 'keep to specific social relations, customs, structure and value' (Arman, 2009: 3039).

In South Africa, Agrément South Africa evaluates the fitness for purpose of non-standardised construction products, materials and systems against performance-based criteria. Performance criteria and test methods are established in consultation with the relevant experts, as required (Agrément, 2012). Agrément South Africa is mandated and funded by the Department of Public Works (Agrément, 2012) to promote innovative building products, and protect consumers against unacceptable ones. This is done by testing non-standardised products against performance-based criteria to determine their fitness-for-purpose. The aspects that are taken into consideration as far as building materials and systems are concerned are structural strength and stability, behaviour in fire, water penetration, thermal performance, durability and the maintenance required, the likelihood of condensation forming on the inside of the building, acoustic performance and the applicant's quality system, as specified by Agrément (2012). The building system is assessed on the basis of, as a minimum, being equivalent to a "standard brick house".

To have a building product certified by Agrément can cost up to R300 000 and it can take between 3 months and 3 years to complete the process, from application to issuing of the final certificate (de Villiers, 2009). If the building system is found to be acceptable, a certificate is issued. The certificate is kept "Active" by payment of subscription fee. The current scenario of expensive and strict performance regulation does not appear to be conducive to the innovation of holistic sustainable housing solutions.

3. METHODOLOGY

The methodology is primarily based on a quantitative approach and focused on the following steps:

- South African Agrément certified building and walling systems were investigated;

- Suitable systems for low cost housing were selected and further filtered considering only active systems: The inactive certificates are not analysed in this paper. Preliminary findings therefore refer to the sufficient and useful data from the active certificated building systems. The analysis of the active certificates provides a representative sample of the original sample group. Therefore, the focus for the preliminary findings provides insight and data for the sustainability of alternative building systems for low cost housing in the South African context. Through the sampling process mentioned above, the initial sample of 103 building systems was then reduced to 41.
- A sustainability assessment tool was developed on the basis of performance indicators defined through the analysis of relevant literature on the topic, with reference to the three pillars of sustainability (economic, social and environmental impact), and to the South African specific scenario (see Table 3.1).
- A questionnaire was created with specific questions (mainly multiple choice) oriented to evaluate the above-mentioned indicators through performance-based values (quantitative) or qualitative ranking. A rating scale from 0 (N/A) to 5 (best performance) was applied to each of the indicators following the options given from worst performance to best performance.
- The sample of 41 (as per the previously described sampling process) was targeted in this stage of the research. The questionnaire was sent to the 41 certificate holders, and this paper presents the preliminary findings based on the response rate of 41% (17 completed questionnaires returned).
- The data and info collected was analysed following the rating scale to provide an understanding of the performance of the system against the listed sustainability criteria.
- Ethical aspects were strictly followed and informed consent forms were provided to participants. The participation was clarified to be voluntary, confidentiality and anonymity were carefully maintained. All results are disclosed without mention of the companies or name of the product, but just the type of building system.

Table 3.1 Sustainability indicators

Sustainability Indicator	Ref Doc	New Indicator	Economic	Social	Environ-mental
Cost / m² Infrastructure	Q	-	X	-	-
Cost / m² External walls	-	Q	X	-	-
Skill Level	Q	-	-	X	
Erection time	Q	-	X	-	-
Economy of scale	Q	-	X	-	-
Module / Flexibility	Q	-	-	X	-
Durability	Q	-	X	X	X
Maintenance Cost	Q	-	X	X	X

Demolition Recycling	Q	-	-		X
Local value	Q	-	-	X	-
Service interface	Q	-	X	X	-
Use of Recycled Materials	-	Q	-	-	X
Environmental Pollution	-	N/A	-	-	X
Social Acceptance	-	Q	-	X	-
Geographic Locations	-	Q	X	X	X
Multi Story	-	Q	X	X	X
Number of buildings erected	-	Q	-	-	X
Embodied Energy	-	N/A	-	-	X
CR value (thermal mass. thermal insulation)	-	N/A	-	X	X
Acoustic Insulation	-	Q	-	X	X

Q – Data based on survey questionnaire
N/A – Data not available in the preliminary study (on-going research)

4. RESULTS AND DISCUSSION

4.1 Barriers encountered in the process of collecting information.

Fragmentation of data availability was evident mainly due to: incomplete returns; requirement to re-adjust the questionnaire deadline; need for collecting missing data by phone; unwillingness to share data and content, which might also suggest the absence of data to share; over willingness in providing full and clear data.

Therefore, in analysing the difficulties and challenges of gaining data (the lack of tested sustainability based performance aspects, the reluctance to disclose information and non-willingness to participate), it can be suggested and deducted that this kind of research into this field and topic is new to the sample group. The deduction of this outcome suggests the validity and contribution to knowledge of this topic and research in this field.

4.2 Sample Group

The sample group of 41 candidate Agrément certified building systems considered for this study, based on the receipt of the survey questionnaire, as previously described in the methodology, provided a data source of 17 systems. Table 4.1 provides a general description of the building systems analysed in this preliminary study and lists them in 12 general building system categories.

Table 4.1 Sample Group

No	Building System Category	Quantity
1	Cement soil stabilised blocks (CSSB)	2
2	Steel frame (SF) clad with fibre panels / boards	2
3	Cast concrete (CC)	3
4	Cellular lightweight concrete (CLC)	1
5	Expanded polystyrene (XPS) with cladding	1
6	Reinforced concrete panels (RFC)	1
7	Hollow expanded polystyrene (XPS) with concrete infill	1
8	Hollow Polyvinylchloride (PVC) filled with concrete	1
9	Factory produced timber panels	1
10	Hollow concrete blocks of concrete/expanded polystyrene (XPS) beads	1
11	Cellular lightweight concrete (CLC) with fibre cement (FC) board	1
12	Reinforced concrete (RFC) panel with expanded polystyrene/concrete core (or lightweight concrete core)	2

4.3 Results from Survey

The findings for the preliminary study, from screening the assessed 17 building systems utilising 17 sustainability indicators is summarised in Fig 4.1 and are placed in order from left to right with worst to best score. It should be noted that the three sustainability indicators that are not included in this preliminary study (shown as N/A in Table 3.1) are largely related to environmental sustainability and should be considered when assessing the current results.

The overall results, including all assessed sustainability indicators show a sector with score of above 4 out of 5 including both cement stabilised soil block systems evaluated and a range of new generation cement based systems such as cellular lightweight concrete (CLC) in the form of prefabricated panels or cast in situ and one of the three cast concrete methods with novel casting method (fig. 4.1).

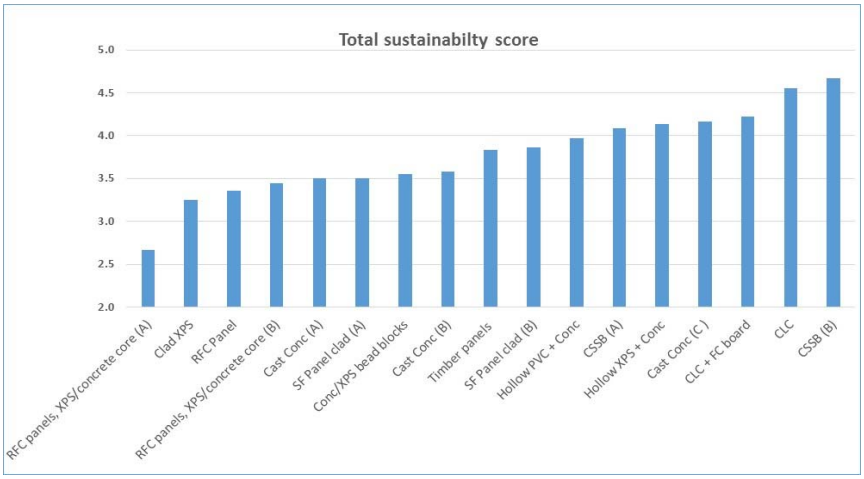

Fig 4.1 Total sustainability assessment

The systems included in the top sector of the environmental assessment changed little from the overall assessment although the scores for the top sector are higher (fig. 4.2). The variation between the lowest and highest score is more significant than the total score graph, this is interesting as there is an absence of the three environmentally strong indicators which are not included in this preliminary study.

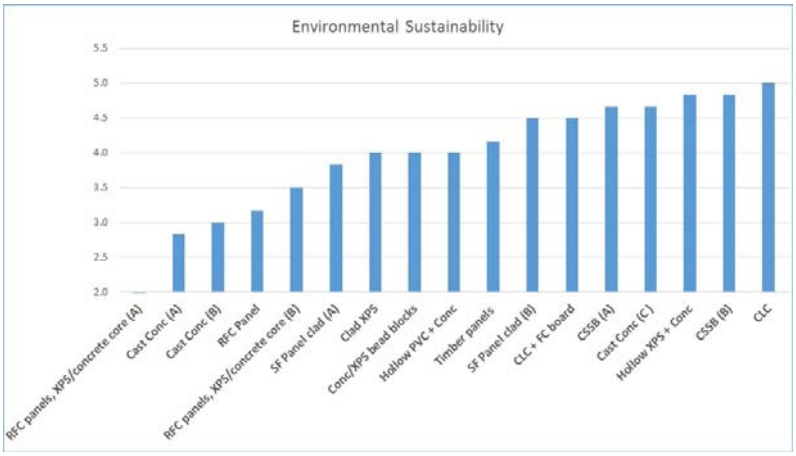

Fig 4.2 Environmental sustainability assessment

The result for the social sustainability assessment (fig. 4.3) shows a relatively flat graph with uniform results compared with the environmental assessment. This may have some influence from the building systems

being Agrément certified with uniform minimum standards bench marked against a standard brick house.

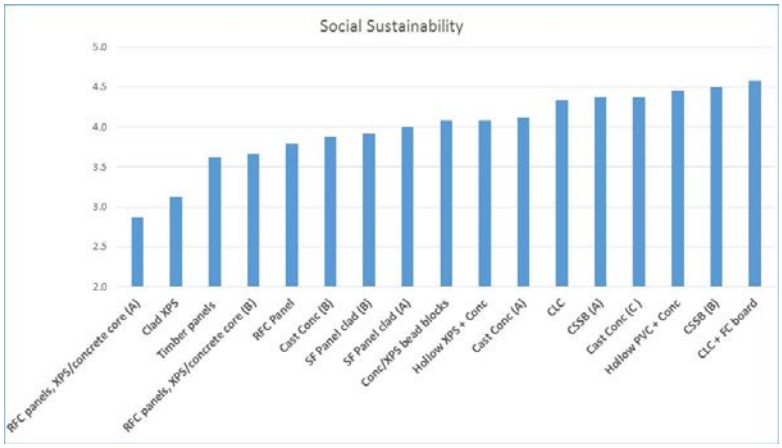

Fig 4.3 Social sustainability assessment

In the economic sustainability assessment (fig. 4.4), four systems stand out from the remainder with high scores indicating that they are more economically sustainable or 'cost-effective' during their lifespan. The remaining systems are relatively similar, possibly as they are all very competitive in the low-cost housing market and are required to meet the minimum Agrément performance requirements.

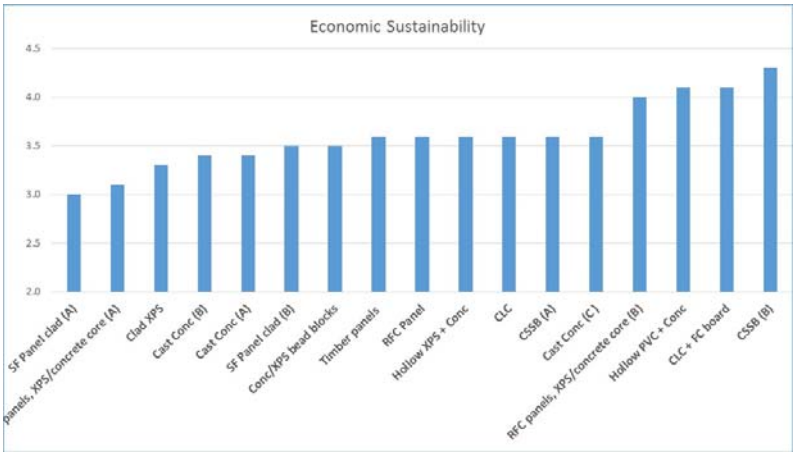

Fig 4.4 Economic sustainability assessment

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4.4 General Discussion

It became apparent in the early stage of this research that finding information on sustainability for the wide range of low cost housing building systems in South Africa was going to be a major challenge, as the emphasis has been on producing housing at low cost and meeting the minimum specified building requirements with little emphasis on sustainability and in the case of material properties, little information on their properties in terms of sustainability. It should be emphasised that the results of this preliminary survey are based upon data received from a questionnaire and qualitative responses are at the discretion of the building certificate holder who may, or may not be over-optimistic about his own products performance.

In some cases, questions were not answered, either because the information was not available or lack of knowledge, time/interest to find the required information, resulting in a zero score for that specific sustainability indicator.

It was clearly manifested by one respondent that the South African building regulations and specifically the Agrément certification has created a barrier for materials and systems by putting excessive emphasis on strength and “so-called” water proof-ness of a material (i.e. cement based products) at the expense of sustainability, health, resource efficiency and a more holistic understanding of how buildings perform as a whole system and not as individual components. The respondent further provided his opinion that the incredibly restrictive regulatory building framework continues to push our building trade away from sustainability and down our heavily carbon based fuel economy, despite the urgency of climate change and conversely natural buildings potential to lead us on a different trajectory.

5. CONCLUSIONS AND RECOMMENDATIONS

The limited available data on sustainable building systems for low cost housing is a clear indication of the lack of emphasis on the topic and suggests the validity and contribution to knowledge of this topic and research in this field. Furthermore, the current scenario of having a high level of performance regulated priorities for alternative building systems should perhaps be modified, whereby the health and thermal comfort of a material, its embodied energy, environmental impacts, acoustic properties, biodegradability and the overall system performance is considered with a view to a full life cycle analysis and not just physical performance.

Current Agrement certification requires the building system to meet minimum requirements without requiring to state the actual performance; it just “passes” a minimum performance. This can be confusing and

misleading and does not stimulate competition between construction products in the market. Manufacturers or start-up companies are not stimulated to improve the quality and to offer a product with better performance then what is available, but limit themselves to just exceed minimum requirements to be awarded the certificate. This limits the possibility of reaching an open competition in the market, based on encouraging manufacturers towards better-quality products and allowing customers to compare easily the quality of different products. This might constitute a factor which can hinder the introduction, advancement and large-scale implementation of sustainable building technologies in the South African context.

On the basis of the preliminary findings, cement stabilised soil block system and cellular lightweight concrete provide the highest rating in terms of the sustainability criteria utilised by the study.

This broad preliminary research provides a platform for further research into workable and meaningful sustainable building systems for low cost housing, whilst providing momentum for the drive towards more flexible building regulations. Potential routes for further research may include the selection and focus on a small group of favourable alternative building systems, conducting an in-depth sustainability assessment, or focusing on the potential benefits of a more holistic regulation and product certification system which focuses on a clear performance-based approach and the declaration of the achieved performance, instead of just on the achievement of minimum benchmark.

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Building Contracts, a method to manage construction processes: A South African perspective

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1. RESEARCH FRAMEWORK

Construction/building contracts are part of daily construction projects. They may take many forms and are interpreted in many ways. When implementing and managing a construction project on behalf of a client, references to the contract become inevitable. There are many fields or areas to keep track of, such as the programme (time), the quality of work, progress payments, and safety, to name but a few. These areas need to be managed, especially in cases that may lead to disagreement between parties (Lester, 2013: 1-2; Bowen, Hall, Edwards, Pearl & Cattel, 2002: online).

It is perceived that the two main parties involved with the construction project have the same objectives, namely to complete the project on time, to specification, and within the cost agreed upon initially. The client's consultant could be viewed as the designated 'compass', guiding the two parties to the final destination and final product. Consultants should capture the needs of their client into a working and executable document. When implementing this document or plan, the consultant has to ensure that the contractor continuously keeps to this document or plan. Consultants should thus get the designation of project manager whether it is their profession or not.

From a multi-disciplinary perspective, capturing the project team's vision into a working document and eventually relaying it to the contractor can become a daunting task. A certain amount of control is needed over the process and questions may arise on how much control the consultant should have.

1.1. Research problem

The construction contract is entered into by the client (the party who initiated the construction project) and the contractor (the party responsible for the execution of the construction project) (Finsen, 2005: 1). It was further observed that, in some cases, the professional team may be blamed for not complying with the conditions of the contract with specific reference to the three identified performance indicators (Finsen, 2005: 215; Emmitt & Gorse, 2003: 165). The identified research problem questions the responsibilities of the consultants in terms of the main building contract by determining the extent of the responsibilities and liabilities of the consultants as stipulated in that contract. The research problem occurs when the contractor, hypothetically, does not comply with the terms and conditions as stipulated in the contract agreement. Should this hypothetical situation occur, does the main building contract empower the consultants to act upon non-performance by the contractor, and to what extent? It is a preliminary observation that, according to the above-mentioned standard contract forms, the client's agents have a managerial responsibility to assist with the execution of the construction contract.

1.2. Hypothesis

The main hypothesis states that some building contracts equip the employer's agent with the necessary power to control or manage the construction project more effectively than others.

1.3. Purpose and importance of the study

The purpose of the study was to investigate the possibility that building contracts can influence the project's budget, time, and quality. Through this study, the practicality of managing a project using a contract was investigated. Different parties' experiences in the field were researched and evaluated to determine whether the contract has an effect on the successful outcome of a construction project.

2. BUILDING CONTRACTS: AN INTRODUCTION

Contractual law can briefly be summarised as a collection of legal rules that control contracts, which in turn forms part of the law of obligations. Obligational law in return forms part of the law of property, which is regarded as forming part of private law (Van der Merwe, Van Huyssteen, Reinecke, Lubbe & Lotz, 1993: 1). McKenzie (2014: 1) defines the building contract as a contract between two parties, the contractor (builder), who agrees to perform building or engineering work for the client. He continues to explain that there are two distinct types of construction works, namely engineering and building work. McKenzie (2014: 1) reiterates Malherbe and

Lipshitz's (1979: 80) stipulation that the following fundamentals should be in place to create a contract. There should be agreement between the two parties to legally bind the contractual relationship, embracing the rights, responsibilities, prerogatives, and privileges; and the parties should be at one with regard to the consequences to the agreement. A legal relationship between the parties flows from the offer to the acceptance. Both the offer and the acceptance should be clear and unambiguous, comprehensive and complete, if reasonably considered.

2.1 Contract types in South Africa

A few standard types of contracts are used in South Africa. The type of contract is influenced by the progress of design (availability of information) and the employer's needs. Construction contracts are usually classified according to means of measurement and the method of payment to the contractor by the employer. The different types of contracts offer different degrees of flexibility, levels of incentive, and different levels of risk to the parties (Loots, 1995: 89). The contract strategy plays an important part in the choice of the contractual arrangement, taking the project team into account. The project team usually remains responsible for choosing the contract. The main differences between the four main contract categories are listed by Loots (1995: 143) as the following:

- the roles of the parties;
- the emphasis on management;
- the method of payment;
- the allocation of risk; and
- the nature of the work.

The type of contract used is influenced by a number of factors as listed above, but can also be influenced by the information available, the parties involved, and the applicable country where the work is earmarked to be carried out. The most common types of contracts in use in South Africa are subsequently discussed.

3. CONSTRUCTION INDUSTRY DEVELOPMENT BOARD REGULATIONS

The standard of uniformity published by the Construction Industry Development Board (CIDB) narrows the contracts down to four suites of contracts for construction work (CIDB, 2015a: 3-4):

- General Conditions of Contract for Construction Works (Third Edition 2015) as published by the South African Institution of Civil Engineering.

- International Federation of Consulting Engineers (FIDIC) suite of contracts. In particular Conditions of contract for Construction for Building and Engineering Works designed by the employer (Red Book) (1999)
- JBCC Principal Building Agreementsuite of contracts (Edition 6.1: March 2014) as published by the Joint Building Contracts Committee.
- NEC3 Engineering and Construction Short Contract or NEC3 Engineering and Construction Contract (referred to as NEC)

Contracts have developed from different directions or angles in the construction industry to meet the different needs therein, e.g. engineering, architecture and contractor needs.

According to the Construction Industry Development Board Act, No.38 (South Africa. Government Gazette, 2000b:18), all contractors that want to conduct public sector construction work should be registered with the CIDB. Although this is not needed for the private sector, it does, however, suggest that the CIDB acts as the governing body on which tenders and construction contracts are based. The best practice guidelines published by the CIDB tries to guide contractors and consultants in the way in which documents should be developed.

4. SIMILARITIES BETWEEN BUILDING CONTRACTS AND PROJECT MANAGEMENT

The contract is a document that spells out the rights and obligations of the parties. It protects the parties against certain risks and is an administrative tool (Verster, 2006: 7). To supplement the above, the meaning of contract is revised. It is an appointment between two legal parties who have the intention to bring about certain obligations on one another. It is a serious and committed endeavour by the parties to fulfil their obligations (Nagel, Boraine, De Villiers, Jacobs, Lombard, Lötz, Prozesky-Kuschke, Roestoff, Van Eck & Van Jaarsveld, 2000: 17). Through the research, it was learned that building contracts have evolved over the years and do not only comprise of the actual contract document. There are many components that, together with the contract, form an overall agreement and standard for the work to be undertaken. In order for the parties to be truly informed about the content of the contract a certain structure has evolved.

Before the construction specialist (builder) becomes the contractor, he/she should be able to price or cost the work. In order to enable him/her to do so, the necessary information is needed. This is usually done through a tender process which encompasses a tender document (CIDB, 2006: i).

Many other project specific items may also form part of the contract, among other, the drawings and specifications. These items all aid in the execution of the work and may include guarantees, bill/schedule of quantities, preliminaries, and trade preambles (Verster, 2006: 8).

There should be an offer and acceptance stipulating exactly what the objectives of each party is. Usually there should be an offer by the contractor for the proposed work and an acceptance by the employer for

the contractor's offer (CIDB, 2006: i). It should be stipulated who is responsible for what documentation or designs, who will be the representing parties, what regulations will apply, and who will be responsible for insurances, indemnities, and work risks (SABS, 2004: 48). With the execution of the work, it should be clearly stated by whom and how the site will be run and who will have access to the site (SABS, 2004: 86). It should be clear when work will be deemed complete, whether work will be completed in stages, how the liability period will apply, if there are penalties, and how and if extension of time is applicable (SABS, 2004: 50). The method and procedure of payment and disputes should be clear and the method of dispute resolution concise (SABS, 2004: 51).

5. STRUCTURE OF THE CONTRACT DOCUMENT

McKenzie (2014: 175) highlights specific topics normally found in a building contract. When compared to the structures of the four main contracts endorsed by the CIDB, the following most common themes are derived:

- general;
- roles and responsibilities;
- time related items;
- payment (costs);
- quality;
- risks or change;
- termination; and
- claims and disputes.

6. MAIN THEMES OF PROJECT/CONSTRUCTION MANAGEMENT

The Project Management Institute (PMI, 2008: 5) defines a project as a temporary undertaking to create a unique product, service or result. There is a definite beginning and end, but the impact may last much longer. Every project creates an unique service or result and can create:

- a product that can be either a component of another item or an end in itself – e.g. a building;
- a capability to perform a service – e.g. a business function to support productivity; or a result such as an outcome or document – e.g. a research project.

With each new project, a new team is put together. The experience of the team plays a major part in the success of the project. Burke (2003: 28) divides projects into four basic phases, known as the project life cycle:

- concept;
- design;
- implementation; and

- closing.

The project and the management thereof usually take place in an environment larger than the project itself. The project life cycle (PLC) is a collection of sequential and sometimes overlapping phases. The allocation and naming is given by the organization or field that the project takes place. The PLC can be captured in a methodology with a definite start and end. The items in between can however vary considerably (PMI 2008:15).

Knipe, Van der Waldt, Van Niekerk, Burger and Nell list nine fields in project management (2002: 19-20; PMI, 2000:7-8). A further knowledge area was added in December 2012 by the Project Management Book of Knowledge (PMBOK), namely project stakeholder management. Previously this area was included in the project communication management field, which included some aspects of stakeholder engagement (Van der Waldt & Fox, 2015: 147). The knowledge areas are listed below:

- project stakeholder management;
- scope management;
- time management;
- cost management;
- quality control;
- human resources;
- communication management;
- risk management;
- procurement management; and
- integration management.

The following table (Table 1) summarises and compares the main themes of the four main contracts against the nine knowledge areas of project management as well as the additional four construction management themes. The main objective of each is to address any change that will inevitably occur to produce the desired product.

Table 1 **Comparison between main contract, Project Management and Construction management themes**

General contract themes	Project Management [1]	Construction Management [2]
General	Scope Management	Environmental Management
Roles and responsibilities	Human Resources	
Time related items	Time Management	
Payment	Cost Management	Financial Management
Quality	Quality Management	
Risks or change	Risk Management	Safety Management
Termination		

Claims and disputes		Claims Management
	Stakeholder Management	
	Integration Management	
	Communication Management	
	Procurement Management	
	Change	

[1] **(Source: van der Waldt & Fox 2015)**
[2] **(Source: Zulch, 2012)**

When comparing the themes of the four CIDB recognized contracts against the main themes of project management, it seems to be very similar in nature. The construction management knowledge areas or themes fill the gaps that may occur from the challenges experienced on construction sites. Where possible (in table 1), the themes have been listed against the appropriate contractual theme where it usually occurs in the contract document. All the themes are interdependent of each other and the listing does not necessary limit the themes to the specific contractual theme. This was highlighted under the contractual theme risk, which is spread throughout the contract.

The main constant through-out any project is change, which is ever present. This change should be managed through the main knowledge areas of project management. The assumed goal of the contract is thus to implement the rules of how these changes will be dealt with between the parties. From Table 1 it is seen that there are four knowledge areas which could not specifically be grouped under the contractual themes. They are stakeholder, integration, communication, and procurement management. Although these knowledge areas are not explicitly linked to any specific contractual theme, it does not mean that correlation does not exist.

It would seem that the objectives of the construction contracts are to deliver projects on time, within budget, and to the required quality. It is clear that similarities occur within the construction contracts, which gives a framework for the management of the project. It would seem that the aim of standardiseing these documents, is to enable all parties to be knowledgeable about what the content of the contract should include.

7. EMPIRICAL STUDY

A quantitative approach was used to collect data by using a questionnaire sent to a selected sample group. Care was taken to analyse the data in a transparent and honest fasion. The prevention of the following statement comes to mind: “if you torture the data long enough, it will confess” (Coase, 1994: online).

7.1 Empirical methodology

Davies (2007: 54-55) notes that during a survey, you will be required to gather a sample that is appropriate to your objectives, that you can recruit in the time available, that you can recruit in the available setting, and that should be as good as you can make it. Specific individuals were identified and targeted during the survey, with the aim to identify knowledgeable individuals, while still being as inclusive as possible. Davies (2007: 57-58) refers to this method of data collection as purposive sampling.

Rated questions are included in the survey and for the purpose of analysis, these questions are evaluated using the following formula (Survey Monkey, [n.d.]: online):

Equation 1: Rated questions

$$\frac{x_1w_1 + x_2w_2 + x_3w_3 \ldots x_nw_n}{\text{Total}}$$

w = weight of ranked position
x = response count for answer choice
(Survey Monkey, [n.d.]: online)

With regard to questions categorising answers according to percentage groups, these answers are analysed by using the average weight of that group. For example, if the category is between 41% and 60%, the weight of this group would be 0.505 or 50.5%.

Twenty-seven questions were asked, with the objective of establishing the background, knowledge, and experience of the respondents, before asking specific outcome-based questions. The questions were categorised as follows:

- Questions 1 to 8 established the profile of the respondent e.g. whether he/she is a professional, etc.
- Questions 9 to 14 highlighted the respondents' expertise on construction contracts and the industry.
- Questions 15 to 24 were aimed at establishing the respondent's opinion on the role the construction contract plays towards managing the project.
- Questions 25 to 27 addressed specific open questions to answer the secondary research questions of the research.

7.2 Data analysis

A questionnaire was sent to 110 professionals within the field of architecture, quantity surveying, project management engineering, contracting, and academics. An initial response rate of 57% was achieved with a total of 64 questionnaires returned. Of these, 48 (44%) were

completed in full, 1 (1%) answered more than 90% of the questions and 12 (11%) completed more than 70% of the questions with 3 (3%) completing less than 30% of the questionnaire.

The respondents that completed 70% or less were not considered during the data analysis. This was to ensure that the quality of the data submitted was not compromised. To put it into perspective, 70% equals 19 questions answered, of which 5 questions are outcome based. The result is that these respondents did not answer the control questions within the survey. After exclusion of the incomplete questionnaires, the real response rate was 45.

7.2.1 Respondent profile (Questions 1 to 14)

Consultants were the largest group at 73% of the total number of respondents. Of the five respondents categorising themselves as 'other', four were academics and one a sub-contractor. Most of the respondents are quantity surveyors (50%) with project managers (17%) being the second largest group. The largest portion of the respondents have more than 25 years of experience, with the general survey pool's experience relatively equally distributed with only one respondent being a non-South Africa citizen. The majority (50%) of the respondents had an honours degree or a NQF level 8 degree. Four respondents indicated that they have a doctoral degree and 41 respondents indicated that they are registered with their respective councils. Some respondents are registered with more than one council Question 8 asked whether the respondents were registered voluntary with any professional body and 35 respondents indicated that they voluntarily belong to a professional body.

From the information above, it can be derived that the respondents represent an evenly distributed pool of professionals and stakeholders within the construction industry. The following section establishes the respondents' exposure the actual construction work. Most of the respondents had either worked on building contracts and/or civil works. They had also conducted most of their work in the Free State Province. Interestingly, specialist work is also rated as high by the respondents and this may be attributed to some being arbitrators and quantity surveyors who are exposed to specialist fields. The majority of the respondents' monetary value for their projects is for work less than R50million. Questions 12 and 13 established that the respondents are mostly exposed to, and comfortable with the JBCC suite of contracts. The majority of the respondents rate contractual matters as part of their daily activities (41% and more of their daily activities). The respondents' expertise towards contracts seems to be relevant with the majority having ample knowledge of contractual matters.

7.2.2 The role the construction contract plays towards managing the project (Questions 15 to 24)

Questions 15 to 24 are specific outcome-based questions to acquire insight into the use and potential of construction contracts, specifically regarding the management of the construction project. Questions 15 and 16 asked the opinion of the respondents towards the involvement of the agent and contractor regarding the management of the three main knowledge areas on projects, namely time, quality, and cost management.

The subsequent questions are interrelated, for instance, Question 19 tried to establish who is responsible for quality, adding the employer as a variable. Through these questions, insight could be gathered on the role of the contract towards controlling the implementation process. By comparing Question 19 to Questions 16 and 17, it can be concluded that even though the contractor is mainly responsible for the quality of workmanship on site, he/she requires the support or involvement of the employer through his/her agents. The respondents indicated in Questions 17 and 18 that the project can be controlled through the contract (47 or 98% of the respondents). A further 62% of the respondents indicated that 61% and more of the project can be controlled through the contract. Questions 20 to 22 are rated questions ranked from 1 to 5 with 1 the least applicable (strongly disagree or least conducive) and 5 the most applicable (strongly agree or most conducive). Question 20 in particular enquired about the respondents' opinion on the contract's ability to manage the project taking into account the ten knowledge areas of project management. All the categories were ranked higher than the mean with cost management ranking the most manageable knowledge area through the contract. Question 21 makes five specific statements towards the successful implementation of the project of which the respondents had to agree or disagree with. The rating averages are all higher than 4 and thus in agreement with the statements made. The contracts were ranked next by asking the respondents' opinion on the contracts' ability to solve problems during construction. The JBCC suite of contracts was ranked the highest compared to the other contracts. Question 23 builds on the above question by asking which contract in the respondents' opinion gives the agent the best opportunity to manage the project. The JBCC enjoyed the highest support with the GCC the lowest. These answers should however not be separated from the backgrounds of the respondents' and their experience or exposure to the applicable contracts. The last question (Question 24) before the open questions, established that the South African construction industry can adapt to management of the construction process using the contract. An emphatic majority (96%) indicated that this is the case.

7.2.3 Open ended questions (Questions 25 to 27)

Questions 25 to 27 were open-ended questions, directly related to the research question. These three questions are listed as follows:

- In your opinion, what is the leading cause for poor management on a construction site?
- What is perceived to be the main objective of the main building contracts in South Africa?
- What are the potential benefits of controlling a construction project through the main contracts in the South African Built Environment?

To enable the data to be analysed and interpreted, different categories were derived from the answers provided. The answers of the respondents were separated into two groups, with the entire pool of respondents' answers listed in one column and those with more than 25 years of experience listed in a separate column. The column named "All respondents" includes the respondents with more than 25 years of experience. It was deemed appropriate to quote three of the respondents' answers. These respondents all have more than 25 years' experience, are registered professionals and are leaders in the industry. They have been exposed to contracts throughout South Africa and Africa and have been advising as well as mentoring throughout their careers.

Question 25 concluded that the main causes of poor management on a construction site which could be categorised are the lack of experience and the lack of good communication. The consultants were blamed the most, with the contractor not far behind. Unfortunately, the categories could not be linked emphatically to the consultants, the contractor, or the client. The following answers are highlighted from the questionnaire:

- Respondent 1: "Poor quality of work by contractor/subcontractors and late payments by client and contractor. Needs firm actions by leading consultant which is often not properly handled"
- Respondent 2: "Incompetent PM by consultants and lack of good experienced construction management by contractors."
- Respondent 3: "Poor design, poor documentation and low skilled staff."

Question 26: From the survey, protection of the parties is perceived to be the main objective of the building contracts. Other categories listed are risk, quality, time, stakeholder, general, scope, and conflict management. Standardised documentation was also mentioned. The following answers are highlighted from the questionnaire:

- Respondent 1: "To provide an equitable distribution of risks and that will recognize and cater for the problems encountered in the local building industry."
- Respondent 2: "To be fair to all parties if applied and managed pro-actively."
- Respondent 3: "Fairness between employer and contractor."

The benefits of managing the construction process through the building contract is highlighted in question 27. The following answers are highlighted from the questionnaire:

- Respondent 1: “The better the project is controlled by all parties involved the better the changes for a successful project.”
- Respondent 2: “On time and within budget projects.”
- Respondent 3: “Understanding the content, using the form of contract as a dispute avoidance tool.”

It is interesting to note that the main knowledge areas of project and construction management are rearing its head. This gives reassurance that the respondents categorise and think in this manner when they refer to the construction process. The following section focuses on the conclusion of the survey information summarised above.

8. CONCLUSION AND RECOMMENDATION

Considering the hypothesis, all but one respondent indicated that the project can indeed be managed through the contract. Most of the respondents (62%) indicated that over 61% of the project’s managerial activities can be managed by the contract. The indication that a specific contract is more conducive to proper project management on site was not considered relevant to the research. The contractor’s ability to manage the project is rather indicative of the respondents’ experience.

In conclusion, the empirical data suggests that the hypothesis is supported. All the knowledge areas are supported by the construction contract, some more than others.

Recommendations that stemmed from the study advise that the compiler of the procurement document and ultimately the contractor should compile the document to act as the project implementation plan (PIP). This PIP is supplemented by the contractor’s plan in accordance with the procurement document. It is also recommended that the project manager, engineer, or agent who will ultimately be responsible for the implementation of the project be appointed from the inception stage together with the proposed site representative.

When the design stage is finished, the documentation should be of a high standard and the basic principle of making changes as early as possible should be applied. Requests for information should be few and far between as the saying goes. If the required information is not available at this stage, allowance for the time and effort needed should be made by all parties. Transparency is needed in this instance and the project life cycle kept in mind.

Very clear completion targets (work breakdown structure (WBS)) with a projected cash flow should be prepared by the contractor. The employer’s agent should then continually compare the actual progress against the PIP.

The focus of the project should be the project as a whole and some elements of the project or knowledge areas. The parties should play the ball and not the players during the project. Transparency is needed and each team member should share their knowledge instead of considering their knowledge as an advantage over the other party.

The employer's agent should take responsibility as project manager on the project. This person should have ample experience to supply the contractor with the necessary information and guidance.

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Cloud Computing, a possibility for the Construction Industry

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ABSTRACT AND KEYWORDS

Purpose of this paper
The purpose of this paper is to explore the concept of cloud computing, its possible use by construction companies and challenges and benefits that may arise from its adoption.

Design/methodology/approach
A comprehensive review of literature was conducted on the concept of cloud computing to indentify challenges and benefits as well as its possible implementation by construction companies.

Findings
The various forms of literature that was consulted thus far on a broad scale indicate a lack of the application and full commitment to the adoption of cloud computing strategies within the structures of construction companies mainly due to the reservations companies have in terms of data security, in depth understanding of cloud computing concepts and the overall process involved with its adoption.

Research limitations/implications
The research is currently at a theoretical stage.

Practical implications

This study highlights the need for more construction companies to change and take a technological leap moving away from traditional methods of handling construction project documentations.

What is original/value of paper?

The paper assess and identifies the need for a shift from the traditional methods to a more technologically inclined way of conducting business/construction projects, in essence enhancing collaboration amongst the various members involved in the construction process and increasing information flow on construction projects.

Response to the Conference Theme

Innovation in Construction Means, Methods and Materials

KEYWORDS: Cloud computing, Construction, Information technology, Software

1. INTRODUCTION

"Technology is a gift of God. After the gift of life, it is perhaps the greatest of God's gifts. It is the mother of civilizations, of arts and of sciences" *(BrainyQuote, 2017)*

An industry without the hassle of sifting through large amounts of paperwork, alleviating the need for large document storage facilities, connected and integrated process and systems all brought forth with the prospect of the adoption cloud computing in construction. A paperless industry where information flows in all channels and is readily available at all times fostering for improved project delivery and management. It is important to also highlight the main objectives of any construction project which are time, quality, health and safety, and cost all of which cloud computing systems in construction would sufficiently cater for and improve.

However, as it stands the construction sector and the current methods that are used in as much as they are largely revered, are slowly becoming the main weaknesses of the industry, the construction industry is largely known for its use of large amounts of paper based systems in their day to day activities all the way through and during projects, from schedules, drawings, buildings designs, and work plans. Its slow transformation and the adoption of new and emerging technologies within the sector and of those sectors around it for example the information technology sector has been one of the inhibiting factors of a paperless and efficient industry.

The purpose of this paper is therefore to explore the concept of cloud computing, its possible use by construction companies and challenges and benefits that may arise from its adoption.

2. LITERATURE REVIEW

2.1. What is cloud computing?

When the concept of cloud computing is mentioned the first thing that comes to mind is the image of a large cloud up in the sky.This, to a large degree is viewed to be the correct representation of cloud computing in that the concept of cloud computing and the physical cloud seem to share similar traits, a cloud is big and up in the distance and consequently cloud computing systems have large amounts of storage capacity, are made up of large datacentres and are placed in remote locations (What is cloud computing, 2016).

The National Institute of Standards and Technology's (NIST, 2017) defines cloud computing as *"…a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction."*

The way cloud computing works is based on a simple principle of use much like the use of water and electricity services which comprises of one input and one output point, meaning that all the processes and processing of data are carried out by a single network alleviating the need for the end user to determine where the data services should be located and placing just the responsibility for paying for what is used on the end user (Xu, Ye, 2014).

The cloud model supports accessibility and consists of five vital traits which are:

- Readily available service;
- Allows access from a variety of devices (broad access);
- Pooling of resources;
- Rapid elasticity; and
- Appraised Service (Mell and Grance, 2011).

The key enabling technologies include: (1) fast wide-area networks, (2) powerful, inexpensive server computers, and (3) high-performance virtualization for commodity hardware."

2.2. Evolution of cloud computing and service delivery models (saas, paas, and iaas)

Cloud computing forms its existence in the ever-growing and readily available internet systems running in parallel with the grid and utility computing methods. The growth of the cloud computing has seen it go

through five definitive stages since its conception till recent years which are depicted in the Figure 1.

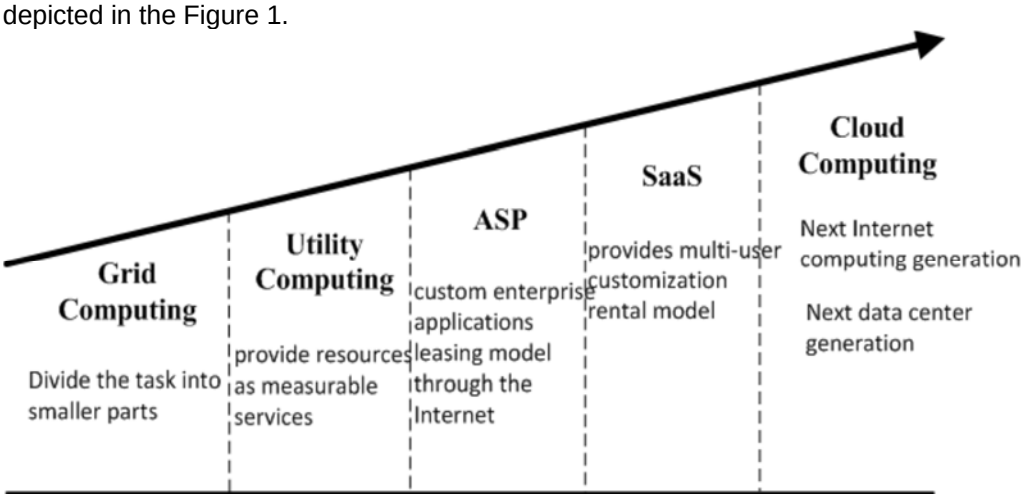

Figure 1.The evolution of cloud computing (Xu, Ye, 2014:202).

Table 1 depicts the five evolutionary stages of cloud computing together with a brief description of each stage and what occurs during each stage.

Table 1. Five evolutionary stages of cloud computing (Xu, Ye, 2014:202)

Stage	Description
(1) Grid computing.	Computing method that divides large tasks into smaller more manageable parts which are then distributed amongst the computers in the grid and processed then returned as a summarised final result.
(2) Utility Computing.	A service model that permits for the service provider to make accessible to the client the infrastructure resources and charges them as they use it rather than using a standard rate. This allows the clients to use less funds for computing assets as the services of computing are provided for.
(3) Application service provider (ASP).	An online platform that grants companies access to third party software via the internet at a price which would have without this service have to be purchased and installed individually on each computer system in the company
(4) Software as a Service (SaaS).	A step up from the aforementioned ASP model it serves a similar purpose with the distinction being the software put forth via this platform is developed by the service provider.
(5) Cloud computing.	As the development trend of next-generation data centre, it was first proposed in 2007. It is the development mode that provides IT resources to users as services via the Internet.

2.3. Service delivery models (SaaS, PaaS, and IaaS)

Cloud computing forms its base on the concept of the delivery of services in the information technology field in units. These forms of delivery can be categorised and classified into 3 main types of groups which are Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS) (Cheng, 2012; NIST, 2017). It is however important to note that these three models are interrelated as there are overlaps and similarities in terms of each models scope.

The SaaS model provide software services to a wide array of people/users which are under the same cloud service. It utilises the web (cloud) to deliver these applications/services which under the management of a third party. This allows for services hosted by this model to be run from the web without the need for installation of software onto the system being used, a few examples of SaaS are applications like Google, Twitter and Flicker which are all hosted online or in a more technical sense “in the cloud”.

The PaaS model allows a platform for which software can be run off (Vaquero, *et al*, 2009). This model allows developers the ability to make changes to their applications, the end user uses the end application and has access to the software part of the provided application but cannot change the application. An example of a PaaS is the Google play service offered on the android smartphones (Apprenda, 2017).

The IaaS model is a service model that provides for the management of remote datacentres. This eradicates the need for the use of hardware and physical systems that need to be constantly managed and have software installed to keep them running (Apprenda, 2017). SaaS allow users the privileges to manage applications, the running of data and the operating systems associated with their organisations.

3. RESEARCH METHODS

In order to explore the concept of cloud computing, its possible use by construction companies and challenges and benefits that may arise from its adoption an integrative literature review was used (Saunders, *et al.*, 2015). Subsequent to the literature review, the study identified some key barriers that could affect the implementation of cloud computing by construction companies. There are however, benefits for the implementation of cloud computing, which the study also identified.

For the purpose of this paper the researcher consulted the various sources of literature such as journal papers, books and conference proceedings, that related to the study. Because this is an emerging field of research the

actual number of sources was limited to what was published and available on the topic, which resulted in a review of 15 journals, books and conference papers.

Thematic analysis which *is a method* for identifying and analysing patterns in qualitative data (Clarke & Braun, 2013) was then used to identify themes in the literature. The thematic analysis was divided into a series of 6 phases as described by Clarke & Braun (2013).

Phase 1: Familiarising with the Data
The researchers in this phase engaged with the literature by repeatedly studing it to establish an indepth understanding of the topic. During this phase the researchers proceeded to develop themes and a system to identify them.

Phase 2: Generating initial themes
For the purposes of this paper the themes established were concept focused. The researchers gained these themes from a series of extisting literature with the main distinction of these themes being done manually by the researchers by means grouping and highlighting themes according to the prevalence and the reoccurrence of the themes. The researcher then highlighted common themes and grouped these accordingly based the frequency of occurance and their relation to the research question.

Phase 3: Searching for themes
The researchers themes were then established at this point , thereafter a code was allocated to each theme. During this stage, the significance of each theme towards the addressing of the papers objectives was established.

Phase 4: Reviewing themes
The researcher then went on to establish each category for the themes and the researcher captured these themes.This process therefore allowed the researchers to find any gaps within the data.

Phase 5: Defining and naming themes
The researchers then proceeded to set out a thorough map of the themes. This process of defining and refining these themes furthermore outlines the “essence” of what each theme is all about.

Phase 6: Production of the report
The researchers once fully establishing and analysing these themes conducted a final analysis and proceeded to write the paper.

4. FINDINGS AND DISCUSSION

4.1. Level of Adoption

Currently there is a limited amount of research papers aimed directly at assessing the adoption of cloud computing strategies within the construction sectors therefore it is imperative to note the nature and history of the construction industry as a whole when assessing the concept of cloud computing adoption (Zainon, Rahim and Salleh, 2011). The adoption of information technology related offerings within the construction industry have been touted to be slow and lagging when compared to other industries and sectors (Kumar,Cheng and McGibbney, 2010).

To further understand the reception of cloud computing, the scope for the purpose of this assessment has been broadened to assess the reception of information technology as a whole within the construction industry. A study by Oladapo (2007) found that information technology software such as Computer Aided Design (CAD) was used on average 70% in countries such as Sweden, Denmark, Canada, Turkey and Nigeria. Furthermore, 98.5% of firms used computers (Oladapo, 2007). Adwan and Al-Soufi (2016) found that of the 33 information related technologies it established related to construction 44% of the use was attributed to web based programmes. Mutesi and Kyakula (2009) reported that 64% of the construction organisations included in their study utilised the internet in their study of information based technologies.

4.2. Barriers to the adoption of cloud computing

The risks that come with the implementation of new systems in a sector are always bound to be a deterrent in some form or another to the adoption of these systems. The following barriers were identified:

- The financial burden;
- Cloud computing's high dependence on an internet connection;
- Lack of knowledge regarding cloud computing options;
- Low priority in terms of the awareness of the need and usefulness of cloud computing within their structures;
- Quality and availability of services;
- The issue of data lock that would potentially make it hard for the customer to switch providers;
- Legal compliance, regulations, legal, contracts, audit;
- Service provision, service level agreements, support, availability, reliability;
- Security concerns such as privacy, confidentiality, access control, visibility and transparency (Armbrust, *et al*., 2009; Betcher, 2010;

Clemons and Chen 2011; Maresova and Halek, 2014; Marston, *et al*., 2011).

As the construction is seen to be heavily data oriented the use, storage and security of data is one of its major focal points. Armbrust, *et al*. (2009) and Kumar, Cheng and McGibbney (2010) concur that the risk of the security of data is the main concern and barrier for the adoption of the cloud.

4.3. Benefits of cloud computing

The potential benefits that follow cloud computing are many and Brohi and Bamiah (2011) highlights cost savings, easy scalability, and increased productivity. Adding onto the aforementioned benefits Carroll,Van Der Merwe and Kotze (2011) found increased flexibility, improved utilisation of capacity, increased efficiencies and more mobility as some of the additional benefits. Cloud computing gives organisations a competitive advantage because of the available flexible and agile computing platforms, furthermore the adoption of the cloud frees up resources allowing for their allocation to more strategic tasks (*ibid*). Another takeaway from cloud computing is that it fosters for communication and data exchange which occurs effectively, efficiently and accurately making where and when the information is presented not an issue of concern (Rawai,Fathi,Abedi and Rambat, 2013). It is imperative to note the implementation of the cloud also fosters for collaborative work meaning that teams and all stakeholders of the project if need be will be able to share their inputs and suggestions in a prompt manner and receive required information as quick as possible (Rawai, *et al*., 2013). Another major benefit of cloud computing according to Mandičák, Mesároš and Kozlovská (2016) is the benefit of coordination of activities within the processes of construction as it contributes to one of the main objectives of any construction project.

5. CONCLUSION

With the literature studied the existence of research on the concept of cloud computing as a stand alone subject is shown to be plentiful and very informative, however in terms of the research on its successful applications in the construction industry very little has been documented. There are vast benefits that are touted and that come with the implementation of cloud computing. Although the industry seems to be gradually growing in terms of the adoption of information technology related services and offerings the construction industry's reception to cloud computing has been lagging. The reasons stated are clearly outlined in the paper and until such concerns are addressed the adoption of cloud computing strategies by the construction

sector as a whole will continue to take a backseat when compared to other industries.Across the various sources of data that have been reviewed it has been established that at least ten of those sources within their literature site the issue of the security of the customers data within the cloud as a detterent factor, as with any company the loss of valuable data could be detrimental to the state of the company.

The current study is presented at a literature review stage. However, from the findings thus far, suggested further steps in the study are (a) to gather empirical evidence on cloud computing; (b) understand the construction industries reluctance to adopt cloud computing.

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Effectiveness of client involvement in construction projects: A contractor perspective

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ABSTRACT AND KEYWORDS

Purpose of this paper
While effective client involvement in their construction projects is important to achieve a successful project, contractors perceive their involvement as being too low resulting in unsatisfactory project delivery. The main aim of this study is to examine the role and level of client involvement on construction projects from the perspective of contractors.

Design/methodology/approach
This research was descriptive in nature and it employed the use of both quantitative and qualitative research approaches. Three sets of questionnaires were developed based on literature review; for client, consultant and contractor samples. The samples were selected through purposive convenience sampling. Data was analysed using the Statistical Package for the Social Sciences (SPSS) version 24.

Findings
Contractors regarded private sector clients to be more frequently involved in their projects than public sector clients. Furthermore, although optimum client involvement across all the project phases is crucial for project

success, contractors regarded the pre-construction phase to be a priority phase for client involvement, followed by the post construction phase.

Research limitations/implications

The study was limited to the views of contractors only and it considered only those based within the Kwazulu-Natal region.

What is original/value of paper.
Realising that clients have a high level of impact to influence project outcomes, it is imperative to focus on their involvement in projects as their effective and appropriate involvement influences successful project outcomes.

Keywords
Clients, client involvement, construction project, procurement, trust.

1. INTRODUCTION

The existence of the construction industry is attributed to clients (Boyd & Chinyio, 2006; Masterman, 2002). The construction sector in South Africa is a significant contributor to employment opportunities and economic growth (CIDB, 2015). In 2013 alone, R262 billion was spent within the industry (Ibid). Clients are arguably the most important construction industry participants, given that they initiate and fund the construction process (Lopes et al., 2011). This fact is confirmed by Gwaya et al. (2014) and Cox et al. (2006) who stated that, inter alia, clients are the originators of projects. Kamara et al. (2002) concur with this fact by stating that clients are central to the construction process and can be best considered as the driving force of the construction industry. Research suggests that clients have the capacity to exert pressure within the construction industry (Blayse & Manley, 2004). This enables them to influence and change the attitudes, behaviours and procedures of other parties that must be addressed, so as to achieve sustainability of the built environment (Ryd, 2014). It is therefore undeniably that clients, through their knowledge and skills play a crucial role which cannot be undermined, as their behaviour is of great importance to the success or failure of construction projects (Boyd & Chinyio, 2006; Ryd, 2014; Blayse and Manley, 2004).

In a study conducted by Ambrose and Tucker (1999) it was found that one of the most important client needs is their involvement on construction projects. Therefore, business in the construction industry is about fulfilling client satisfaction (Pries, et al. 2004) cited in (Boyd and Chinyio, 2006). Client satisfaction has been linked to the level of client involvement and

control in construction projects Ahmed and Kangari (1995) quoted in (Kamara et al., 2002). Alsolaiman (2014) and Assaf & Al-Hejji (2006) alluded that inadequate client involvement, especially during many of the most critical project activities has led to problems experienced on construction projects, some of which hinder project success. These problems include but are not limited to construction disputes, uncertainties in plans and specifications, and delays in giving the contractor vital information or instructions. While effective client involvement in their construction projects is important to achieve a successful project, contractors perceive their involvement as being too low resulting in unsatisfactory project delivery.

Noteworthy to mention is that clients have different roles and responsibilities, and project complexity is increased by the fact that the involvement of individuals may change during the project (Blyth and Worthington, 2010). The role of the client has generally evolved from one of a passive fund provider to an increasingly active participant (Alharthi et al., 2014), although their roles and responsibilities have been neglected in much of the literature (Alvesson et al., 2009; Gwaya et al., 2009). The level of influence or responsibility clients have on a project varies over the course of the project life cycle (Alharthi et al., 2014), with the greatest influence reportedly being during the early stages of the project (Sivunen, 2015; Thomson, 2010) where the scope is defined in the form of a brief (PMI, 2013).

The roles, responsibilities, level of involvement and cooperation between clients and contractors during the construction process are determined by the procurement method followed (Pesamaa et al., 2008). The type of procurement method followed influences project success or failure (Mathonsi and Twala, 2009). This is partly due to the fact that procurement sets out the level of cooperation between clients and contractors (Pesamaa et al., 2008). The effective implementation of the procurement method followed, coupled with competencies as well as practical experience of those involved in the process ensures that the risks are minimised, costs are managed and project outcomes are optimised (Pesamaa et al., 2008; APCC, 2002). This study seeked to learn about the various procurement methods, so as to enhance the selection of the appropriate type of procurement method is selected in an effort to facilitate optimal and effective client involvement; at the same time fostering cooperation among the project stakeholders so as to facilitate successful project delivery. The adoption of the most appropriate procurement method greatly contributes to the overall client's satisfaction and project success (Muriro and Wood, 2010; Mathonsi and Thwala, 2012)

2. LITERATURE REVIEW

2.1 Defining clients

A client is a person or organisation who takes the initiative to have a project designed and constructed, and in turn pays for the construction (Van Rijn, 2005; Bennett, 2003). Aiyetan (2010) defined a client as the project initiator who is responsible for the production of the project. A client is an organisation or individual who commissions the services necessary to execute and complete a project in order to satisfy its needs and thereafter enters into a contract with other parties (Masterman 2002:6). Contrary to common understanding of a client being a sole individual as a result of historical factors (Tzortzopoulos et al., 2008), in construction, clients are often large organisations that are accountable to a board of trustees (Gould & Joyce, 2014). Generally, clients tend to be complex and multi-faceted in nature, and they involve various individuals and/or groups whose objectives differ and often conflict (Boyd and Chinyio, 2006). Clients do not conduct their business in a uniform manner but are diverse, having differing approaches and inclinations towards project execution and the construction industry at large (Boyd and Chinyio, 2006; CIDB, 2011a; Alvesson et al., 2009).

2.2 Client categories

Clarification and categorisation of the client type and interests is essential so that construction professionals are aware of the appropriate course of actions to take during each project phase (Tzortzopoulos et al., 2008, Alsolaiman, 2014). Clients can be categorised into;

i. Public or Private sector clients

With public sector clients, construction is undertaken using public money either from local or state sources (Gould & Joyce, 2014), whereas private sector clients fund for their own projects in one of two ways, either internal (own) or external (financial institutions) (Masterman, 2002).

ii. Primary or secondary clients

Primary clients derive their primary income from constructing buildings such as, for example, property developers whereas secondary clients are the users of the buildings that house their

businesses such as, for example, manufacturing companies (SACQSP, 2016b).

iii. Level of knowledge or experience

- Experienced clients have detailed knowledge and understanding of the construction process they possess the capability to assist and influence the consultant team on construction and project matters (SACQSP, 2016b).

- Parially informed clients have been described by Boyd and Chinyio (2006) as those who have very little knowledge of the construction processes, and therefore hire professionals in the process of facility procurement.

- Inexperienced clients generally lack the knowledge, understanding and expertise of the processes and procedures of the construction industry (Masterman, 2002); therefore, they tend to rely on advice from their professional consultants (SACQSP, 2016b).

iv. Frequency of commissioning for construction work

- Once off clients have very little or no experience and knowledge of the construction industry, and as a result, they are less likely to understand how the industry operates and the importance of their role in ensuring project success and therefore rely on advice from professional consultants (SACQSP, 2016b). They are assumed to constitute the largest proportion of all construction industry clients (Boyd & Chinyio, 2006; Cox et al., 2006), yet they contribute to only a small percentage of the value of all construction work (UK Parliament, 2007).

- The other type of client procures construction projects on a regular basis (Boyd & Chinyio, 2006). Gholipour (2006) and UK Parliament (2007) found that the majority of construction clients usually have large ongoing construction portfolios.

2.3 Effectiveness of client involvement

Baccarini (1999) defined effectiveness as the degree of achievement of project objectives. In most of literature, effectiveness has been referred to as project success (Baccarini, 1999; Kylindri et al., 2012). Takim and Adnan (2008) argued that effectiveness encompasses the measures of achieving of project objectives, user satisfaction and the use of the project". Generally speaking, effectiveness is concerned with doing the right thing

(Ibid). With those definitions in mind, effectiveness of client involvement in their projects therefore measures the degree to which their involvement influences successful project outcomes. Effectiveness of client involvement refers to measuring the success of a project as a result of client involvement.

Effective and appropriate involvement by clients in their project influences good outcomes, and the degree of their involvement is influenced by, inter alia, taking the right decisions at appropriate project phases (Alsolaiman, 2014). Al-Kharashi & Skitmore (2009) suggested a link between ineffective involvement of project participants (clients included) and poor project outcomes. Effective client involvement in their project requires flexible guidance throughout the project life cycle (Alsolaiman, 2014). Furthermore, to increase the effectiveness of client involvement in their projects, emphasis should be placed on team contributions to the construction process, such as for example, exchange of ideas (Ibid). Alsolaiman (2014) indicated that in order for clients to be effectively and efficiently involved in their projects, they should have adequate knowledge and skills of the construction process.

2.4 Construction procurement

Procurement forms an integral part of the construction process and it occurs at any point across the project cycle (Mathonsi and Mathwala, 2012). It is aimed at assisting the client in obtaining competent construction services (Charvat, 2000). In an effort to improve procurement performance, which arguably contributes largely to project success, several changes in the client and the procurement systems have been effected (Alharthi et al., 2014). Procurement can be described as the process of placement of the contract (Aiyetan, 2010). It has also been defined as a method for clients to provide and fund constructed facilities (Shrestha et al. 2012).

The adoption of the most appropriate procurement method greatly contributes to the overall client's satisfaction and project success (Ambrose and Tucker, 1999; Muriro and Wood, 2010; Mathonsi and Thwala, 2012). Ideally, clients must retain authority to exercise maximum control of the procurement process and should be actively involved in contractor selection so as to ensure their satisfaction with the contractor to be ultimately selected (Charvat, 2000). In an effort to minimize friction between project stakeholders, it has been suggested that clients should have the liberty to choose whom they want to do business with (Mills, 2011).

2.4.1 Procurement Methods in South Africa

According to Grobler and Pretorius (2002), the three types of procurement methods which are widely used in South Africa are; traditional method, design and build, and construction management. Mbanjwa (2003) added management contracting to the list.

i. *Traditional Method (also termed Fixed Price Contracts)*
It has been the first if not only choice for the majority of construction industry clients (Bennett, 2003; Mathonsi and Thwala, 2012). Under this form of arrangement, the design responsibility is separated from the construction responsibility (Alharthi et al., 2014), where the design responsibility and any errors or risks emanating from omissions lie with the client and the construction responsibility lies with the contractor (APUC, 2012). The separation between the contractor and the client under the Traditional Method reduces the client's influence and involvement on the project, leaving the client dependent on the consultant (Assaf & Al-Hejji, 2006).

ii. *Design and Build*

Bennett (2003) noted that under Design and Build (DB), the owner retains the services of a design-builder under a single contract. The contractor is appointed much earlier in the process and his price is based on the information provided by the client (Lahdenpera, 2001).

iii. *Management Contracting*

Under management contracting, the client appoints an independent professional team and a management contractor (Davis et al., 2009). Trade sub-contractors are then mutually evaluated and selected by the client, consultants and the management contractor (Alharthi et al., 2014).

iv. *Construction Management*

Under this method, the client has the opportunity to partake fully in the construction process (Oshungade & Kruger, 2015).This form of arrangement is very similar to management contracting, the difference being that the client and works sub-contractors have a direct contract between them and the construction manager acts as a consultant in managerial position (Davis et al., 2009; SACQSP, 2016b).

3. RESEARCH METHODOLOGY

A descriptive survey was employed because of its capacity to include data collection techniques such as questionnaires (Merriam and Simpson, 1995). Secondary data was collected through review of literature and it aimed at examining and recording all issues as discussed by different authors in various sources such as; books, journals, government articles and other scholarly works. Primary data was collected through the use of questionnaire survey where semi-structured questionnaires were administered to contractors, clients and consultants.

Sample Design: A sample of 133 contractors, 25 clients and 25 consultants was used. Since the research was primarily focused on the contractor's perspective, a sample of 133 contractors was used to gather insight into their perspective of client involvement in the projects that they undertook. Smaller sample sizes of 25 each for both the consultants and clients were used so as to provide some form of validation of the findings and to compare them with the views of contractors.The samples were selected through convenience sampling which is a non-probablistic sampling technique. The researcher intentionally chose the samples, focusing mostly on the respondents that were well known to the researcher in order to maximise the response rate and to collect as much data as possible. Respondents were also selected based on their location, preference being on those in close proximity to the researcher so as to minimise any travelling costs. Some of the respondents were referrals suggested by other participants. As such these samples may be considered to be purposive convenience samples.

Table 3-1 shows the distribution of the instruments to the various samples and the related response rates.

Table 3-1: Number of returned questionnaires

	Sample	No. of responses	% of response rate
Contractor	133	101	76%
Consultants	25	19	76%
Clients	25	18	72%
TOTAL	183	138	75.4%

4. RESEARCH FINDINGS

4.1. Client involvement as perceived by different samples

Table 4-1 presents the experience that clients, consultants and contractors had of procurement methods which are currently used in construction projects in SA.

Table 4-1: Comparison of usage of different procurement methods

Procurement Method	Clients		Consultants		Contractors	
	Public	Pvt	Public	Pvt	Public	Pvt
Traditional procurement	88%	60%	74%	68%	83%	60%
Design-build	40%	50%	16%	32%	9%	12%
Negotiated	25%	50%	11%	26%	26%	40%
Construction management	13%	0%	11%	16%	2%	2%
Cost-plus	0%	10%	11%	16%	5%	16%
Management contract	0%	0%	11%	11%	2%	2%
Turnkey	0%	0%	11%	16%	2%	1%

From Table 4-1, it can be seen that the traditional procurement method was the most dominant method according to clients, consultants and contractors. It is clear that the public sector utilised the traditional method more than the private sector, with >70% and >60% of each respondent sample reporting to having used this method on public sector and private sector projects respectively. This finding aligns with findings of studies conducted by Mbanjwa (2003) and Oshungade & Kruger (2015) who found that the traditional procurement method was the most widely used method, especially within the public sector. The predominately high usage of the traditional method is in line with the perceptions noted in literature review in which clients are viewed as being resistant to change and their habitual behaviours impeding changes of the procurement methods in use (Laedre et al., 2006).

Contractors had the negotiated method as next most common whereas both the client and consultant samples indicated that the design and build method was the second most common method. A study conducted by Oshungade & Kruger (2015) concurs with outcome of the consultant and client samples as they found that the design and build method was the second most common method in South Africa. It can be deduced that the procurement methods widely used for construction projects in South Africa were the traditional, design and build and negotiated methods respectively.

4.2. Mean client involvement per project phase

Table 4-2 presents mean client involvement per project phase as reported by the three respondent samples.

Table 4-2: Comparative client involvement per project phase

Project Phase	Contractors		Consultants		Clients	
	Public	Pvt	Public	Pvt	Public	Pvt
Pre-construction	3.49	4.08	3.88	4.41	4.73	4.45
Post construction	3.41	4.14	3.77	4.27	4.71	4.22
Construction	3.28	4.10	3.58	4.16	4.70	4.25

It is evident that although contractors considered both client sectors to be often involved (mean<4.20>3.41) in all project phases they considered private sector clients to be more frequently involved in their projects. This could be attributed to the dominant usage of the traditional method in which, as indicated by Assaf & Al-Hejji (2006) there is separation between the contractor and the client as consultants are appointed by clients to act or operate in their best interest. The contractor therefore had to rely on a third party and not the client. This therefore implies that the contractor had limited interaction with clients, leaving the contractor with the desire to be more engaged with clients. Probably because, inter alia, of the longer and indirect communication channels involved and the generally slower or late provision of project related information (which sometimes would be critical), as the contractor would have to go through the consultants to relay any information to the client and vice versa. It is likely that contractors would prefer alternative procurement methods which allow for frequent and direct client involvement such as for example, the design and build method.

4.3. Summary of client involvement constructs

Respondents were presented with a series of statements within four constructs about client involvement on their projects and they were requested to indicate to what extent they either agreed or disagreed with them. A 5-point scale was used where 1=strongly disagree, 2=disagree, 3=neutral, 4=agree and 5=strongly agree. Table 4-3 is a list of construct statements.

Table 4-3: Statements about client involvement

Statement
Client roles and involvement
The lack of client understanding of the construction process contributes to unsuccessful project delivery
Appropriate client involvement is beneficial to the project
The lack of adequate client involvement in their projects leads to numerous problems encountered across the project lifecycle such as disputes, time and cost overruns, etc
Dealing with experienced clients is better than dealing with those that are inexperienced
The success of a project is linked to the extent of client involvement and client control in their projects
Client interference is a hindrance to project success
Expert and experienced clients play a more active role in their projects
Clients experience more satisfaction and product quality when involved in their projects
Construction clients understand their roles and responsibilities and adequately perform them
Contractor perceptions
Delays in payments by clients contributes to negative project consequences
Prequalification of contractors is essential to ensure project success
Contractors strive to fulfill client satisfaction
Client satisfaction is essential to securing client loyalty and retention
Clients tend to delay payments due to the contractors
Procurement
Clients tend to choose the procurement method which they are familiar with, which might not necessarily be the best
It is fundamentally important for clients to obtain appropriate advice on the choice of procurement method
Clients must retain authority to exercise maximum control of the procurement process
The selection of an inappropriate procurement method can have a major impact on project success
Clients should have the right to choose the procurement method they want to use
Clients' understanding of the procurement process influences the level of their involvement on construction projects
Clients are adequately involved during the procurement stage
Project stakeholder relations
Adequate client knowledge of construction projects influences teamwork and collaboration
Trust, honesty and cooperation by clients is vital for successful project delivery
Greater involvement of clients in their projects will change the current adversarial construction environment

Table 4-4 is a summary of the constructs for client involvement in order of importance as indicated by the respondents.

Table 4-4: Summary of constructs for client involvement

Construct	Contractors	Consultants
Project stakeholder relations	4.40	4.59
Client roles and involvement	4.38	4.14
Procurement	4.34	4.18
Contractor perceptions	4.33	4.23

The findings in Table 4-4 indicate that both contractor and consultant samples regarded all the constructs to be very important (all means>4.20), with the most importance placed on project stakeholder relations. As clearly indicated in this study, the traditional procurement is the single most used method in South Africa. The shortcomings of the traditional method, which include but are not limited to adversarial relations (Kadefors, 2001; Pinto et al., 2009) and high occurrence of misunderstandings and conflicts (Kadefors, 2001) could be linked to the importance placed on stakeholder relations. The second next important construct according to contractors is client roles and involvement. This is an indication that contractors are aware and want clients to fully understand the importance of their roles and importance of their frequent involvement in projects, as these are key factors influencing project outcomes (Aiyetan, 2010; Alsolaiman, 2014). The importance placed on client roles and involvement could be attributed to the dissatisfaction which contractors have with the traditional approach which deters clients from being frequently involved in their projects as they tended to depend on consultants.

Furthermore, the results indicate that there was congruence between the consultant and contractor views on client involvement indicating that both respondent samples concurred that there was still more that clients could do to improve their involvement in projects thereby improving overall project performance.

5. DISCUSSION OF FINDINGS

In terms of client involvement, when compared to public sector clients, contractors regarded private sector clients to be more frequently involved throughout all project phases. The high private client involvement could be linked to the generally better project delivery by the private sector. The findings are an indication that there is a difference in the way the two client sectors operated and this could be attributed to, inter alia, the extent to which the clients needed to adhere to various regulatory frameworks, the extent to which the client sectors relied on their professional advisors, with

the public sector having to adhere to stringent regulations and overly relying on the professional team to act on their behalf.

It was also found that the significant and dominant usage of the traditional procurement method by both public and private sector clients in South Africa can be confirmed. The possible reasons why the traditional method was predominantly used could be that clients were resistant to change and they tended to choose the method they were most familiar with. Additionally, it could be that clients wanted to minimize the amount of risk they were exposed to, and that clients required cost certainty. The study also found that although alternative procurement methods were not widely adopted in South Africa, the private sector was more open and flexible in utilising them, with the next most used methods being the design and build and negotiation. Considering the high usage of the traditional procurement method, it was therefore not surprising that all respondent samples emphasised on the need for good project stakeholder relations as important factors that facilitated project success and this could be attributed to the adversarial nature of the traditional method.

6. CONCLUSIONS

Comparison was made between the two client sectors, namely the private and public sectors. This was important in determining whether there were any differences in their involvement level based on the sector in which the clients operated. This study confirmed that there were more differences than similarities in the level and extent of their involvement. One of the key findings to emerge from this study is that the current level of client involvement in construction projects was different for the two client sectors, with private sector clients being more involved in their projects. Previous studies Babatunde et al. (2010) & Jha (2011) found that one of the most important needs of construction clients is for a project to be delivered on time, within budget and to the desired quality. Furthermore, Al-Kharashi & Skitmore (2009) and Alsolaiman (2014) indicated that if adequately involved in their projects, clients had the potential to influence project success. It is therefore evident that in order to enhance successful project delivery, both client sectors, especially the public sector clients need to improve in terms of their involvement in projects, as the public sector was found to be more prone to experiencing negative project performance outcomes such as time overruns (Alsolaiman, 2014). This study further confirmed the need for adequate and effective client involvement in their projects to ensure successful project delivery.

There is widespread recognition of the importance of client involvement throughout all the phases of a construction project (Boyd and Chinyio, 2006; Ambrose and Tucker, 1999). Boton (2011), Sivunen (2015) and Alsolaiman, 2014) found that out of the three construction project phases,

the pre-construction phase was considered to be a priority phase for client involvement, as it encompasses many important activities such as planning and design, which are critical for project success. According to (ASCE, 2012) clients' key roles fall within the pre-construction phase and these include early formation of the project team and assigning responsibilities. In the present study, although all the respondents agreed that the pre-construction phase was the most important phase for client involvement, both the contractors and consultants indicated that public sector clients were inadequately involved during this phase and this low involvement could possibly be linked to the inefficient delivery of most of the public sector projects in South Africa.

The study confirmed the findings of Watermeyer (2011), Mbanjwa (2003), Oshungade and Kruger (2015), Mathonsi and Mathwala (2012) and Muriro and Wood (2010) that the most significant and dominant procurement method utilized by both public and private sector clients in South Africa was the traditional method. Despite its various shortcomings, it is still the most common method, and this could be due to the resistance to change by the client sectors. Additionally, the study found that private sector clients were generally more aggressive in adapting alternative procurement methods when compared to the public sector (Karna, 2004; Ling et al., 2013). Contractors regarded the negotiation method as the second most common procurement method whereas consultants and clients considered the design and build method to be second most common. In a study conducted by Oshungade & Kruger (2015) it was found that the design and build method was the second most common method in South Africa. Despite whichever procurement method was used, client involvement was varied, with the private sector reportedly being more involved in the procurement process when compared to public sector clients.

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Exploratory factor analysis (EFA) to determine critical success factors of managing joint venture construction projects in South Africa

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ABSTRACT

Purpose
The formation of joint venture between construction companies is a recent effort in combating construction project delivery problems in South Africa. Furthermore, there is no consensus of the critical success factors (CSFs) to be used in managing the successful delivery of joint venture projects. This study, therefore determines the CSFs using EFA in order to manage the successful delivery of joint venture (JV) construction projects in South Africa.

Research design
Empirical data was collected using structured questionnaire survey, administered to the professionals from the South African Council for Project and Construction Management Professions (SACPCMP) who have been involved in joint venture projects. Statistical Package for Social Sciences (SPSS) version 23.0, was used to analyze the reliability and validity of the CSFs.

Findings
Results revealed that nine CSFs were valid and reliable for managing JV construction projects in South Africa, i.e.: comprehensive and fair written agreement; mutual understanding; co-operation between the members; commitment of the partners; communication between the partners; contract management; management control; inter-partner trust and implementation of contract agreement.

Limitations
The study was not conducted across South Africa, hence the findings cannot be generalized.

Practical implications
This research provides empirical evidence for the valid and reliable CSFs that can be used to successfully manage JV construction projects in South Africa. However, these CSFs should be validated to ensure that they positively influence the successful delivery of the JV construction projects.

Keywords
Construction, Critical Success Factors, Joint Venture.

1. Introduction

Construction industry plays a vital role in South Africa's economic and social development. The industry provides the physical infrastructure and it is the backbone for economic activities by providing large-scale employment to its populace (Construction Industry Development Board, CIDB, 2010). In order for the social and economic benefits of the populace to be realized, the need to manage the construction projects successfully is imperative. Hence, different management strategies have been suggested e.g. contract management, design and build and JVs but to name a few. In-spite of these management strategies suggested to successfully deliver the construction projects successfully, clients are still not satisfied with their projects outcomes.

According to Farrel (2014), at least 40% to 70% of joint ventures fail. Therefore, during the formation of JV in construction projects, several critical success factors (CSFs) need to be implemented to improve the delivery of JV projects. The CIDB, (2004) and Kale et al., (2013), suggested that; fair and comprehensive written agreement was a CSF for JV projects. Furthermore, Hong and Chan, (2014) indicated that; comprehensive and fair written agreement, mutual understanding, inter-partner trust, commitment of the partners, and the ease of communication between the partners were CSFs of JV. Hyun and Ahn (2013), suggested

that; comprehensive and fair written agreement, mutual understanding, and inter-partner trust were CSFs of JV project success.

It can be inferred that different authors have suggested different CSFs. This statement suggest that no consensus has been reached of the types of CSFs that will be used to influence JV project success. Furthermore, the measures of these CSFs contrasts and hence lacks consensus (the construction industry development board,2014; Manitshana, 2012). In relation to this gap two specific research questions were stated:

- What is the validity of the CSFs for successful construction project delivery of JVs in South Africa?
- What is the internal reliability of the valid empirical CSFs for successful construction project delivery of JVs in South Africa?

2. LITERATURE: CRITICAL SUCCESS FACTORS OF JV PROJECTS

One of the key challenges in evaluating JV success is the measurement of its performance. According to Jha and Lyer (2006) and Nisaa, Javed and Akhtar (2015), project performance of JVs has been restrained to four performance evaluation parameters, i.e.: schedule, cost, quality and no-dispute. Furthermore, the measures of JV performance can be classified as subjective measures (such as overall satisfaction) and objective measures (such as return on investment) (Zheng and Larimo 2010). According to Adnan and Morledge (2003), critical success factors are those few key areas of activity in which favorable results are unequivocally essential for a particular manager to influence his or her own objectives. It can therefore be concluded that specific critical success factors according to several authors influence the performance of JVs in construction projects. On the backdrop of this background a number of CSFs have been identified that will influence the success of JV projects;

Comprehensive and fair written agreement: It is a recipe for possible disaster if a JV is not constituted by means of a comprehensive and fair written agreement between the members, which sets out their obligations, rights, risks and rewards (Construction industry development board, 2004). Adnan and Morledge (2003) put forward the idea that a good joint venture agreement is an essential success factor and can avoid a great deal of trouble and conflict in future JV operations. The joint venture participants join through a form of agreement to contribute with resources in the form of skills, experience, financing and/ or physical resources.

Mutual understanding: According to Adnan and Morledge (2003) and Manitshana (2012), mutual understanding contribute to the success of JV construction projects. In fact, it is extremely important that friendly personal contact is regularly maintained between the leaders of the partnering organizations (Adnan and Morledge, 2003). The careful selection of people who are to work in an alliance will assist the prospects

of mutual bonding of partners, therefore mutual understanding (Hyun and Ahn, 2013).

Inter-partner trust: A high degree of trust and co-operation between the members for a successful operation of a JV is important (Construction industry development board, 2004). Inter-partner trust is often considered to be a very important ingredient of managing relationships (Adnan and Morledge, 2003; Hyun and Ahn, 2014; Hong and Chan, 2014). In other words, mutual trust is indispensable to overcome the restrictions of the contractual agreement (Govindan, 1995). However, within organizations, trust contributes to more effective implementation of strategy, greater managerial coordination and more effective work teams (Adnan and Morledge, 2003).

Co-operation between the members: Cooperation is an important factor as problems solving reflects the degree to which the parties share responsibility both for dealing with problems and maintaining their relationship (Adnan and Morledge, 2003). Yet, the review of the effect of cooperation/conflict on joint venture performance has been a prevalent topic for many researchers, according to Govindan (1995). The power of one partner can interfere with the goal attainment of another partner and thus conflict is possible only when the interfering party has some power (Govindan, 1995). Therefore, it follows from this argument that, the more resources one partner has to contribute to the JV becomes comparative to the other partner, the more power the partner would have to affect the achievement of the other party's goals (Govindan, 1995).

Commitment of the partners: Adnan and Morledge (2003) as well as Hong and Chan (2014) suggested that commitment reflects the actions of some key decision makers regarding continuation of the relationship, acceptance of the joint goals and the values of the partnership, as well as the willingness to invest resources in the relationship. Moreover, it is believed by Lambe et al., (2011) that a number of researchers argued that relational factors which include trust and commitment contribute to joint venture success. Achievement of the other party's goals (Govindan, 1995).

The ease of communication between the partners: Undoubtedly, for any business to be run appropriately the communication / information aspect plays a major role. Adnan and Morledge (2003) as well as Hong and Chan (2014) emphasized this point by highlighting the fact that the ease of communication between the partners is another potential problem which should be considered when evaluating a potential partner’s suitability. In fact, without proper communication, problems can occur as a result of differences between national or ethnic cultures, including language, as well as differing corporate cultures (Adnan and Morledge, 2003; Manitshana, 2012).

Management control: The management aspects of the project play a very significant role in the successful completion of a JV construction project where the role of project participants is vital in this regard (Divakar and Subramanian, 2009). According to Adnan and Morledge (2003) and

Govindan (1995), the influence that major stakeholder groups have on the organization's decisions and activities which can easily be achieved in joint ventures by reporting to both majority shareholders. Thus, insufficient control over a joint venture (JV) can limit the ability of the parent to synchronize their activities, efficiently and utilizing their resources and effectively implementing their strategy (Talman, 2009).

Partner experience: According to Adnan and Morledge (2003), firms with multinational experience are considered more likely to have the ability to manage and monitor appropriately the joint venture. In addition, Lambe et al. (2011) argued that, partners` experience contributes to the success of the alliance because such a competence has an indirect impact on positively influencing the acquisition of complementary resources.

In order to determine the validity and reliability of these eight identified factors, exploratory factor analysis was undertake.

3. RESEARCH DESIGN

Quantitative research approach was adopted for this study. A questionnaire survey was developed from extensive literature and a pilot study was conducted with professionals registered with the SACPCMP and determined the content validity of the CSFs. The final questionnaire was presented to 400 conveniently sampled SACPCMP respondents. The data was collected using email and drop and collect method, of which 115 questionnaires were returned representing 28.75% response rate from Gauteng, Western Cape and Limpopo. It has been indicated that the response rates for mailed questionnaires are usually low, thus, a response rate of 15% to 25% is still considered appropriate and acceptable (Wahab et al., 2010), whilst according to Fryrear (2015) a response rate of 10% to 15% is still considered appropriate. It can therefore be indicated that the current response rate is appropriate for analysis.

The final questionnaire presented to the respondents consisted of eight constructs of CSF consisting of 31 measures. The respondents were required to indicate their level of agreement in practice with the CSF measures. The measures were rated on a five point Likert scale, where 1=strongly disagree, 2=disagree, 3=neutral, 4=agree and 5=strongly agree.

Other parts of the questionnaire were designed to profile the participants in terms of their; gender, experience in joint venture projects, and qualification before being registered as a construction project manager or construction manager. The questionnaire also profiled the organization in terms of; type of joint venture and geographic location. The statistical package for social science (SPSS) version 23 was used to conduct descriptive statistical analysis of the data computing the frequencies, mean scores and standard deviation. The SPSS was further used to determine the factor analyzability of the CSFs using inferential statistics. Exploratory

factor analysis (EFA) using principal component analysis (PCA) was used to determine the uni-dimensionality of the CSFs. Yang et al., (2009) and Pallant (2013) highlighted that PCA is used to identify a relatively trivial number of factor groupings that can be used to represent relationships among sets of many inter-related variables. Therefore, the uni-dimensionality of the constructs was determined using construct validity and criterion validity. Further, the internal reliability of the CSFs were determined using Cronbach alpha. This approach is supported by the studies undertaken by Kolbehdari and Sobhiyah (2014) and Wahab et al. (2010). Field (2006), Tavakol et al., (2011), Yount (2006) and Pallant (2013), suggested that the acceptable values of Cronbach alpha would range from 0.70 to 0.95. In the current study a cut-off value of 0.70 was adopted. Furthermore, the optimal inter-item correlations mean should range from 0.2 to 0.4 in order for the factor to be reliable (Pallant, 2013). However, in this study a value of 0.3 and above was adopted.

4. FINDINGS AND DISCUSSIONS

4.1 Respondents' Profile

Table 4.1 indicates that, 74.8% of the respondents are male while 25.2% of the respondents are female. Whereas, 35.7% of respondents were between the age of 31 and 40. The professional construction project managers and construction managers had different professional backgrounds. Majority that 19.1% of the respondents were construction project managers, whereas only 2.6% were electrical engineers. 33.9% of the respondents had been involved in JV projects for a period of less than 5 years, and 32.2% had been involved in JV projects between 5 to 10 years. The result further suggests that the type of JV the respondents have been involved in South Africa is the combined JV with 39.1%. Further, the integrated JV was used by 36.5% of the practitioners and the non-integrated method was used by 24.3%.

Table 4.1 Profile information of respondents

Classification	*Frequency*	*Percentage*
Male	86	*74.8*
Female	29	*25.2*
Younger than 21	1	*0.9*
21-30	23	*20.0*
31-40	41	*35.7*
41-50	29	*25.2*
51-60	16	*13.9*
Older than 60	5	*4.3*
Integrated	42	*36.5*
Non-integrated	28	*24.3*
Combined	45	*39.1*
Less than 5 years	39	*33.9*
5-10 years	37	*32.2*
10-15 years	25	*21.7*
15-20 years	7	*6.1*
More than 20 years	*7*	*6.1*

Continuation Table 4.1 Profile information of respondents

Classification	*Frequency*	*Percentage*
Architect	13	*11.3*
Chemical engineer	4	*3.5*
Civil engineer	19	*16.5*
Construction Manager	19	*16.5*
Construction Project Manager	22	*19.1*
Electrical engineer	3	*2.6*
Quantity surveyor	18	*15.7*
Mechanical engineer	5	*4.3*
Other	*12*	*10.4*

Source: Field data 2016

4.2 Factor analysis of the Critical Success Factors (CSFs) of JV

In assessing the correlation matrix of the 31 measures of the eight factors identified from the literature review. It revealed the coefficients of the measures were 0.3 and above. This is in line with the requirement of Pallant, (2013). This result revealed the suitability of the data for factor analysis.

The Kaiser-Meyer-Olkin measure of sampling adequacy (KMO-test) value was 0.781, exceeding the recommended value of 0.6 (Kaiser 1970, 1974). The Barlett`s test of sphericity (Barlett 1954) reached statistical significance at p= .000 ($p<0.05$), supporting the factorability of the correlation matrix (Pallant, 2013, Williams et al., 2010). The anti-image

matrix of correlations as a Measures of Sampling Adequacy (MSA) having diagonals all above 0.5 supports the factorability of the data set (Field 2000). PCA technique using principal axis factoring exhibited nine components which had eigenvalues above 1 (8.354, 2.436, 2.322, 1.814, 1.548, 1.472, 1.353, 1.195 and 1.102), explaining 26.950%, 7.857%, 7.489%, 5.853%, 4.992%, 4.750%, 4.363%, 3.853% and 3.554% of the variance respectively and 69.661% of the total. The results of the scree plot test suggested that the first nine components accounted for 69.661% of variance (Figure 4.1). The nine factors retained were analyzed using Varimax with Kaiser Normalization rotation during the first order of factor analysis. Results revealed the loadings of each of the measures on the nine components (see Table 4.2). The measures loaded strongly on all the nine components. However, components 7 and 9 loaded with only two variables/measures. They were retained because the measures loaded strongly on these two components. It is imperative to note that the nine factors were re-named as discussed in section 4.2.1.

Table 4.2 Rotated Factor Matrix of the Critical Success Factors (CSFs) of JV projects

Measure	Factor								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
E13.20.1	**0.812**								
E13.33.1	**0.654**								
E13.13.1	**0.573**					0.415			
E13.21.1	**0.508**								
E13.19.1	**0.470**	0.291	0.270	0.382					
E13.26.1		**0.813**							
E13.27.1		**0.692**							
E13.28.1	0.268	**0.487**	0.476		0.355				
E13.24.1		**0.399**		0.251		0.333			
E13.2.1			**0.687**			0.250			
E13.29.1			**0.615**						
E13.16.1		0.303	**0.416**		0.275				
E13.11.1				**0.654**					
E13.12.1				**0.593**					
E13.6.1		0.330	0.253	**0.424**			0.359	0.278	
E13.31.1					**0.644**				
E13.36.1					**0.534**				
E13.30.1			0.268		**0.529**			0.269	

E13.35.1				0.462	**0.486**				
E13.32.1	0.364		0.440		**0.454**				
E13.15.1	0.307					**0.702**			
E13.3.1			0.316	0.441	0.293	**0.493**			
E13.17.1			0.352			**0.426**			
E13.4.1							**0.783**		
E13.5.1	0.289			0.252			**0.640**		
E13.8.1							0.302	**0.677**	
E13.9.1		0.417						**0.513**	
E13.22.1								**0.447**	0.408
E13.10.1	0.342			0.326				**0.435**	
E13.1.1			0.268						**0.562**
E13.14.1					0.320	0.444			**0.556**

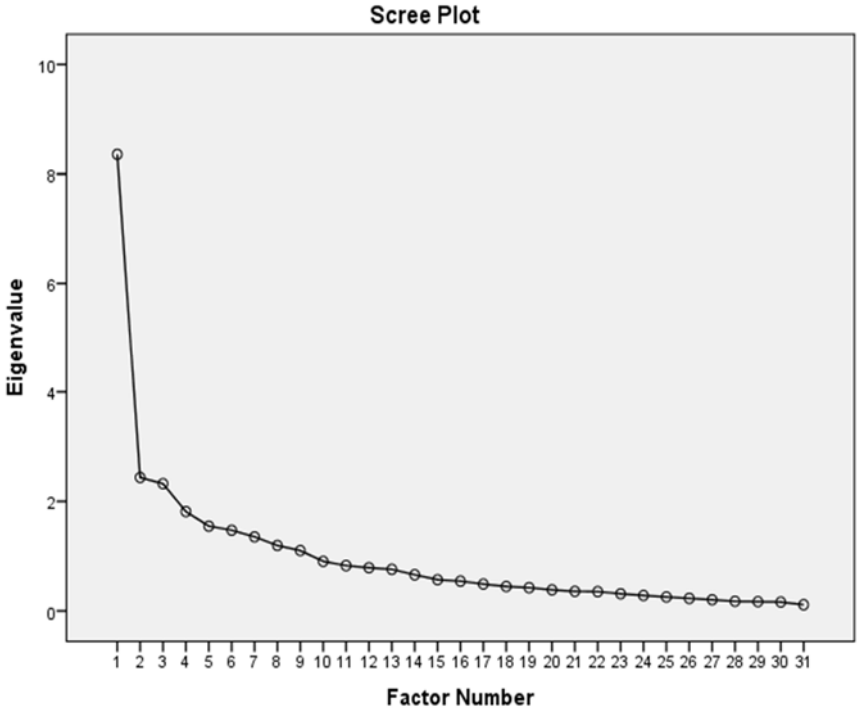

Figure 4.1 scree test for Critical Success Factors (CSFs) of JV

4.2.1 Re-naming of factors of CSFs

Component 1 (SF1): Co-operation between the members/partners - The term co-operation between the members/partners connotes the involvement of each partner to share their resources and information in order to enable coordination of activity whilst implementing organizational strategies within the JV. Thus, this component is thoroughly supported by authors such as Adnan and Morledge (2003) and Govindan (1995).

Component 2 (SF2): Communication between the partners - Communication between the partners has to do with communication at cultural and ethnicity level in order to avoid misunderstandings and suspicion within the JV. Moreover, it is important to evaluate the full commitment from each partner within the JV as it reduces conflicts and facilitates the achievement of JV goals (Adnan and Morledge, 2003; Manitshana, 2012, Dikmen, et al. (2008).

Component 3 (SF3): Contract management - It refers to the process of thoroughly and efficiently managing contract creation, execution and analysis for capitalizing on operational and financial performance and reducing risk (Elsey, 2007). This factor was defined by three variables. These included the percentage participation by each member including the risks, rewards, losses and liabilities, the conducts and decisions of the partner in the organization in alignment with the JV goals and policies. Finally, the capability trust in order to ensure professional experience from each partner.

Component 4 (SF4): Mutual Understanding- It defines the selection of partners based on their technical competence, their ability to form good relationship in order to promote consensus between the members involved in a JV. This was suggested by Adnan and Morledge (2003), Manitshana (2012) as well as Hong and Chan (2014). They argued that friendly personal contact should be regularly maintained between the leaders of the cooperating organizations. This will assist the prospects of mutual bonding of the partners.

Component 5 (SF5): Management control. It describes the ability of the partners to synchronize their project activities; the acquisition of complementary resources, and the efficiency of utilizing the partners' resources as was suggested by Adnan and Morledge (2003), Govindan (1995), as well as Talman (2009).

Component 6 (SF6): Inter-partner trust- This component, SF6, comprised the different contractual element involved in a JV as well as the input by each partner to the policy-making and management activities of the JV (Govindan, 1995, Adnan and Morledge, 2003; Hyun and Ahn, 2014; Hong and Chan, 2014).

Component 7(SF7): Comprehensive and fair written agreement- It emphasizes the provision for a management body for the JV, to limit the losses to the joint venture by the defaulting members based on the agreed measures put in place. As argued by the Construction industry

development board, (2004) and Adnan and Morledge (2003), it is a recipe for possible disaster if a JV is not founded by means of a comprehensive and fair written agreement between the members which lays down obligations, rights, risks and rewards of each partner.

Component 8(SF8): Commitment of the partners- These included the varying nature of JV objectives, inputs by the parties, and management systems of the JV, the friendly personal contact between the leaders of the cooperating organizations, the actions of key decision makers and acceptance of joint goals, and finally, partner selection criteria. These aspects were supported by Adnan and Morledge (2003), Hong and Chan (2014) and Lambe et al. (2011).

Component 9(SF9): Implementation of contract agreement - The contribution by each member needs to be set out as well as the implementation of strategy, a greater managerial coordination and more effective work teams. This is consistent with Durr et al. (2007). Durr et al., (2007) emphasized that a good plan helps optimize the use of the project resources and limits the time spent on resolving complications during implementation.

4.2.2 Empirical internal reliabilities of the re-named CSFs

In the current study, the Cronbach alpha coefficients of the nine empirical factors and the inter-item correlations means were all reliable. SF1 - Co-operation between the members/partners reached reliability with α=0.80, SF2 - Communication between the partners (α=0.78), SF3 - Contract management (α=0.65), SF4 - Mutual Understanding (α=0.70), SF5 - Management control (α=0.70), SF6 - Inter-partner trust (α=0.70), SF7 - Comprehensive and fair written agreement (α=0.80), SF8 - Commitment of the partners (α=0.70), and SF9 - Implementation of contract agreement (α=0.451). This findings concurs with the suggestion of acceptability of Field (2006); Tavakol et al. (2011); Yount (2006); and Pallant (2013).

5. CONCLUSION AND FURTHER RESEARCH

In conclusion construction projects managers are the one the most involved during questionnaires and thus eight theoretical factors consisting of 31 measures were identified in the literature and were analyzed using principal component analysis (PCA). In assessing the correlation matrix of the 31 measures of the eight factors identified from the literature review, the measures were suitable for factor analysis. Moreover, the Kaiser-Meyer-Olkin measure of sampling adequacy (KMO-test) reached the recommended value of 0.6 as well as the Barlett`s test of sphericity. The anti-image matrix of correlations as a Measures of Sampling Adequacy (MSA) having diagonals all above 0.5 supports the factorability of the data set. Results from the scree plot test suggested that the first nine

components accounted for 69.661% of variance and these were: co-operation between the members; communication between the partners; contract management; mutual understanding between partners; management control; inter-partner trust; comprehensive and fair written agreement; commitment of the partners; and implementation of contract agreement. The researchers recommend that further empirical research should be undertaken to validate the influence of these CSFs on JV construction project outcomes based on time, cost, quality and health and safety.

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Fostering Innovation through Managing Diversity in Architectural Design Firms in Developing Countries

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ABSTRACT

Purpose
This paper aims to investigate the role of diversity as a tool for fostering innovation in Architectural Design Firms (ADFs) in developing countries.

Design/methodology/ application
In order to achieve this aim, a research methodology, is designed to accomplish four objectives.

1. Conducting a comprehensive literature review about the research topic including nature of the construction industry, characteristics of developing countries, diversity and innovation.
2. Presenting and analyzing four case studies to investigate how the adoption of diversity concept fosters innovation.
3. Presenting and analysing the results of a survey questionnaire conducted with a representative sample of ADFs in Egypt to investigate the role of diversity management towards fostering innovation in ADFs.
4. Outlining research conclusion and recommendations useful for ADFs.

Findings

The construction Industry in general and ADFs particularly are characterised with different types of diversity. Diversity plays a key role in fostering innovation in ADFs, which in turn sustain competitiveness, increase market share and profitability. Since their high diverse communities, developing countries are in need to utilise their diversity for innovation as an approach for competing with other countries and enhancing the quality of life of their citizens.

Research limitations
The focus of this research was limited to ADFs in developing countries.

Originality / Value
The value of this research stems from the need to foster innovation in ADFs as an approach for economic development. Although diversity has been used in other industries for fostering innovation, it has not been used widely in construction in developing countries. The topic makes better utilisation of the diverse workforce in ADFs in developing countries, which consists of a large population of diverse communities.

Keywords: Innovation, Diversity, Architectural Design Firms, Developing Countries.

1 INTRODUCTION

Developing countries, in which 85.4% of the world's population lives, are nations of contrast. Despite the fact that developing countries are rich in their natural resources and diverse human capital, they lack of innovation and development. This could be attributed to their characteristics of: (1) low standard of education and vocational training as well as out flow of best brains, (2) corruption and political instability, dearth of capital, outdated technology and low levels of production, (3) poor health care, low life expectancy and high growth rate of population, and (4) difficulties related to social, demographic and culture (Cohen, 2006; Human Development Report, 2011; Othman, 2013). One of the pressing issues that relate to human capital in developing countries and hinder innovation, is the lack of managing human resources diversity and making better utlisation of theis capabilities (Loosemore et al, 2003). Unlike other industries like information technology (IT) and electronics, the construction industry in general and Architectural Engineering Profession particularly, do not effectively use the talents of all professionals within society to its advantage (Meng, 2016). The potential benefits of workforce diversity are enormous, but so are the challenges of harnessing it. Hence, this paper aims to investigate the role

of managing diversity as an innovative approach or fostering innovation in ADFs in developing countries.

2 Research Objectives and Methodology

To achieve the abovementioned aim, a research methodology based on literature review case studies and survey questionnaire was designed to accomplish four objectives.

1. Building a comprehensive background about the research topic through reviewing the nature of the construction industry, characteristics of developing countries, diversity and innovation.
2. Presenting and analyzing three case studies to explore the role of diversity management towards fostering innovation in ADFs.
3. Presenting and analysing the results of a survey questionnaire conducted with a representative sample of ADFs in Egypt to investigate the role of diversity management towards fostering innovation in ADFs.
4. Outlining research conclusion and recommendations useful for ADFs.

3 LITERATURE REVIEW

3.1 The Construction Industry

The construction industry is one of the biggest industries worldwide that affect the social and economic development of countries (Ofori, 2005). Socially, it plays a pivotal role towards providing the society with buildings and infrastructure projects that fulfil their requirements, meet their needs and enhance the quality of life. Economically, it contributes towards increasing the country's DGP, offers job opportunities and stimulates other industries that support the construction industry to prosper (Abdullahi, 2014). In spite the technological development in many industries, the construction business still relies heavily on human resources. Accordingly, the construction industry is plagued with challenges that relate to human resources. The Construction Sector Council (2003) in Canada and Muir (2005) classified these challenges as:

1. Meeting the need of the market of skilled labour.
2. Designing a training system that is responsive and flexible.
3. Fostering innovation and providing efficient training in order to improve skills.
4. Provide the transportation needed for the labour across the country.

5. Quality of working people depending on the skills and knowledge of people.

The architectural design process is an integral part of the construction industry. It aims to transfer client requirements into technical drawings that are able to be constructed. Emerging client requirements, meeting user needs, coping with regulatory changes, exploiting business opportunities, adapting to technology improvement, adding more values, and managing associated risks called for the construction industry in general and the Architectural Engineering profession to be innovative in attaining these objectives. To be innovative, architects must become more responsive to their users and environments. In other words, they must incorporate feedback from their physical and cultural contexts rather than relying solely on conventional analytical or internal processes of development from design to construction. Literally, architects are among the very few providing custom design services to their customers. This presents a profound problem, especially since few clients possess an understanding of the efforts necessary to create custom products, and even fewer are willing to adequately finance them. Second, while emerging digital technologies offer architects fundamentally with new possibilities for designing and building, current architectural attitude remains largely confined to limited evolutionary steps. ADFs that fail to innovate encounter the risks of losing their customer and market share (Celanto, 2007).

Graft-Johnson, Manley and Greed, (2005) stated that despite the fact that 37% of architectural students are women, they represent only 13% of the workforce in the architectural profession. Analysis revealed that women are leaving the profession after qualifying. This could be attributed to low pay, poor promotion prospects, discriminatory attitudes and sexist behaviour. There are serious implications for the future of the profession as it loses skilled people after they have qualified which hinders innovation.

3.2 Characteristics of Developing Countries

Generally, the classification of a country as “developed” or “developing” is based on certain measures such as (1) economic development, (2) education and training provision, (3) political stability, technological development, infrastructure and production rate, (4) healthcare, life expectancy and growth rate of population, and (5) society, demography and culture issues. Economically, the World Bank (2012) classified countries into four income groups based on their Gross National Income (GNI) per capita. All low (GNI ≤ US$ 1,025), lower (GNI = US$ 1,026 - US$ 4,035), and upper middle-income countries (GNI= US$ 4,036 - US$ 12,475) are classified as developing countries. In 2011, the United Nations developed the Human Development Index (HDI) as a measure to gauge

the level of human development of countries. The index showed that 18% the world's population lives in low human development countries (HDI below 0.500), while 52% populate countries falling in the medium human development category (HDI = 0.500 – 0.799), all of which represent developing countries (Human Development Report, 2011). Table (1) summarises the remaining characteristics of developing countries.

Table (1) Characteristics of Developing Countries

Characteristics related to Education, Training & Brain Drain
1. Low standard of education and vocational training 2. Out flow of best brains (Connexions, 2012; WDR, 2012; Kumar, 2012; Economics, 2010; Kintu, 2008).
Characteristics related to Policy, Economy, Technology, Infrastructure and Production
3. Corruption and political instability 4. Lack of capital and technology 5. Dualistic economy 6. Vicious Circle of Poverty 7. Low levels of productivity 8. Inequalities of national income distribution 9. Inadequate infrastructure 10. Heavy dependence on agricultural production 11. External resources dependence 12. Lack of industries and enterprises 13. Underutilized natural resources 14. High and rising levels of unemployment and under-employment (Economic Concepts, 2013; Connexions, 2012; Kumar, 2012; Economics, 2010; Bobrova and Kalvina, 2004; Fry, 1998)
Characteristics related to Health Care, Life Expectancy and Growth Rate of Population
15. Poor health care 16. Low life expectancy 17. High rates of population growth and dependency burdens (Economic Concepts, 2013; WDR, 2012; Connexions, 2012; Kumar, 2012)
Characteristics related to Society, Demography and Culture
18. General and social backwardness 19. Demographic characteristics 20. Socio-cultural characteristics (Economic concepts, 2013; Bobrova and Kalvina, 2004)

3.3 Diversity

3.3.1 Definition and Classification

Diversity as a team is used when describing a group of people having significant differences. Merriam Webster Dictionary (2017) defined it as condition of having or being composed of differing elements, especially: the inclusion of different types of people (as people of different races or cultures) in a group or organization. McGrath, Berdhal and Arrow (1995 cited in Roberson, 2004) defined diversity as the demographic differences among a group of people. Also, it can be defined as the differences in points of view that results in behaviour and identity differences, which appear within the group or with other groups (Larkey, 1996 cited in Roberson, 2004).

3.3.2. Types of Diversity

Diversity is classified into two dimensions (Milliken & Martins 1996 as cited in Roberson, 2004). 1) Observable dimensions, which are the biological characteristics such as: gender, race, ethnicity and age. 2) Non-observable dimensions, which are characteristics derived from the environment such as: Culture, Background, Intelligence and Technological skills (Kochan et al., 2003).

3.3.3 Benefits of Diversity

Organisations that manage workforce diversity effectively, develop creative solutions to problems and have better knowledge and sharing ideas (Smith, 2015). This perspective supports the argument that innovation can be fostered through proper management of diverse human capitals. Diversity of workforce in business environment can result in:

- Mutual respect, as dealing with different backgrounds and cultures increase the respect for other cultures.
- Conflict resolution, as although employees come from different backgrounds and cultures, they share the same goal. This provides an environment for solving conflicts.
- Business reputation, as employing people with different cultures increases the credibility of the firms in the customers' opinions.
- Job promotion, as it allows the firm to compete better in market and enhance its performance.
- Increasing exposure, as employees learn from each other different working styles, which improves their performance (Mayhew, 2016).

3.4 Innovation

3.4.1 Definition and Classification

Innovation was defined according to Oslo Manual (2015) as the application of new or redefined product, process or method. It is the creation, development and implementation of a new product, process or service, with the aim of improving efficiency, effectiveness or competitive advantage (Digital Strategy, 2009). Innovation is a mindset, a pervasive attitude, or a way of thinking focused beyond the present into the future vision. Noketehdan et al (2015) has designed a classification system for innovation according to its type and novelty. Classification according to Innovation types:

- Product innovation: introducing a new product or material.
- Design innovation: introducing new sketches, plans or innovative concepts.
- Tool innovation: introducing new equipment or machine.
- Function innovation: introducing new tasks
- Technology innovation: mix between the design and the product innovations.
- Method innovation: mix between the tool and the function innovations.

Classification according to Innovation novelty:

- Incremental innovation: the application of a small change that affects the project gradually.
- Modular innovation: the application of innovation in a specific area that does not affect the whole system.
- Architectural innovation: the application of a small change that results in a major shift in the system.
- System innovation: the application of a small number of changes linked together producing new functions.
- Critical innovation: the use of science and technology to change the nature of an industry.

3.4.2 Benefits of Innovation in Construction

Innovation is intended to improve the performance of organisations in the construction industry and achieve the objectives of its stakeholders. The benefits of innovation in construction are (Blayse and Manley, 2004; Gunnigan and Eaton, 2008; Nussabaum, 2009; OECD, 2012; Fortune, 2015; Cody, 2015; Hobcraft, 2016; Hogue, 2015; Schwabel, 2015).

- Reducing construction cost, time and injury rates.

- Improving productivity, increasing competitiveness and competitive advantage, marketing growth and achieving social objectives such as affordable housing development.
- Enhancing design buildability and economy as well as improving communication and learning.
- Reducing operational and maintenance costs as well as maximising additional opportunities for using the facility to generate future income.
- Partnering and Alliancing between project stakeholders helps increasing productivity, achieving client satisfaction and improving quality.

Construction innovation is classified into four categories as shown in figure 1, (Xue et al, 2014).

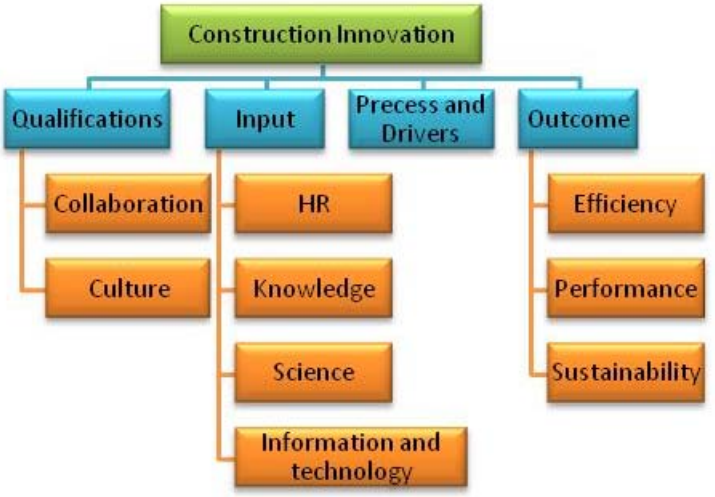

Figure (1) Construction innovation categories

3.4.3 Barriers to Innovation in Construction

A barrier to innovation is a circumstance or obstacle that prevents the implementation of innovation in construction. The barriers to innovation in construction are (Mohamed and Tucker, 1996; Gann and Salter, 2000; Gann and Salter, 2000; Gann, 2000; Leiringer, 2001; Sexton and Barrett, 2003; Budiawan, 2003).

- The short term of projects that are won on the bases of lowest price and the minimal opportunity or motivation for industry stakeholders to invest in R&D initiatives for innovation.

- The impact of the economic recession on the construction industry in terms of reducing profits and hindering the implementation of innovation.
- The project-based and fragmented nature of the construction industry, non repetitive products, change of construction methods with every site according to the scope and objectives of the project hinders the implementation of innovation in construction.
- The industry is predominantly made up of small firms which have their own focus and challenges that hinder the ability to innovate.
- The risks associated with implementing innovation in the construction industry are higher than any other industry which may lead to failure and affect the company's reputation and credibility.
- The conventional method of managing construction projects and Government statutory regulations and procurement methods adopted have a significant impact on innovation in construction.

3.5.3 Approaches used to foster innovation

Some approaches were mentioned to foster innovation such as:

- Motivation
- Supply needed resources
- Offer diversity within the group (Boundless, 2016).

3.5 Relation between innovation, diversity and Architecture Design Firms in Developing countries

The ADFs goals are to overcome the competitiveness and to exceed the customers' expectations. In order to achieve these goals, they depend innovation. Innovation can be fostered using different approaches; one of these approaches is managing diversity. Since developing countries are diverse communities, therefore this approach can be fruitfully applied in fostering innovation.

4 CASE STUDIES

Four case studies are presented and analysed to build a better understanding of the role of diversity in fostering innovation.

4.1 Case Study1: Cummins

4.1.1 *Background and problem statement*

Cummins is an American corporation, founded in 1919 in Columbus, Indiana. Cummins is concerned with designing, manufacturing and distributing engines and power generators, starting from fuel systems to electrical power generators. Cummins distributes its products to about 190 countries, and on 2014, its net income was of 1.65 billion dollars and its sales were 19.2 billion dollars (Investor Cummins, 2015). The company identified a wider increase of customers' expectations besides the fierce competition in business environment. Therefore, it had to find a solution to overcome these problems.

4.1.2 Cummins Vision, Mission and Objectives

Cummins realised that teamwork that is based on personnel with diverse genders, cultures, experiences, skills and qualities as well as placing the right people in the right place can overcome these problems. The company developed its vision to change people's lives into better lives through releasing the workforce diversity power. This vision was transmitted into a mission of directing the employees to cooperate with the customers in order to deliver innovative products and services to meet customers' expectations and maintain its competiveness. The company set a number of objectives and values that included innovation and diversity, namely.

- Tackling best talents in the profession.
- Covering wide range and different customers' needs.
- Achieving diversity at different levels.
- Creating a free working environment that makes different types of people feels inclusion.
- Getting use of different cultures to achieve more effective solutions and high levels of creativity.

Cummins planned to achieve diversity through:

- Applying diversity at all levels (managerial levels and employees). Currently the company contains 40,000 employees with differences in age, race, nationality, gender, personality, sexual orientation, religious beliefs and many other differences, which by its turn helps in building a huge customer base.
- Development of a flexible and open inclusive environment.
- Wide range of recruitment sources (starting from internet to external agencies, this diverse sources includes many experiences and encourages employees working together to think of different, new and better solutions).

4.1.3 Evaluating the diversity strategy

In order to evaluate the success of the diversity strategy in Cummins, the corporation designed a year by year diversity plan that provides a guide that included:

1. Meeting customers' expectations and exceeding it.
2. Ensuring that all activities lead to cleaner, healthier and safer environment.
3. Create wealth for all stakeholders.
4. Attract and retain best talents.
5. Create an inclusive environment that fosters innovation.
6. Encourage different viewpoints to boost problem solving and decision making.
7. Increase the competitive skills of the company.

4.1.4. Learned Lesson from the Case study

As a result from adopting the diversity approach for innovation, Cummins was able to satisfy increasing customer expectations and maintain its competitiveness and market share.

4.2 Case Study 2: SCIRT

4.2.1 Background and Problem Statement

Stronger Christchurch
Infrastructure Rebuild Team (SCIRT) is a programme responsible for rebuilding the city of Christchurch in New Zealand after its destruction in the earthquakes of 2010 and 2011. The problem was to rebuild a city that reflects the needs and expectations of its users. Accordingly, this programme was designed with Alliance contract in which as agreement was established between a number of organisations sharing the same interests. This programme aimed to:

1. Connect between the public and private sectors in experience and skills.
2. Encourage sharing information and teamwork.
3. Deal with the risks and seek opportunities in order for work progress (SCIRT, 2016).

4.2.2. Action taken

Innovative ideas were needed in order to rebuild the city. Therefore, they decided to foster innovation through encouraging different types of people to report their innovations through their organisations on monthly basis as a part of the organisation's key Performance Indicators (KPI). Reporting the innovations is connected to the reward system in the contract, which makes the organisations keen on reporting innovative ideas (Noktehdan et al, 2015).

4.2.2 Impact of action taken

More than 500 innovative ideas were reported to the programme which resulted in offering solutions for problems faced by the operational team (Noktehdan et al, 2015). In addition, the programme continued and was successful, as 99 percent of the designed plans have been implemented.

4.2.3 Learned Lesson from the Case Study

This case study showed that the use of diverse people to generate ideas increased innovation and helped in resolving arising problems and building the city and increased the collaboration between the private and public sectors.

4.3 Case study 3: Diversity in construction

4.3.1 Background and Problem Statement

"Diversity in Construction" is a project held in Scotland, aiming to allow a diverse workforce in the construction industry. This project is initiated by "Equate Scotland" in partnership with "Skills Development Scotland". "Equate Scotland" is an organization concerned with gender equality (Equate Scotland, 2016). After the recession of 2008, the Construction industry became one of the least attractive professions, which resulted in a skills shortage (RICS, 2015). In addition, employees lost their motivation to perform, which led to low job performance and absence of innovative ideas (Egan, 1998; Agapiou, 2002).

4.3.2 Action taken

The project decided to allow more females to apply and work in the construction profession.

4,3,3 Impact of the actions taken

Applying workforce diversity through engaging female employees in the Construction industry provided a wide pool of talented employees, which in turn resulted in better job performance (Equate Scotland, 2016).

4.3.3 Learned lessons from the Case Study

This case study proved that applying diversity (gender diversity), results in widening the pool of talented employees that increases the performance and changes the negative image of the construction industry.

4.4 Case study 4: Marshall Construction

4.4.1 Background and Problem Statement

"Marshall Construction" is one of the leading construction firms in Scotland. It was founded in 1983 with the aim of designing a strong company that can compete in market, build a strong relations with clients through increasing their satisfaction and maintain quality standards for the company (Marshal Construction, 2014).

4.4.2 Action Taken

The founders of the company found that the best way to achieve the set goals is through providing a diverse workforce that allows differences and welcomes diverse backgrounds and cultures of people.

4.4.3 Impact of actions taken

Through applying the adopted actions, the firm was able to employ diverse, talented and experienced employees that resulted in allowing the firm to meet the customers' expectations easily, even those who are with different backgrounds and cultures. In addition, the firm was able to compete in the Scottish market. It also built a strong reputation through delivering innovative first class projects (Marshall Construction, 2014).

4.4.4. Learned Lessons from the Case study

This case study shows that diverse workforce can result in increasing the company's competitive skills and increases its innovation levels.

Table (2) Comparative Analysis of the Case Studies

Case Study	Problem faced	Solution	Learned Lesson
Cummins	Fierce Competition Wide increase in customers' expectations	Embrace diversity Flexible environment Wide range of recruitment sources	Diversity helps to satisfy the increasing customers' expectations and maintains competitiveness
SCIRT	New Zealand's 2010 and 2011 earthquakes, led to destruction in the city's infrastructure	Encourage a wide pool of employees to report their innovations through applying a reward system	they were proactive and prevented facing problems in the construction phase
Equate Scotland	Construction industry negative image Skills shortage Low performance Loss of motivation	Allow females to apply more for construction profession	Provide a wide pool talented employees Change the negative image of the construction industry
Marshall construction	Their aim was to Compete in market Increase the customer's satisfaction	Providing a diverse workforce	Diversity increases competitive skills and innovation levels

5 FIELD STUDY

5.1 Overview and Response Rate

A survey questionnaire conducted with a representative sample of 44 ADFs that are registered in the Egyptian Engineers Syndicate in Cairo Region for 2015/2016, to investigate the role of diversity towards fostering innovation in developing countries. Out of 44 firms that received the survey questionnaire, 30 firms responded, representing a response rate of 68.18% that supports the research findings and recommendations

5.2 Summary of the Survey Questionnaire

5.2.1 General Information

The surveyed ADFs are of range of positions and experience, which by its turn enriches the research with different points of views with regard to diversity and innovation.

5.5.2 Diversity

- 66.7% of the respondents showed that they were aware of the concept that reflects awareness and knowledge of the surveyed ADFs.
- 45.4% of responded ADFs applied diversity in their system, due to the benefits reflected from it such as: Promoting mutual respect (56.7%), Solving conflicts (70%), Improves organization's reputation (53.3%), Improves organization's performance (66.7%), and allow employees to learn new skills (73.3%).
- 33.3% of respondents did not apply the diversity, which is due to lack of awareness (39%), lack of education (42.2%), difficulty in communication (50%), absence of diversity in recruitment process (46%).

5.5.3 Innovation

- 86.7% of respondents showed that they were familiar with the concept, which reflected their awareness.
- The types of innovation applied in these ADFs are product innovation (26.7%), design innovation (70%), tool innovation (36.7%), function innovation (53.3%), technology innovation (60%), method innovation (46.7%).
- The used approaches to foster innovation in ADFs are: motivation (80%), providing needed resources (46.7%), offering diversity within workforce (46.7%), providing organizational support (56.7%), other suggested approach from the respondents is providing the needed training.
- 13.3% of ADFs were not familiar with the term innovation due to: lack of organisational support (28%), lack of education (50%), lack of awareness (12.5%), No sufficient training (37.5%).

6 CONCLUSIONS AND RECOMMENDATIONS

This paper investigated the role of diversity as a tool for fostering innovation in ADFs in developing countries. Literature review, case studies and survey questionnaire highlighted the lack of diversity in the construction industry in general and architectural engineering profession in particular, in developing countries, which in turn hinders innovation.

Developing countries are in need for innovation to compete with other countries and transform from Developing to developed countries. Innovation in ADFs is essential for sustaining competitiveness and exceeding customers' expectations. The diverse communities and various skills of architects in developing countries is an opportunity that can be utilised for foster innovation in ADFs in Developing countries. Accordingly, the research recommends developing a strategy to overcome the barriers and foster innovation through managing diversity in ADFs in developing countries. This strategy has to involve different levels of participants and decision makers including government, industry, ADFs and employees.

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Market Availability of Information and Communication Technologies and their adoption in Site Management in South Africa

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ABSTRACT AND KEYWORDS

Purpose of this paper
To present a comparison of the availability of recent Information and Communication Technologies (ICT) and automation technologies and there adoption in construction site management practice by management level practitioners.

Design/methodology/approach
Review of a purposive sample of literature exploring construction site management, Information and Communication Technologies, and their adoption in construction site management process was carried out. Primary data from a global product survey was compared with case analysis of specific recent research on technology adoption in site management process in South Africa.

Findings
It was revealed that there is appreciable local availability, but more external availability of the technologies studied. In view of the collective level of market availability determined, results suggest poor adoption in site management. In addition to factors identified from case analyses, existence of additional challenges is suggested.

Research limitations/implications (if applicable)
Limitations were due to the proliferation of technologies studied, and inherent constraints due to partial use of documented technical data.

Practical implications (if applicable)
The study provides a basis for future research on issues concerning market availability, peculiarities of local and international availability of specific technologies and their adoption via awareness, working knowledge, acquisition and utilisation. Furthermore it presents an opportunity to explore the full spectrum of factors that influence adoption of such technologies in site management and other aspects of construction.

What is original/value of paper
The study explores the market availability of ICT and automation-based products in relation to the adoption of technologies in site management processes, using the construct of local and international availability.

Keywords
Availability, ICT, automation technology, site management, South Africa.

1. INTRODUCTION

The primary research interest here is the availability of ICT and automation technologies that can be exploited for various uses in construction site management, and their adoption in South Africa. This study is based on a recent multi-staged research on the uptake of such technologies in site management in South Africa.

Major concepts in the study include availability as it relates to products and services; adoption of technological innovations; and the application of innovation adoption in construction site management process, bearing in mind the nature of the job, construction environment, strains on site management and the need for ICT adoption. Product availability here refers to the commercial availability of ICT-based products and services, as per local and international availability.

Adoption of innovation/technology adoption is taken from the seminal definition in (Rogers, 2003), which refers to the third step in the process of taking up an innovation for utilisation. Ling et al. (2007) also describe it as the harnessing of innovation for a perceived area of usefulness. For the context of this study, the exploitation of recent ICT for usefulness in construction site management is explored by comparing the market availability of such ICT to their adoption. Furthermore adoption is viewed through the lens of awareness, general use in construction, and use on site, as articulated in Ozumba and Shakantu (2014).

2. LITERATURE BASIS FOR THE STUDY

Site management refers to a complex set of responsibilities, which vary depending on unique project and site situations. It is a demanding job in the sense that efficiency and effectiveness must be achieved (Fryer in Mselle and Manis, 2000). Site management staff must have fair understanding of trades and processes involved, making it a pressured work (Rogers, 2009). The job requires so called 'hard' and 'soft' skills (Shiraz and Hampson in Mselle and Manis, 2000). Effective and timely communication with relevant parties, in addition to change management decisions are equally important (Mselle and Manis, 2000). The site management role playing involves a mix of directing, coordinating and controlling. Present day construction site management places emphasis on effective coordination and management of increased stakeholders' inputs, and diversity of participants (Harrison, Donn and Skates, 2003).

Due to the complexity of site management, the myriad of problems which could emanate from the construction site include health and safety, materials management, information and communication, the human factor, and security (Forster, 1989); poor accountability and consequent poor monitoring and tracking (Mselle and Manis, 2000); challenges of sub-contractor management (Gray, 1992; Rogers, 2009). It is therefore arguable that site management would need enhanced operations for effectiveness; beyond what manual systems could offer in any site scenario. Such enhancements would inarguably emanate more from the exploitation of potential in ICT.

The need to adopt technology would be fulfilled through the awareness of 'process needs' (Ozumba and Shakantu, 2008), and identification and acquisition of relevant and available technology. This argument follows the phenomenon of adoption by perceived needs, which is a known route for technology/innovation adoption in construction, where it has been noted that adoption involves a necessity to fulfil some identified need (Bitner et al., 2000). There is therefore a nexus between availability, awareness, and adoption. There are many factors which influence technology adoption as highlighted by authors such as Ugwu and Kumaraswamy (2007); Begh and Kagioglu (2004); Wilkfross and Lofgren (2007); Kareem and Bakar (2011). However it is arguable that product availability plays a very important role, especially in creating awareness of a product and its potential benefits. Considering the context of South Africa, there is a growing body of research on ICT adoption in the construction industry. However there is a gap in the area of critical exploration of ICT products' availability, in comparison with their adoption, in the specific area of site management.

2.1 The study

The current study explores the availability of ICT-based products and services on the backdrop of recent research on the adoption ICT-based products and services; using the specific context of construction site management processes in South Africa. This study is a sequel to previous studies on ICT adoption in construction in South Africa. The said studies have explored issues around the adoption of recent ICT in site management process, theoretically and empirically. Ozumba and Shakantu (2014) is of particular interest. The authors explored the adoption of ICT in site management, but did not empirically explore the issue of availability, or its possible association with adoption of ICT. As such the current paper explores availability of ICT and possible association with adoption in site management.

3. RESEARCH DESIGN FOR THE STUDY

Further study in this paper is derived from the field investigations of a larger research project conducted between 2009 and 2012. The data utilised in the current paper was collected in 2011. Methodology for the said project was framed around a multi-stage research design, which involved mixed method research, involving a number of strategies. For the current paper, the research design consists of a review of relevant literature which has been presented; Analysis of primary data from a survey of ICT-based products, case analysis of (Ozumba and Shakantu, 2014) on the adoption of ICT-based products in site management by construction practitioners; and a comparative analysis of ICT availability and adoption in site management. The choice of data from Ozumba and Shakantu (2014) is based on the fact that the variables in terms of ICT-based products accommodate all variables investigated in the current study.

The survey strategy was used due to the expected large samples. Although survey research is inclined to inductive reasoning, appreciable quantitative data could also be realised (Saunders et al., 2009). The ICT-based product survey was pitched at a global level. It involved a survey of items of ICT, and then a study of each individual range of products to determine their relevance to the study. Data was sourced from ICT-based products' manufacturers; representatives and vendors; industry publications, websites, brochures and catalogues. Sources were in digital and hardcopy formats. All information used was in the public domain. It was possible to utilise content analysis to extract the relevant information from official technical documentation, as primary data, following descriptions in Leedy and Ormond (2010).

The survey was based on largely pre-determined categories. The sample population was not known due to ICT products proliferation. Thus purposive sampling was used for greater focus. A large pool of brands and ICT-based products was gathered as the effective sample population; numbering 1841 products, identified from 139 brands. To address sampling

issues, a structure was designed to accommodate a wide spectrum of ICT-based products deemed relevant for site management. The structure was made up of Five (5) levels namely: ICT Category, Sub-group, Brand, Sub-brand, and Product. Four (4) ICT categories were created. Seventeen (17) Sub-groups (product types) were selected and a total of Five (5) brands were sampled for each product type amounting to 85 brands. The brands in each product type were then explored for product models available. All together 439 product models (sub-brands) were identified, out of which a final sample of 1635 products or items of ICT were identified. Hence out of 5 layers of sampling, only the first three were truly purposive. The final layer was made up of all identifiable items under each product model or sub-brand.

Figure 3.1 ICT survey data model.

Categories and product types were determined from literature. Brands were chosen based on relevance for the delineated focus of the study, availability, and depth of relevant information about their products. The need to achieve homogeneity was considered since individual groups of ICT in the study were non-equivalent. However Trochim and Donnelly (2008) support the normality of having non-equivalent groups in such a non-experimental study. The sample size was also uniquely limited in order to increase focus and emphasis on relevance to the site management process.

The category represents a broad grouping of related products types. The sub-group level represents individual groups of products under one category. Within each sub-group, five (5) brands or product maker names were studied, which make up the brand level of detail. Within each brand, sub-brands or models are differentiated. The final level of detail within each sub-brand or model is the number of products. Taking the mobile / handheld category for example: A sub-group would be smartphones / cell phones. At the brand level there would be names such as BLACKBERRY; for the model or sub-brand level there would be names such as BLACKBERRY CURVE; at the products level there would be CURVE-8520 and CURVE-9300, among others. In collecting data, occurrence of the relevant ICT item was observed in addition to its availability on the local and international markets.

ICT-based products studied include physical products and services which fall into several predetermined categories as follows: Mobile hand-held devices (MOBILE); Geographic and surveillance devices (GEO-SURV); Sensors and Scanners (SENSE & SCAN); and Hybrid technologies (HYBRID TECH).

3.1 Findings and discussion

The presentation of results starts with the ICT global product survey, and then a comparison with secondary data published in (Ozumba and Shakantu, 2014). The case analysis of the published article is utilised to shed more light on results of the comparison.

3.1.1 Results of ICT product survey

In order to record the occurrence of each ICT, binary coding was used to enter the data (1 = yes/occurrence and 0 = no/no occurrence). Highest value for each product was 1. Table 1 presents a distribution of the number of items studied by category, the brands investigated, models (sub-brands) for each brand name, and number of products per category. Total number of products studied was 1635. Mobile hand-held devices were the most observed, with a total number of 596 products. Geographic and surveillance devices ranked second highest in number, with a very low margin of 3. In addition the Hybrid technology category had the lowest of products observed, with an amount of 87. For Mobile-handheld devices there were 25 brand names in all, with 185 sub-brands amounting to 595 product items or models. For Geographic and surveillance category there were 20 brand names with 109 relevant sub-brands, amounting to 593 products. In the Sensors and scanners category there were 30 brand names and 128 sub-brands, amounting to 359 products. Sensors and scanners have the most brands observed, with 30 brand names recorded. Mobile hand-held have the most sub-brands observed, numbering 185. It also has the highest number of products observed. A summary of surveyed ICT items is presented in Table 3.1.

Table Paper 3.1: Summary of ICT items observed by category, brand, model (sub-brand) and product

ICT	Mobile	Geo-Surv	Sense and Scan	Hybrid Tech	Totals
ICT types	5	4	6	2	17
Brands (ICT type multiplied by 5 brands)	25	20	30	10	85
Sub-brands	185	109	128	17	439
Products	596	593	359	87	1635

Only Hybrid technology category was scored low at all three levels. In addition there is an appreciable difference between the Mobile hand-held category and the rest, when considering the distribution across different levels. Although the Sensors and scanners category has the most ICT

types studied, Mobile hand-held category has the most sub-brands and products. Essentially mobile and hand-held devices have the highest occurrence in the survey, followed by geographic and surveillance equipment.

In line with themes of the study, availability of each item of ICT was recorded under international and local categories. Availability in the paper refers to the item of ICT being commercially available within the local market or that it is available to be ordered from another part of the world. Capacity to order ICT items internationally include access to do so online or through manufacturers' representatives, vendors, and local branch. Data was measured in binary form (1 = available, 0 = not available). For each item the maximum value would be 2, for both local and international availability. Averages were calculated for each sub-group and then grand means were computed to generate a summary for each category of ICT as shown in Table 3.2. Thus grand mean for each category = SUM of (averages for each sub-group in the category), divided by (number of sub-groups in the category). The results are here referred to as availability values.

Table Paper 3.2: Availability values (mean values) for ICT by categories

Mobile	Geo-Surv	Sense and Scan	Hybrid tech	Grand mean
1.96	1.95	1.83	1.8	**1.89**

From Table 3.2 availability values for each category were at 1.8 or above, out of a possible maximum availability value of 2. Individually, Mobile hand-held category and Geographic and surveillance categories ranked the highest with marginal difference in between them, at 1.96 and 1.95 respectively. This pattern is repeated for Sensors and scanners at 1.83 and Hybrid technologies at 1.8.

Table 3.3 presents the detailed analysis of ICT availability by model, sub-brands, brands, sub-groups, and groups.

Table 3.3: Availability analysis of ICT products by sub-group

ICT category	ICT sub-group	Brands	Sub-brands	Models	Availability (Mean values)
Mobile-handheld	Laptops	5	29	128	2.00
	Smart / cell phones	5	112	351	2.00
	Tablet PC	5	7	17	2.00
	Digital Pen	5	7	7	1.80
	Digital assistants/ Handheld comp.	5	30	93	2.00
Geo-surveillance	GPS	5	31	215	2.00

	Surveillance	5	19	234	1.80
	Laser Range Finder / Measurer	5	33	59	2.00
	Digital Surveying instruments	5	26	85	2.00
Sensors & scanners	Alcohol Breath tester	5	33	47	2.00
	Barcode Scanner	5	22	117	2.00
	Biometric Systems	5	20	54	2.00
	Circuit Tracers	5	9	28	1.40
	Concrete Scanners	5	21	41	1.60
	RFID / Auto-ID	5	23	72	2.00
Other hybrid tech.	Collaboration Tech.	5	5	22	2.00
	Machine Control	5	12	65	1.60

With reference to Table 3.3, the grand mean in Table 3.2 was derived by adding the availability means for each five sub-groups and dividing the sum by the number 5.

A total of five (5) sub groups, 5 brand names resulting in 351 products were investigated under Mobile hand-held category. Except for Digital Pen, which has an availability value of 1.8, there is consistency in the commercial availability of sub-groups in this category, at a mean value of 2.

Four (4) sub-groups were investigated under Geographic and surveillance category, resulting in 234 products. The sub-groups also pair closely together with regard to availability. Surveillance equipment though ranking lower, still has an appreciable availability value of 1.8. The total availability value for the sub-groups in this case, 1.95, is close to the maximum value of 2.

Six sub-groups were recorded under sensors and scanners. Availability of products in this case is varied. Four out of the six sub-groups investigated have the maximum average of 2 points for availability. However circuit tracers and concrete scanners have 1.4 and 1.6 respectively. Overall the category average is 1.83 out of the maximum 2 points.

Two sub-groups were recorded in the Hybrid technologies category namely. Collaboration technologies sub-group has the maximum 2 points for availability while machine control has 1.6 points. The category average is appreciable, at 1.80 out of maximum of 2 points.

In summary, Mobile hand-held devices rank highest in the list of available categories, and overall number of products. Out of the 17 sub-groups of ICT investigated, smartphones and cell phones rank the highest for availability, followed by surveillance equipment, General Positioning System (GPS), laptops and barcode scanners. Out of these four sub-

groups, only surveillance equipment has an availability value that is less than the maximum 2 points.

3.1.2 Case analysis of Ozumba and Shakantu (2014)

In Ozumba and Shakantu (2014), awareness values for identified ICT-based products and services were below 50%. The aggregated values for use of ICT in construction, use on site, utilisation of product features, and ICT skills, were likewise quite low. A number of analytical procedures were employed; contingency tables, bar charts, chi=square test of goodness of fit, covariance, and correlation analysis. All tests support the deductions of low values of adoption in site management. Regression analysis was utilised to further explore the deterministic strengths of the variables. Awareness was found to be weaker than some other variables in some instances. Essentially the study concluded that awareness of available ICT did not translate to a commensurate degree of utilisation in site management. However analysis was performed at the aggregated (ICT category level), as opposed to the sub-group, brand, or model level.

3.1.2 Comparison of availability (data from current study) and adoption of ICT in site management (data from Ozumba and Shakantu (2014))

To further explore the association between data on availability from the current study, and data on adoption from Ozumba and Shakantu (2014), Table 3.4 is presented below. The analysis compares adoption (awareness and utilisation) of ICT-based products in site management with their market availability. The comparison is performed at the sub-category level. All values have been converted to percentages for ease of comparison.

Table 3.3: Availability analysis of ICT products by sub-group

ICT category	ICT sub-groups	Aware %	Use in construct %	Use on site %	Availability (Mean values) %
Mobile-handheld	Laptops	100.0	92.6	70.4	100
	Smart / cell phones	100.0	81.5	74.1	100
	Tablet PC	74.1	16.7	14.8	100
	Digital Pen	46.3	3.7	1.9	90
	Digital assistants Handheld comp.	44.4	11.1	11.1	100
Geo-surv	GPS	92.6	68.5	64.8	100
	Surveillance	48.1	20.4	18.5	90
	Laser Range Finder / Measurer	61.1	31.5	29.6	100

	Digital Surveying instruments	64.8	31.5	27.8	100
Sensor-scanners	Alcohol Breath Tester	77.8	37.0	33.3	100
	Barcode Scanner	72.2	22.2	20.4	100
	Biometric Systems	53.7	16.7	16.7	100
	Circuit Tracers	37.0	5.6	5.6	70
	Concrete Scanners	46.3	20.4	22.2	80
	RFID / Auto-ID	14.8	0.0	0.0	100
Hybrid-tech	Machine Control	25.9	7.4	7.4	100
	Collaboration Tech.	40.7	16.7	13.0	80

As shown in Table 3.3, essentially half of each category or items within each sub-group have both international and local market availability. However the association between availability and adoption is varied across the various ICT sub-groups. Of particular interest in the study is the issue of awareness, which is considerably quite low in a number of instances where the ICT is available locally and internationally. Examples include; digital pen, digital assistants/handheld computers, surveillance equipment, circuit tracers, concrete scanners, radio frequency identification (RFID)/ automated identification (Auto-ID) systems, machine control technology and collaboration technologies. The examples mentioned here also have low levels of reported usage in construction generally and on site. Another point of interest is that only few ICT items have corresponding high availability and adoption values. Examples include; laptops, smart/cell phones, and GPS equipment. The rest have appreciable awareness values but very low utilisation values, to compare with their high availability values.

4. CONCLUSION

The study presented here followed on from a previous study on adoption of ICT in site management in South Africa. Utilising case analysis of a previous study as basis, the availability of relevant ICT-based products and services were investigated with the criteria of local and international availability.

Findings suggest that the mobile-handheld devices category has the highest level of availability. However only few of the sub-groups/types investigated, have commensurably high adoption values. While values for awareness vary closely with the availability values, to some extent, values for utilisation do not follow any close order.

Ozumba and Shakantu (2014) suggested that awareness of available ICT and their utilisation in site management do not correlate well. The current study further suggests that availability of ICT does not correlate well

with its adoption in site management. Therefore it would seem that availability, whether local or international, is not stronger than other determinants, which have not been explored in the current study. Findings in the current study supports initial studies on South Africa such as Ozumba and Shakantu (2014) on the knowledge function in ICT adoption; Ozumba and Shakantu (2013) on barriers to ICT adoption; Ozumba and Shakantu (2012) on ICT in site management. Such previous studies are also extended, because of the suggestion that availability of ICT products relevant to site management, does not translate to awareness of such products on the part of relevant practitioners.

The current study provides a complimentary conjecture on product availability, to previous studies investigating ICT adoption in various aspects of construction project management in South Africa. It would however require follow up studies in longitudinal time framework. It would be beneficial to study the challenges to ICT adoption in various aspects of construction within South Africa, differentiating between common and peculiar challenges, and various technology and application areas.

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The effectiveness of Quick Response Codes on construction materials in South Africa

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ABSTRACT AND KEYWORDS

Purpose of this paper
This study explores the use and possible effectiveness of Quick Response (QR) Codes on construction materials in an attempt to improve the construction industry by becoming more technologically savvy.

Design/methodology/approach
This was a qualitative study. A sample of 30 construction material suppliers in the Durban region were purposively selected and interviewed using an interview schedule. Knowledge, experience and the impact of QR Codes on construction materials were examined.

Findings
The main finding of the investigation was that most of the participants are in favour of the concept even though QR Codes are currently not widely used for construction materials in South Africa. Those participants that are using QR Codes on products have given only positive feedback.

Research limitations/implications
The sample of construction material suppliers were purposively selected from the Durban area. A study encompassing other geographical areas is encouraged.

Practical implications
The findings afforded the opportunity to improve the construction materials sector by introducing and implementing QR Codes as a technological advancement in the construction industry.

What is original/value of paper?
This study introduces QR codes to construction material suppliers to promote QR Codes as a technological advancement to the construction industry.

Response to the Conference Theme
Innovation in Construction Means, Methods and Materials

Keywords
QR Codes, Construction Materials, Construction Industry.

1. INTRODUCTION

The study explores and enlightens construction material suppliers on the use and effectiveness of QR Codes in an attempt to improve the construction materials sector by becoming more technologically savvy. It is anticipated that the knowledge generated from this study would afford new insight on QR Codes on how they can be used in construction in order to benefit the South African construction industry. The objective of this study was to explore the awareness of QR Codes to the construction industry material suppliers and to determine its possible effectiveness.

2. CONSTRUCTION MATERIALS

The construction industry is extremely important in any country as the economic development can be measured using the construction industry as one of the indices (Mewomo and Maritz, 2015). Construction projects are complex in nature and takes place in an unprepared, uncontrolled and dynamic environment as each project goes through several phases that leads to completion. Real-time and accurate information is therefore required for sharing amongst all parties involved in order for efficient and effective planning to occur (Sardround, 2012). The performance of construction relies on active participation of contracting parties and resources (Mewomo and Maritz, 2015). Resources are always inputs to any construction project in the construction process (Wibowo, Elizar, Sholeh and Adji, 2016).

One major resource is material. Construction materials are one of the project resources that are dominant in influencing the quality of the construction project (Wibowo, et al, 2016). A vast variety of construction materials is obtainable for the civil engineering and construction structures (Gulghane and Khandvi, 2015). Materials make up sixty percent or more of

the total cost of a construction project depending on the type of the project (Gulghane and Khandve, 2015). Construction materials are therefore an extremely critical element in all construction projects and can make significant contributions to the cost effectiveness of projects (Sardroud, 2012). Projects can be completed within the project budget and deadlines due to the correct use of materials. New technologies can be used in an attempt to improve the identification, tracking, delivery, receipt and location of materials and components (Sardroud, 2012).

3. QR Codes- The next big thing for Construction Materials

The built environment requires an estimate of over 100,000 different materials for construction, operation and maintenance. Materials such as cement in the form of concrete is one of the most heavily consumed materials on the planet, more so than even food or fuel (Skanska, 2017).

Primary building and construction activities make up the market for building and construction materials. Of about R158.6 billion per annum from construction investment, R95 billion is materials, with 60% sold directly to end-users and 40% sold through the distribution channel. Eighteen percent which is R17 billion of the R95 billion of materials are used for additions, alterations as well as the home improvement market (CIDB, 2007).

QR Codes are put on product packaging for information sharing and to increase traffic on websites as buyers are directed to websites to find out more information on the product, brand and company. The objective is to share information and to reinforce the brand (QR Codes for Innovative Product Packaging, 2017).

Packaging sits on shelves and when a potential buyer picks up the product, they have sufficient time to study the product and brand. The use of QR Codes on packaging can be used to connect valuable product information. QR Codes are ideal for waiting in line to pay or order as clients have enough time to take out their smartphones and scan the code for instant information (Divvy, 2016). In the case of sales representatives been busy, QR codes can be inserted in store on the shelf taker so that the customer can scan the QR Code and get valuable information about the product and brand (Marketing Natural Products Using QR Codes, 2017).

The researchers believe that the above methods, even though not part of construction materials can be adapted to construction materials and assist the South African construction industry. Construction materials are extremely important in the industry and QR Codes have the potential to be the driving force towards a more technologically advanced industry. The researchers believe that the ways QR Codes are currently used on packing and shelfs can be adapted to construction materials.

3.1 What is a QR Code?

QR Code which is an abbreviation for Quick Response Codes is a machine readable two-dimensional barcode (Price, 2013). QR Code forms part of a matrix barcode technology. QR Codes are currently in its third generation. The storage capacity did not only increase with each generation but new features were added such as the addition of company logos on QR Codes (Demir, Kaynak and Demir, 2015). Figure 1 depicts a first generation QR code and Figure 2 shows the changes to the now third generation QR code.

Figure 1: First Generation QR Code (Demir, 2015)

Figure 2: Third generation QR Code (Demir, 2015)

QR Codes were first created by a Toyota subsidiary, Denso Wave, in 1994 (Weir, 2010). According to Probst (2012), Denso Wave developed the QR Code in an attempt to improve the manufacturing process and the tracking of vehicles and parts. QR Codes were designed to allow for fast decoding speeds and owe their existence to the development and success of barcodes (Wave, 2016).

The use of QR Codes became widespread in Japan in 2002 which was facilitated by the trend of marketing mobile phones with a QR Code-reading feature. The popularity of the code amongst the general public was due to the sheer convenience because QR Codes are an open code that anyone can use. It was also approved by International Standard Organisation (ISO) in 2000 as one of its international standards. During the spread of the QR Codes globally, new types of codes were developed to meet more specific needs (Wave, 2016).

QR Codes contain specifically located areas for data and recognition that makes detecting and decoding possible. QR Codes use Reed-Solomon arithmetic algorithms to retrieve vandalised areas (Sabreen, 2010). The structure of the QR Code is shown in Figure 3, highlighting the functional elements.

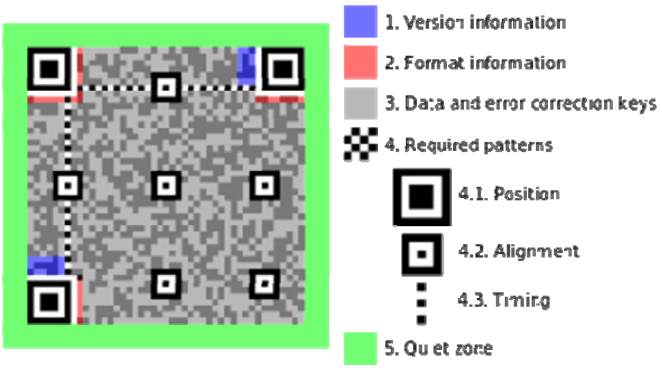

Figure 3: Structure of a QR Code (Sabreen, 2010).

3.2 Advantages and disadvantages of QR codes

The advantages of QR codes are listed below:

a) The main advantage of QR Codes is its versatility which makes it very easy to use. They have been used for almost anything and are beneficial for both the customers and businesses (Estate QR Codes, 2016).
b) QR Codes can store a great deal of information as it is possible to store text, video, advertisement, business card information, personal information and any other type of digital information (Demir, 2015).
c) QR Codes also bridge different forms of marketing streams together as they act as the link that exposes clients to other forms of advertising (Estate QR Codes, 2016).
d) QR Codes are extremely cost effective as there is no startup costs or monthly fees and many QR Code generators and readers are free (Price, 2013 and Gramigna, 2016).
e) QR Codes are extremely easy to make if one has a QR Code generator in possession which can easily be found (QR Code Stickers, 2013).
f) QR Codes can be made by anyone which adds to its benefits (QR Codes Stickers, 2013).
g) Using QR Codes can save paper thereby displaying content in a '*green way*' (Price, 2013).
h) QR Codes can be put almost anywhere as they are relatively small in size (QR Code Stickers, 2013).
i) QR Codes tend to keep the printed marketing costs low as they simply direct the audience to more information about the product, service or promotion, while ensuring valuable print space in the form of brochures and catalogues, for example, are not wasted (Gramigna, 2016)
j) Audience response can be tracked with ease based on specific objectives (Gramigna, 2016).

The disadvantages include:

a) The lack of familiarity of the QR Code is one of the biggest disadvantages and although QR Codes can be found almost anywhere, people do not know how to gain the information they require (Estate QR Codes, 2016).
b) A mobile device or a smartphone is required to gain access to a QR Code (Estate QR Codes, 2016).
c) QR Codes were created to act as a shortcut however they do not provide the simplest customer experience because an app needs to be downloaded to support the reading of the code (Gramigna, 2016).
d) Security issues may arise as before scanning a code, the scanner will not be exactly sure about where it will lead them (Gramigna, 2016).

4. RESEARCH METHODS

This study adopted a qualitative research approach informed by the interpretivist philosophical paradigm. This is due to the fact that QR Codes are relatively new in South Africa and many people may not know what it is or the benefits that it has. The researcher therefore needed to explain the advantages or disadvantages of QR Codes, the way they can be incorporated in the construction materials industry as well as the effect it has on the industry. A sample of 30 construction material suppliers were purposively selected in the Durban region for this study. The data was collected through interviews using a structured format and analysed using thematic analysis. The researcher ensured the same questions were asked to all interviewees and only the correct and accurate responses were used when analysing the data to ensure reliability and validity.

5. FINDINGS AND DISCUSSION

The sample consisted of 5 tile suppliers, 3 paint suppliers, 2 bricks and precast cement suppliers, 1 glass supplier, 5 timber suppliers, 5 carpets and flooring suppliers, 1 truss supplier, 3 electrical and lighting suppliers, 2 blinds suppliers as well as 3 plumbing suppliers.

Only one third of the interviewees knew what a QR Code was. After showing a picture of a QR Code and explaining to the twenty interviewees that did not know what a QR Code is, the researcher found that only one respondent still did not know what it was. This shows that QR Codes are known of but people do not necessary know what it is called. Out of the ten people who knew what a QR Code was, only thirty percent are using them on products while the other thirty percent use QR Codes for payments, advertising or as a link to their website. This clearly indicates that although some suppliers may use it, they have not yet seen the full benefits of QR Codes.

When asked about the type of marketing tools that the company currently uses, 74% of the respondents replied websites and print, 21% replied social media and television and 6% replied by word of mouth. From the literature review, it can be seen that different forms of marketing can be streamed together as QR Codes can act as a link that exposes clients to many different ways of advertising the product. QR Codes can therefore maximise exposure and produce revenue.

The suppliers that were not using QR Codes were then asked why they were not utilising it, 12.5% said they don't see a need for it, 29.5% of them weren't sure and 58% said '*it hasn't been introduced*', '*they haven't thought about it*' or '*the lack of knowledge about it'*. This indicates that more marketing about QR Codes and the benefits of QR Codes need to explained before it can be adopted in a company.

The suppliers who were using QR Codes were asked if they measured the impact of QR codes and the following responses were provided: -

- *"No as we just started using QR Codes."*
- *"It is definitely working."*
- *"It is effective."*
- *"It brought in business."*

Out of the 24 interviewees who were not using QR Codes, only 2 interviewees did not see themselves using QR Codes as a marketing tool in the future with the reasons been given that "*customers already know what they are looking for when they come in the store*". Six of the interviews said maybe. Sixteen interviewees saw themselves using QR Codes as a marketing tool in the future stating the following reasons:

- *"The company tries its best to keep up with technology."*
- *"I will now, that it has been brought to my attention."*
- *"QR Codes are the next big thing."*
- *"It will definitely help."*
- *"I was just in a meeting about better ways to market and communicate so QR Codes has definitely given me an idea."*

The interviewees who were using QR Codes were then asked if they see the company continuing to use QR Codes. The explanation given by a particularly happy respondent was *"We has been using QR Codes for the past 8 years and it has really made a difference. It brought in a lot of business and clients are extremely satisfied with the company and the idea of being technologically advanced. QR codes are very attractive and clients always notice them and ask more about them. This makes them scan QR Codes. Therefore, I definitely see us continuing to use QR Codes as a marketing tool in the future."*

The respondents also discussed other ways in which QR Codes can assist the company such as:

- *Brand awareness;*
- *To assist with making more money and bringing in business;*
- *Marketing;*
- *Advertising;*

- *For compliance as the respondent believed they fail in this regard and QR Codes can now be stamped on the product for effective tracking and communication;*
- *On websites; and*
- *As a payment method*.

Seventy percent of the respondents believe QR Codes are in fashion. This implies that QR Codes are known of and can certainly make an impact on the industry. Twenty five respondents believed that QR Codes is a trend set to grow.

When asked about the benefits of using technology in construction, the following responses were received:

- *"… bringing in more business";*
- *"being easier";*
- *"saving time and paper";*
- *"upgrading equipment and software";*
- *"testing materials";*
- *"cutting out human error";*
- *"assisting with safety regulations"; and*
- *"Assists the entire construction process*".

From the literature review, it was seen that the developers of QR Codes, Denso Wave Incorporated, were contacted to develop barcodes that could hold more information and so developed QR Codes. With QR Codes, information is coded in two directions as opposed to the traditional one-dimensional barcode where information is coded in one direction only. By adding positional information, reading of the code became fast and efficient. QR Codes can therefore be seen as a technological advancement of barcodes and so is a quick and efficient way to move information.

A positive response was received when asked about whether QR Codes can impact construction materials in South Africa, with one of the respondents who is currently using QR Codes responding *"it impacted this company tremendously for the past 8 years"*. Indicating unanimously that the interviewees believe that QR Codes are the way forward for the construction materials sector of South Africa.

According to the literature review, there are many advantages of QR codes and these advantages can be adapted to construction materials. QR codes are versatile which makes QR Codes easy to use. QR codes can be used for almost anything and can benefit customers and businesses. A great deal of information can be stored on the code. The gap between offline print and online pages is eliminated with the use of QR codes. There are no startup costs or monthly fees which makes QR codes extremely cost effective. The generators and readers are free to install and use which makes QR codes user friendly. Once the application is downloaded, it is easy to make the QR codes. QR codes can be made by anyone and can be put anywhere as they are relatively small in size. Paper is saved and so information is displayed in a green way. Responses on QR codes can be tracked with ease based on specific objectives.

Ninety percent of the respondents believe that QR Codes should be implemented in the construction materials sector of South Africa. *"They*

MUST", emphasized one respondent. The negative comments received were that *"QR Codes should not be implemented in the construction materials sector of South Africa because there is no need for it."*

The interviewees were asked if they think there are any implications with using QR Codes. Eighty percent of the interviewees said there was no implications while twenty percent of the interviewees believed there are implications. The explanations given for the implications are:

- "*sales representatives will no longer be needed",*
- *"specifications on the QR Code may be found in the hands of competitors and lack of skills training as not everyone is technologically orientated*."

6. CONCLUSION

QR Codes are set to become '*the next big*' thing due to its vast scope and platform for information sharing. The purpose of this study was to determine the impact of QR codes on construction materials in the construction industry. It was therefore important to develop an interview schedule that could potentially determine if QR codes can make a positive difference in the industry.

The findings showed that the respondents are in favour of QR codes and would like to adopt QR codes as a marketing tool on products even though QR codes are not currently widely used for construction materials. The respondents that are using QR codes have given only positive feedback about the impact of using them. QR codes can therefore assist the construction industry to provide customer satisfaction and convey information simply and effectively while becoming more technologically advanced.

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The efficacy of innovative technology in improving the performance of low costhousing in South Africa: A case study

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ABSTRACT AND KEYWORDS

Purpose of this paper
The purpose of this paper is to evaluate the efficacy of Science, Technology and Innovation (ST&I) interventions piloted on the Kleinmond Sustainable Human Settlement Project.

Design/methodology/approach
Two surveys were undertaken: the first was a condition assessment of the ST&I interventions applied (quantative analysis) and the second to obtain the views of the beneficiaries of the ST&I interventions through structured interviews (qualitative analysis).

Findings
The condition assessment found that the anticipated performance enhancements were achieved. The interviews found the services interventions were perceived as beneficial but that better communication and training on their purpose, performance and use was required.

Research limitations/implications
As there were 411 housing units a representative sample was used for inspection and interview purposes. The condition assessment only considered the outcomes from those ST&I interventions applied and not the development as a whole.

Practical implications
The research has resulted in the development of a viable and sustainable innovative low cost house type. The research also highlighted challenges on how beneficiaries interact with ST&I interventions.

What is original/value of paper.
The paper will be of value to all stakeholders involved in the planning and design of human settlements.

Keywords.
Science, technology, innovation, post-occupancy evaluation, sustainability.

1. BACKGROUND AND CONTEXT

The CSIR was appointed by DST in 2006 to apply, examine, test, and evaluate STI interventions aimed at delivering more cost effective houses of improved quality and providing a more sustainable lifestyle with regard to the development of 411 subsidy-houses in Kleinmond in the Western Cape. The project was formally completed in December 2011.

Anecdotal evidence collected during the construction process indicated that the outcomes of the application of the ST&I interventions held substantial promise in terms of improving quality of life for the poor and meeting sustainability imperatives. In 2015 the CSIR was contracted to undertake a Post-Occupancy Evaluation (POE) to determine the efficacy of the ST&I interventions on improving quality of life.

1.1 Post-Occupany Evaluation (POE)

Preiser, Rabinowitz and White (1988) define POE as “the process of evaluating buildings in a systematic and rigorous manner after they have been built and occupied for some time”. POE forms part of evidence-based design, where the objectives of design decisions can be validated for future use. Proponents of POE note that POE usually involves feedback from the building occupants, through questionnaires, interviews and workshops, but may also involve more objective measures such as environmental monitoring, space measurement and cost analysis. POE proponents note that a POE usually includes a mix of quantitative and qualitative techniques. More recently, PoEs tend to include sustainable measures such as energy consumption, waste levels, and water usage.

1.2 The Kleinmond Sustainable Human Settlement Project

Low cost subsidy housing in South Africa is generally the delivery of basic building with minimal services to reduce costs and to maximise the quantity delivered. Subsidised housing is generally of a poor construction quality (cidb 2011:4). In addition, the design of the house typically limits the extension and alteration of the house with regard to future expansion by virtue of the location of services (kitchen and bathroom) and the direction of the fall of the roof.

While ST&I interventions are generally only applied to the upper end of the housing market in complex buildings the focus on this project was to apply ST&I to subsidised housing to improve its performance with little or no increase in cost. The project is located on steeply falling land adjoining the nature conservation area.

2. REVIEW OF INNOVATIVE TECHNOLOGIES APPLIED

The following section provides an overview of the applied ST&I interventions relevant to this paper. The interventions were aimed at overcoming the structural shortcomings and installing rainwater tanks, solar water heating, and photovoltaic panels.

2.1 Description of the house layout

The house layout is based on a prototype developed by the CSIR (Figure 2.1). The prototype is designed to be expanded without having to remove any component. The house is also capable of entry from either end.

In Kleinmond this flexibility facilitated the orientation of the unit towards the street without compromising the sea views. The roof layout was also modified to facilitate the building of semi-detached units.

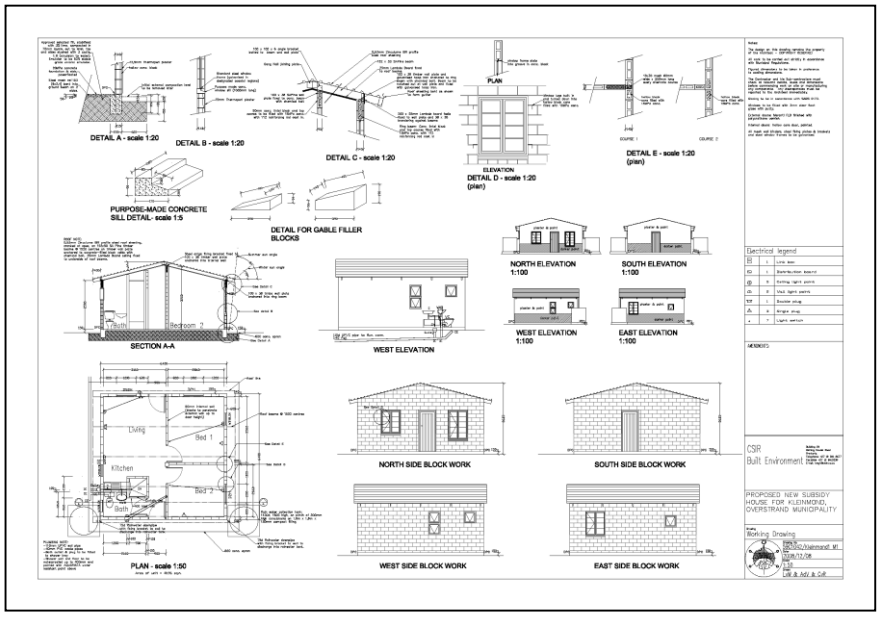

Figure 1.1 Layout of CSIR prototype subsidised house.

2.2 Description of the house construction

As stated above improving the structural integrity of the unit thorugh ST&I intevrneiotns was one of the objectives. To this end an ultra-thin continuously reinforce concrete pavement (UTCRCP) technology was used to form a raft slab. The UTCRCP consists of an ultra-thin (50 mm), continuously reinforced concrete slab with a 400mm deep and 350mm wide concrete foundation downturn ringbeam. This is a new innovation in subsidised housing. Unfortunately, due to concern raised by the local building inspector in Kleinmond, the thickness of the slab was increased to 100mm which reduced the cost benefit from the UTCRCP significantly.

The application of the conventional hollow concrete masony blocks was done in strict accordance with Concrete Manufacturers Association guidelines (CMA undated). Howver, to improve structural integrity the a 390 mm deep reinforced concrete ring beam is formed at wall plate level. A conventional U-shaped lintel block row is built in at door and window head height and is filled with 15 Mpa concrete and reinforced with a single Y12 steel reinforcing bar. With an open hollow block above it, filled with concrete, the effective depth of the beam is 390mm. At the corners of the house, the lintel blocks are 45° mitred for continuity of reinforcing and concrete filling.
This forms a full perimeter beam that binds the entire structure together.

To further improve the structural integrity the house dimensions are all based on modules of 400 mm. This not only avoids unnecessary cutting or breaking of blocks thereby minimising wastage, but also retains the structural integrity of the masonry block. Further to the use of modular dimesnions, precast concrete window sub-frames were installed into which were fixed aluminium framed windows. This aided in improving the joint between the window and the window reveal thereby improving the airtightness of the house.

2.3 Description of the additional services installed

A low-pressure, gravity-fed Solar Water Heater (SWH) of 100 litre capacity was installed to each house. Optimum orientation could be achieved by fitting an adjustable bracket to the ridge of the roof. The heated water is piped to the kitchen sink and the shower. The hand wash basin was not provided with hot water since the intermittent use of small quantities of water, as is normal for hand basins, wastes water while waiting for the water to run warm.

A 80 Watt Photovoltaic Panel (PVP) was provided to each house. This was coupled to a ‘deep-cycle’ battery located in an insulated container in the ceiling. The PVP was wired to supply electricity to 5 Compact Fluorescent Lights (CFL) fittings and a cellphone charger. CFL fittings were installed in lieu of incandescent light fittings as they are more energy efficient. Light-emitting Diode (LED) fittings were investigated but the

replacement cost was beyond the financial means of the beneficiaries at the time.

Each unit was provided with a 2500 litre rainwater tank. No first-flush interceptor was installed, and no provision was made for filtering or treating the water. It was intended that the rainwater be used for gardening purposes or for car washing where it would represent a resource and financial saving to the occupant and to the municipality

3. RESEARCH METHODOLOGY

In order to evaluate the efficacy of the proposed interventions a quantitative and qualitative approach was used.

The quantitative study involved the physical inspection of a sample of the 411 houses using a pre-prepared and piloted survey sheet. The areas of assessment involved the structural integrity of the foundation slab, the walls, and the roof. The functioning of the rainwater tank, the PVP, and the solar water geyser was also assessed. In addition, improvements made to the unit were recorded and a general overall condition rating giving to the unit.

The qualitative study involved interviews with a sample of occupants from the project, municipal officials involved with the project, a local estate agent, the chairperson of the ratepayer's association, and members from the ward committee. The group interview followed a list of structured questions that served to guide the discussions.

4. QUANTITATIVE ANALYSIS

4.1 Sample selection

To expedite the physical inspection a representative sample of houses was selected. The selected houses were chosen at random from an aerial photograph of the development. The selection was done before the physical inspections were done to ensure that no bias was included in the selection process, i.e. selecting only the "best" or "worst". Although the intention was that at least 50 houses would be assessed, a total sample of 65 houses was identified to allow for the possibility that some houses may not be available for inspection due to unexpected logistical problems.

Officials from the Overstrand municipality visited the selected houses to inform the households that they would be visited during the physical inspection and to obtain the written consent of the household, where possible.

4.2 Data collection and capture

The survey team, consisting of four technical staff members from the CSIR, visited the project on Wednesday 28 October 2015 and managed to inspect 56 of the selected houses. Where the households had not given their consent forms to the municipal officials, consent was obtained from the households prior to inspection.

The team used a check-list which had been developed and piloted on houses on the CSIR Innovation Site. After the pilot test, the team discussed aspects of the assessments where team members had differed. Small adjustments were made and definitions clarified. The team then physically inspected each identified unit and took supporting photographs of some of the physical features and the appearance of the unit (permission for this was included in the formal consent form).

The completed checklists were captured into separate MSWord documents by each member of the inspection team, and the associated photographs were added at the bottom of the completed checklist. The data from the checklists was separately captured into an MSExcel spreadsheet and analysed using Statistical Analysis Software Version 9.4 (SAS).

4.3 Data analysis methodology followed

Since the objectives of the condition assessment were to establish the structural soundness of the building units five years after construction with particular reference to the specific structural aspects addressed by the CSIR in the design of the building, as well as to establish whether the technology additions were still in place and working, the data analysis focussed on summarising these portions of the survey. Data analysis consisted mostly of combining the assessment of various features into a combined overall assessment.

4.4 Results obtained

4.4.1 Condition assessment of structure of the houses

The findings presented in Table 1 to Table 8 show an encouraging picture regarding the overall structural condition of the housing units. In order to read the tables, note that the descriptions are ordered from the biggest to the smallest number found in the sample. In each table the percentage that the count represents out of the total sample is also provided. It should be clear that in each of the tables the categories related to small or no structural problems was by far the biggest category. The survey team were able to assess all the aspects on the survey list.

The results indicate that usually more than 80%, sometimes more than 90%, of the houses in the sample either showed no damage or

showed only minor damage (such as hairline cracking) on each of the various structural aspects listed.

Table 4.4.1.1 Summary of foundation slab condition.

Raft Slab Status	Count	Percentgae of Sample
No cracks	52	92.86
Hairline cracks only	4	7.14

Table 4.4.1.2 Summary of external wall condition.

External Wall Status	Count	Percentgae of Sample
No cracks	33	58.93
Hairline cracks only	17	30.36
2 to 5 Substantial Cracks	4	7.14
1 Substanbtial Crack	1	1.79
More than 5 Hairline and Substantial Cracks	1	1.79

Figure 4.4.1.3 Summary of walls around the doors and windows

Cracks around doors and windows	Count	Percentage of Sample
No cracks	26	46.43
Hairline cracks only	21	37.50
2 to 5 substantial cracks	7	12.50
1 substantial crack	2	3.57

Figure 4.4.1.4 Summary of condition of wall at wall plate level

Wall plate level cracks	Count	Percentage of Sample
No cracks	40	71.43
Hairline cracks only	8	14.29
2 to 5 substantial cracks	4	7.14
1 substantial crack	1	1.79
2 to 5 cracks	1	1.79

4.4.2 Condition assessment of the services additions

As stated above each of the housing units was supplied witha rain water tank (RWT), a solar photovoltaic panel (PVP) and a solar water heater (SWH). A condition assessment was performed for these fittings as well.

Figure 4.4.2.1 Summary of observed condition of rain water tanks

Rainwater Tank Status	Count	Percentage of Sample
Present and in good condition	49	87.50
Not used/present	5	8.93
Present but damaged	2	3.57

Figure 4.4.2.2 summary of observed condition of solar water heaters

SWH Status	Count	Percentage of Sample
Present and undamaged	39	69.64
Tubes damaged or missing	14	25.00
Present but not working	2	3.57
Missing	1	1.79

Figure 4.4.2.3 Summary of condition of photovoltaic panels

PVP status	Count	Percentage of Sample
Present and working	28	50.00
Missing	11	19.64
Present, not sure its working	8	14.29
Not present, not working	3	5.36
Present, but damaged	3	5.36
Present not working	3	5.36

4.5 Condition assessment summary

The findings indicate that the houses surveyed are structurally sound. The innovative interventions introduced into the structure of the house appear therefore to be successful. The technology additions were mostly still in place, although some damage had occurred, and are mostly still working.

Since there does not seem to be any reason to suspect that the sample was not representative, the findings from the survey can safely be

assumed to represent the entire development. As such, the survey findings are very encouraging, since it seems that most of the design features have "worked" in the intended way.

Figure 4.5.1 Summary of overall condition assessment score by team

Overall score of house by team	Count	Percentage of Sample
Similar to handover with normal wear and tear	22	40.00
Better than handover condition	19	34.55
Worse than handover condition	9	16.36
Significantly better than handover	5	9.09
Not recorded = 1		

5. QUALITATIVE ANALYSIS

As stated earlier, the qualitative analysis involved interviews with identified stakeholders involved in the project. Invitations were sent to the occupants who had granted consent to the physical inspection of their homes. Of the invitees, 17 attended the discussion session held in the local community hall. While this number may seem low, we were satisfied, in the light of the consensus among participants to the issues raised, that the responses were typical of what might be found in the broader community.

5.1 Occupants response to rainwater harvesting

There was overwhelming endorsement of the rainwater tanks. The respondents were aware that the water quality prohibits human consumption although they described the water as looking 'clean'. The respondents indicated that they use the waster 'as is' from the tank, predominantly for laundry, gardening, and car washing respectively. They indicated that they do not treat the water before use and were not aware of any treatment methods. The respondents indicated that in their experience the tanks do not run empty during the dry, summer months, nor do they overflow during the wet, winter months. The respondents acknowledged that the tanks save them money and that they would have had less water available without the tank. The respondents did indicate that they would have liked a bigger tank as this would enable them to wash large items such as blankets.

It is the view of the interviewers that the appreciation of the water is a consequence of the respondent's background. Many came from the squatter camp where running water is not provided to each shack: occupiers had to collect water from a separate water point some distance away. It is thought that the continual presence of water in the tank is due to their careful management of this resource.

5.2 Occupants response to solar water heaters

There was overwhelming support for the solar water heater. Respondents indicated that they preferred solar water heaters to conventional geysers from an operating cost perspective anyway but not from a usage perspective. The water is used predominantly for dishwashing, personal bathing, and cleaning the floors of the house.

Differing views were expressed regarding the availability of hot water with one respondent indicating that hot water is only available for 2 hours while another indicated availability for 24 hours. On further enquiry it became apparent that the availability was connected to the number of people in the house. In addition, the overcast conditions found in the area impacts negatively on the performance of the SWH. Respondents noted that when there was hot water it was very hot, which is typical of evacuated tubes. Respondents noted that the evacuated tubes are susceptible to damage especially as the children throw stones onto them.

5.3 Occupants response to photovoltaic panels

The group agreed that the PVP was beneficial and that "the panel saves electricity when it works." Respondents noted that replacing the CFLs were more expensive than conventional lights.

The comment relating to "when it works" is probably a result of the overcast conditions predominant in in the area and an rapid draining of the battery. It was noted that there were many hours in the day when it is overcast thus impeding the performance of the PVP. It is also likely that under these conditions the battery is unable to recharge sufficiently and this is likely to have a negative impact on the battery life over time.

6. DISCUSSION OF FINDINGS

6.1 Improved building quality

The visual assessment indicates that the buildings have stood up well over the past five years. The building failures typically associated with low income housing appear to be absent in this project. Where cracks have appeared they are generally consistent with typical settlement cracks.

It is estimated that the UTCRCP reduced the concrete material mass by 1 123 tons (CSIR 2011). Using a weighted average of 0.83 t CO_2/t this equates to a carbon emission saving of 932 t CO_2 equivalent (CSIR 2011).

6.2 Rainwater harvesting

The provision of rainwater tanks is probably the most successful intervention from the beneficiary perspective: this is most likely due to rainwater harvesting being a familiar concept for the respondents. Assuming the tank is filled only once a year about 1 027.5Kl of water may be harvested annually (CSIR 2011). Given the water challenges facing South Africa, enforcing the installation of rainwater tanks should be considered. Greater use of the water could be achieved if a sand filter was attached to the system to improve water quality.

6.3 Solar water heating

The reaction to the installation of solar water heaters was generally favourable. Given that it was a modest installation (only 90 litres) and the greater than usual number of occupants, providing the entire family with sufficient hot water for the duration of the day is not possible. However, a larger installation, obviously at greater cost, would better meet the needs of the occupants. In addition, this installation made use of an evacuated tube units, which comes with the risk of tube damage. Although the unit continues to function, its efficacy is diminished. Future installations should make use of flat plate units which are more robust.

It is estimated that the energy savings associated with SWH amounts to 724 572,45 kWh/annum for the project (CSIR 2011). Together with the PVP electricity generated, it is estmated that the beneficiaries enjoy an overall saving of R2 266.67/annum (CSIR 2011).

6.4 Photovoltaic panels

The PVPs produced the most reaction. The PVPs were tampered with and were not immediately accepted, in part because of the restricted solar exposure and in part because of improper use (not allowing the battery to recharge). Proper training in the use and maintenance of ‘new’ technologies is crucial for them to be used correctly and last the lifetime they were intended to.

It is estimated that on a sunny day the project is collectively generating about 32,88 kW at any point in time from a modest installation (CSIR 2011). The design and installation of a solar farm would have increased the number of panels (from the saving from omitting the cost of the batteries) and allowed the installation of more powerful panels (200 W in lieu of 80 W). This would have undoubtedly increased the electricity generated.

7. CONCLUSION

The stated intention of the intervention was to improve quality of construction and enhance sustainability through the application of ST&I. The POE indicates that these objectives have been met. The study finds that the community has benefitted from the additional investment and that they understand and acknowledge the savings accruing to them as a result of this investment.

The study has however identified a number of areas where greater performance could have been achieved. It is therefore important that future interventions of this kind take note of the recommendations made in the POE.

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An investigation into the employment of persons with disabilities in the KwaZulu Natal (KZN) construction industry

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ABSTRACT AND KEYWORDS

Purpose of this paper
South Africa has a history of oppression and the legacy of the apartheid regime still remains in the form of discrimination. Although a movement away from this discrimination was embarked upon with the change in government in 1994 when apartheid was overturned, the implementation of enabling equity policies have been inhibited by negative issues surrounding the employment of Persons with Disabilities (PWD). Despite the current skills shortage in the KwaZulu Natal (KZN) construction industry, adequately skilled PWD are still overlooked and under-represented. This study aims to examine the attitudes, perceptions and knowledge of potential employers, labourers and PWD as well as the implementation of equity policies in the KZN construction industry to determine why PWD are so underrepresented.

Methodology
A quantitative research method was adopted in which 50 construction firms, 30 labourers and 25 job seeking PWD were randomly selected and surveyed by means of a structured questionnaire. The resulting data was analysed with the Statistical Package for Social Science (SPSS) version 24.

Findings
The results demonstrated that while PWD were capable and willing to participate in the construction process, insufficient commitment to equity policies, a general lack of knowledge by employers about the potential role of PWD, discrimination against PWD through lack of accommodation, and negative attitudes of employers and labourers have hampered the plight of PWD in the KZN construction industry.

Value of this paper
This paper aims to create awareness of the plight of PWD in the KZN construction industry and show that they are a viable resource for alleviating the current skills shortage.

Keywords:
Persons with disabilities (PWD), Contractor, General labour, Employment, Discrimination, Awareness, Accommodation, Able-bodied.

The definition of disability
According to Metts (2000), approximately one in every ten people are disabled worldwide. The lives of persons with disabilities (PWD) - and the quality of their lives - are primarily affected by two disadvantages, namely the disability itself and the response of the general public to their disabilities in the form of discrimination and stigma (Corrigan, 2014).

Maja, Mann, Singh, Steyn & Naidoo (2008)) suggest that the societal stigma related to disabilities can be directly attributed to the misunderstanding of the meaning of the term “disabilities.” It is important to note the difference between the terms “impairment” and “disability.” “Impairment” can be defined as ‘an injury, illness or congenital condition that causes, or is likely to cause, a loss or difference of physiological or psychological function.’ While “disability” denotes ‘the loss or limitation or opportunity to take part in society on an equal level with others due to social and environmental barriers.’ A “disabled person” is described as a person with impairments who experiences a disability resulting from negative interactions with his or her social environment. The impairment is part of the negative interaction between the parties involved, but it is not the cause, nor does it justify someone’s disability (The Northern Officers Group (TNOG), 2015)

TNOG (2015) describes disability as being the function or condition of an individual who is deemed significantly impaired when compared with the standards usually applied to a normal reference group. The term disability is also used to refer to the impairments to an individual’s functioning, physical, sensory, cognitive and intellectual abilities that inhibit the individual from carrying out his/her normal day-to-day activities.

Skills shortage in the South African construction industry.

The South African construction industry contributes 2% - 3% to the GDP and is a key contributor to the alleviation of poverty through the creation of jobs (Lawless, 2005). In the South African construction industry, contracting contributes the most to job creation. The contracting industry is split into 3 parts: Civil engineering; non-residential; and residential. Contractors are reliant on the labour force that predominantly consists of: Unskilled labour; semi-skilled labour; and artisans.

Lawless (2005) shows that there are 422,000 contracting employees in South Africa, making it the fourth largest employer in the country. In theory, this group represents an employment opportunity for PWD as there is little or no formal training required for the basic jobs (e.g. unskilled labourer). However, the meaningful participation by PWD is still low.

According to the South African National Treasury Budget Review (2015), the South African Government will spend R813 billion on infrastructures over the calendar year ending 31 December 2019. These investments will improve access by South Africans to healthcare, schools, water, sanitation, housing and electrification. Development of roads, railways and ports has also been planned. Such developments represent growth opportunities across many of the country's crucial sectors but predominantly within the construction industry.

Wordon (2015) estimated that 800,000 skilled people emigrated in the period 1995-2005 while statistics issued by the Higher Education Department (2015) showed a shortage of 46,000 artisans within South Africa. With this large quantity of skills constantly exiting the country, there may be a need to look outside mainstream able-bodied personnel for skills.

Barriers to the meaningful participation of PWD in the construction industry.

The image of the construction Industry

Rameezdeen (2007) has stated that even though the construction industry is a large contributor to the economy, it has nevertheless been tarnished with a negative image that applies especially to persons with disabilities (Gale, 1994). Research conducted by Ball (1988) has suggested that the construction industry has always been associated with exceeding high costs, chaotic working conditions and has a very poor health and safety record A study conducted by Amaratunge & Haige (2007) has also shown that many people see construction as dirty, non-professional, tedious, dangerous, cyclical and non-technical.

This negative image has caused a widespread belief that there are few worthwhile career opportunities within the construction industry and that for the sake of their own well-being, PWD should have no place in such an environment. The negative image of the construction industry has

caused a negative attitude by jobseekers looking at the construction industry for employment, which, in turn, contributes to the shortage of skills in the industry (Rameezdeen, 2007).

Construction industry attitudinal barriers towards persons with disability

Potential employers see PWD as permanently incompetent. The adoption of this negative attitude has caused the potential employers to be closed to the possibility that persons with disability can perform certain designated functions and they tend to focus instead on all the functions PWD cannot do. This negative focus has caused a chronic prejudice in the work place that sees potential employers discouraging PWD by making the route to employment for PWD very difficult (Lagadien, 1996).

Cheshire (2002) conducted research in the United Kingdom that showed that employers, concerned with maximising their profits, feel that employing PWD will reduce their profit margin. This feeling has caused employers to adopt a negative employment attitude towards PWD and entrenches a feeling of prejudice towards them that excludes assessing the possibility of their employment.

Health and Safety view

A study conducted by Lagadien (1996) has shown that potential employers see PWD as a threat to their holistic health and safety planning and implementation. According to the Health and Safety Executive (2014) there are ways of dealing fairly with PWD and affording them equal job opportunities within the lines of health and safety. Further, health and safety covering PWD is a joint venture between the employer and the employee and both parties should be responsible for making sure that PWD are safe at work. One of the key methods of executing this strategy is a risk assessment exercise comprising a careful inspection of things in the workplace that could cause harm to people. The risk assessment enables the employer to decide whether they have made enough provision to prevent harm to their employees or the surrounding community or whether they need to do more (Burgon, 2013). However, employers should not make assumptions about PWD regarding what they can or cannot do. They need to look at each PWD individually and focus a risk assessment on identifying their potential role in the workplace (*ibid.*).

The South African Culture

In the South African context in which there is a significant relationship between culture and business, cultural beliefs and ethics form a large basis for how businesses are run (Maja *et al.,* 2008). Landsdown (2002) has stated that the relationship does not necessarily bode well for the disabled population. In the African cultural context, being disabled has the implication of a punishment for, or a curse on the disabled person's family

and often leads to their ostracism. In addition,the community in rural areas does not frown upon the father of a disabled person abandoning his family and starting a new family. The impact of the stigma often causes the mother - or caregiver - to hide the disabled person from the public to avoid any further victimisation (Landsdown, 2002).

Educational Barriers

The Constitution of the Republic of South Africa states that it is compulsory for all children aged 7 - 16 to be enrolled in school. Studies by the Integrated National Development Strategy (1997) have shown that only 30% of children with disabilities who are within this defined age range are attending school. Statistics South Africa (2011) has shown that more than 35% of disabled children that were supposed to be enrolled in the early childhood development program were not. Children with severe walking and communicating disabilities showed a high prevalence of absenteeism at primary and high school level. This marginalisation and lack of access to education has resulted in a corresponding lack of knowledge and skills. Even employers who were willing to employ persons with disabilities did not because of their lack of basic knowledge (Bachelder & Braddock, 1994).

Active discrimination by not providing reasonable accommodation.

All employees should reasonably accommodate their employees; this is an affirmative action and non-discrimination requirement. The purpose of reasonable accommodation is to afford PWD the opportunity to perform the functions of the job. It refers to modifications or alterations to the way the job is ordinarily performed to allow a suitably qualified disabled person to perform the job. The amount of accommodation depends on the job and its essential functions, the work environment and the type of impairment the person has. (Employment Equity Act No. 55 of 1998).

Legislation.

There are policies that are in place to protect PWD, and these include, inter alia: Section 9 of the Constitution; The Promotion of Equality and Prevention of Unfair Discrimination Act; The Employment Equity Act 55 of 1998; The Labour Relations Act 66 of 1995, chapter viii 1 (f), 10 (1), 11 (b) (2); Code of Good Practice on Key Aspects of Disability in the Workplace, Section 1.1 -1.3; The White Paper on Integrated National Disability 1997; The National Skills Development Strategy 2005 -2010; Broad-based Black Economic Empowerment Act 53 of 2003; and The Occupational Health and Safety Act 85 of 1993

The removal of discrimination in the work environment does not ensure that equality will be achieved. The elimination of unfair discrimination and employment equity are complementary and once the relevant authorities understand this, more practices should be put into

place to further assist the plight of PWD. Without these new practices, there are not enough supportive structures to address the issue of employment of PWD (Marumoagae, 2012).

Although employers cannot employ unsuitably qualified candidates on the basis that they are disabled (Marumoagae, 2012), the Code of Good Practice on Key Aspects of Disability in the Workplace does state that PWD cannot be prejudiced on the basis of lack of experience if they are appropriately qualified and have the capacity to gain the skills needed for the job.

Study objectives

The study objectives are:

- To examine the employment strategy of construction firms in KZN to determine the pervasiveness of the implementation of policies pertaining to persons with disabilities;
- To establish whether there is a skills shortage in the KZN construction industry and whether persons with disabilities are being considered for employment to alleviate such shortages;
- To determine whether there is an underlying prejudice against the employment of disabled persons that prevents their entry into and participation in the KZN construction industry;
- To identify the entry barriers to the KZN construction industry by PWD; and
- To establish whether construction stakeholders actively create opportunities for PWD to participate through making minor changes to construction activities and the work environment.

Methodology

Through a quantitative approach, this study aims to determine why PWD are not considered for positions within the KwaZulu Natal construction industry. The study considers the key factors in the process of hiring PWDs, i.e. the knowledge, attitudes, and perceptions of the stakeholders, the implementation of legislature and the experiences of employers, co-workers and PWD.

Sample

The target populations for this study are: Decision makers within construction firms (to gain insight into the opinion of potential employers); Construction labourers (to gain insight into the opinions of potential colleagues in the construction environment); and PWD capable of performing functions on an active construction site.

Non-probability purposive sampling was adopted owing to the predetermined criteria for participation. Fifty construction firms working in

KZN were surveyed, derived from the Transnet CIDB database. A non-probability convenient sampling method was adopted for the general labourers who would be surveyed at the same time as their employers to enable the use of the responses to either corroborate or refute each other. Where possible, a single general labourer was selected from each responding contractor's company to voluntarily participate on behalf of, and in consultation with the entire able-bodied staff. In addition, there were 25 PWD surveyed from a Construction Education and Training Authority (CETA) accredited learnership. CETA is an organisation that supports training, education and skills development in the construction industry.

Data gathering tool

The structured questionnaire - Due to the sensitive nature of the research topic, the structured questionnaire was chosen. The questionnaire format is commonly known to accurately measure attitudes and opinions both past and present. The formal nature of the structured questionnaire was appropriate as some participants from the target demographic have not had sufficient formal education to properly articulate on paper their responses to open ended questions. Also favouring this method was a consideration of the time constraints that are usually associated with stakeholders in the construction environment and the fact that opinions could be better extracted from a structured questionnaire rather than by being deduced from general responses that are subjective in nature and subject to bias.

Findings

The difficulty of implementing legislature

The majority of respondents suggested that they were familiar with the terms and conditions of the EEA and have policies in place to ensure that they are equal opportunity employers. This was, however, not supported in practice as very few employers employ PWD and the majority stated that, even though they had policies conforming to the EEA, the ideals of the act are not realistically achievable. Most contractors do not implement TAG. Had they been aware of, and implemented TAG, there would be greater chance of systems of compliance being in place to give PWD a chance of fair participation in the construction industry.

Non-conformance is also due to the fact that contractors are not aware of their obligations as per the EEA, and this, in turn, is the result of the lack of enforcement by government sectors which should have prompted contractors to continuously keep abreast of the EEA and implement its policies correctly. The employers further stated that in terms of employment equity they were more concerned with the issues of gender and race than PWD. It was also evident that there was little or no focus on proactively recruiting PWD or promoting PWD within the organisations. It is then fair to say that even though there are some employment equity

policies in place, contractors in the main do not have specific formal written policies that actively address the issue of employing PWD in the KZN construction industry.

Knowledge and awareness of opportunities
Most respondents stated that given the opportunity, adequately skilled PWD could potentially alleviate the skills shortage within the KZN construction industry. PWD have also stated that they are capable of doing many of the construction related functions on site, meaning they are an employment option during the construction phase. However PWD are still struggling to make a meaningful contribution to the workforce within the KZN construction industry and are currently a wasted human resource. Results also show that, despite the fact that PWD are capable of participating in the construction process, many contractors are not fully aware of this and usually consider them a risk. The research showed that they would rather employ able-bodied persons. Further, it was seen that PWD are often deterred by the negative image of the construction industry when pursuing positions. This becomes a vicious cycle as seen by Rameezdeen (2007).

Negative attitudes
Many contractors and labourers have been found to discriminate against PWD by having prejudices that create barriers to their employment. These include the perception that it is too costly to employ PWD in terms of accommodating them. Further perceptions were based on the following beliefs: PWD are not on a par with abled-bodied persons and would reduce profit margins; the employer could face legal action from employed PWD; PWD stay away from work more often than able-bodied persons; PWD do not have the skills required to perform on site; and PWD require extensive supervision that inhibits the construction process.

This study showed that general labour was supportive of PWDs, both of their on-site capabilities and their need for accommodation, and believed that any modifications required would be minor and inexpensive. However, when being directly compared to PWD they did not respond well. They displayed a certain degree of prejudice and hostility towards PWD insinuating that PWD were not better than corresponding general labourers. While this response could be a natural self-preservation response to a potential threat to their jobs, it revealed one of the underlying barriers to the entry of PWDs into the KZN construction industry. The result was a stifling of the potential of PWD so they would not be a threat to the vast majority of able-bodied staff.

This study further revealed that PWD faced discrimination in many forms in the KZN construction industry and employers actively discouraged their employment through the creation of barriers. PWD themselves,

however, still had a very positive view of their potential participation in the KZN construction industry often playing down the need for any accommodation.

Discrimination

This study found that PWD are capable in the working environment. However, despite this finding, it was found that general labourers show hostility when being directly compared with PWD, showing a degree of discrimination towards them. The study has also shown that contractors did not agree with an equal comparison, thinking that it would be a risk to appoint PWD over able-bodied staff. The study shows contractors and general labourers both disagreed that employing PWD will enhance a company's image and agreed it was just for social commitment, nothing more. This attitude shows discrimination by taking the issue of the employment of PWD and the plight of PWD very lightly. The study demonstrated that many contractors believe that PWD want preferential treatment and that it would be very costly to accommodate them. These perceptions have resulted in contractor's failing to both accommodate PWD and to actively implement policies to recruit PWD (which they have a legal obligation to do) as well as showing other incidences of active discrimination.

The resistance to creating special opportunities for PWD

Reasonable accommodation is defined by EEA as: "any modification or adjustment to a job or to the working environment that will enable a person from a designated group to have reasonable access to or participate or advance employment." This study has shown that despite understanding reasonable accommodation, and ensuring their place of work is reasonably accessible by PWD, contractors do not modify training; they do not think that PWD can use the machinery as it stands, and they resist modifying inputs of work functions so as to include PWD.

The study has revealed that in construction the financial bottom line matters; any perceived potential negative change to that bottom line through modification and interruption of continuity is not welcomed. It has further shown that contractors do not monitor PWD when they are employed, do not provide active help, and do not provide risk assessments or exit interviews, therefore they are not aware of what inputs could possibly be changed to accommodate PWD.

Research Limitations

The study was subject to the following limitations: it was conducted in KZN only due to financial constraints and it targeted only contractors as representatives of the construction industry (and not consultants) in order to get an accurate depiction of the "on-site" situation.

For the purpose of this study, the researcher used disabilities that are restrictive but still allow function on an active construction site. The study focused on PWD who have the capacity to function productively in one way or another on an active construction site.

Value of this paper
Skills shortages in South Africa still pose a major threat to the construction sector. In lieu of this threat, this paper proposes to look outside of the norm and to suggest that PWD be used to alleviate the skills shortage in the KZN construction industry.

Conclusions
Findings have shown that even though legislation is in place covering equity policies, it is still difficult to apply these policies. Despite the fact that PWD are suitably qualified to perform certain functions on site, they are not being considered for employment for various reasons including but not restricted to: Negative attitudes of potential employers regarding PWD; lack of knowledge by potential employers regarding employment of PWD; and physical barriers to the participation by PWD and employers' unwillingness to actively accommodate PWD.

By employing PWD, a contractor can potentially improve productivity by increasing the resources available, can fulfil a social commitment to the community by increasing job opportunities for a demographic that is stereotypically known to be inactive, and can enhance the company's image by being equitable (Maja *et al.*, 2008)

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Perceptions on the Cost Provision for Construction Health and Safety in South Africa

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ABSTRACT AND KEYWORDS

Purpose of this paper
This study was done to determine the perceptions, knowledge and practices of contractors to address the legislative and regulatory requirement to price for the cost of making provision for construction health and safety on their projects to enable clients to appoint them using their financial allocations as a basis for such appointment.

Design/methodology/approach
A sample of 42 contractors and sub-contractors were surveyed to determine the level of financial provision that they made for construction health and safety on their projects.

Research Limitations
The research is limited because the findings are based on a sample of 42 contractors and sub-contractors in the KwaZulu-Natal Province, South Africa drawn from the MBA KZN database. The sample could be

considered a purposive convenience sample. The findings may not be generalizable to reflect the perceptions, knowledge and practices of contractors throughout the country. They are however indicative of a trend.

Findings
The findings provide an indication of the trend in financial allowance by industry practitioners for construction health and safety on their projects. The findings confirm that standard forms of contract do not require specific allowance to be made for health and safety. Further, in the absence of specifically accounting for all associated costs related to health and safety it is difficult to accurately determine what the financial provision is and whether the allowances are adequate.

Originality/value of the paper
The findings of this study have implications for the level of financial provision that is adequate for effective management of construction health and safety. Currently no research has been done to determine the best means of determining the adequacy of the financial provision for health and safety on construction projects. This study provides some insight into the difficulty and complexity of this exercise.

Keywords: construction health and safety, financial provision, forms of contract

1. INTRODUCTION

In South Africa the construction industry falls within the services sector which contributes approximately 73% to the national gross domestic product (GDP). It can be seen as goods or services that are paid for, which is considered a cost, as an economic value is placed on the goods or services provided by the construction sector. One of the services provided by the construction sector is the implementation of the health and safety (H&S) regulations, which is paid for. The phrase, “you get what you pay for”, holds true because if contractors have a limited H&S budget the sector must expect to receive poor / sub-standard service delivery. The converse also holds.

By all accounts construction is dangerous. Consequently an increased emphasis on H&S is necessary to reduce the overall cost to the industry (Lin and Mills, 2001) resulting in reducing accidents and improving efficiency. There is general consensus that construction contractors should increase the H&S investment on their projects (Tang, 2004). Arguably, the greater the investment in H&S, the better the H&S performance. However, determining the extent or how much is enough is the challenge. Hinze (2006) argues that construction managers should consider H&S from a purely economic perspective.

It is common practice for contractors to discount their jobs just to win the

tender. H&S often suffers because it is more often than not the first item to face cost cutting. They believe that implementing H&S management systems will cost more. In addition, managerial focus tends to concentrate on production “at cost.” Since H&S is perceived not to improve production, the investment is reduced when a project runs over budget. Contractors prioritise production criteria, regarding resources dedicated to occupational safety as expenditures that have nothing to do with the production aims of the organization - costs rather than an investment (Fernández-Muñiz, Montes-Peón and Vázquez-Ordás, 2009)

2. **INVESTMENT IN HEALTH AND SAFETY**

Construction can do more to improve the standard of H&S performance without marginalising competitive tendering. The H&S well-being of the industry is essential. Its ability to compete with the best in the world market, to attract the best talent, and to have an attractive image and reputation is key (Ikpe et al 2007). H&S management must be viewed as an investment and not as an expense, and that H&S are aspects of production and competitiveness (Ikpe, et al., 2007) which leads to improved and increased service delivery. The bottom line is that it is time for some broad, well considered, and clearly drafted information and guidance for the construction industry to help those who grapple daily with the complex practical problems of compliance (Anderson, 2008) especially in terms of cost. Investment in construction H&S management results in, for example,

- Improved H&S performance, since it reduces the accident rate, and consequently personal injuries and material damage, and simultaneously improves working conditions, which raise employee motivation and reduce their absenteeism;
- Improved organization competitiveness, due to its positive influence on the image, reputation, productivity and innovation of the organization; and
- Improved economic-financial performance, due to its positive influence on the profits and profitability of the organization (Fernández-Muñiz, Montes-Peón and Vázquez-Ordás, 2009).

3. **RESEARCH APPROACH**

The design of any research study is concerned with assembling suitable data for investigating and testing research hypotheses. Further, the methods used to gather information depend on the type of data and the problem to be researched (Welman and Kruger, 2001; Leedy, 1993; Leedy

and Ormrod, 2001). A short quantitative questionnaire was used to determine the extent to which standard forms of contract used in South Africa addressed or referred to construction H&S, which of them included a provision for the cost of H&S, opinions on various approaches to costing for H&S, and whether contractors actually computed the percentage H&S constituted of estimates and project costs (Haupt and Hefer, 2015). The sample comprised of 42 contractors and sub-contractors in the KwaZulu-Natal Province of South Africa who were emailed the instrument after having been identified from the database of the MBA KZN. The sample could be considered a purposive convenience sample.
The findings may not be generalizable to reflect the perceptions, knowledge and practices of contractors throughout the country. They are however indicative of a trend. The data was analysed using SPSS version 22.

4. FINDINGS AND DISCUSSION

All study participants were presented with statements under each of the sub-sections and asked to respond on a 6-point scale as follows:

- Extent of reference to H&S in contracts and documents where 0 = unsure, 1 = nothing, 2 = limited, 3 = neutral, 4 = somewhat and 5 = extensive;
- Extent of agreement with perceptions of costing of and financial provision for H&S where 0 = unsure, 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree; and
- Importance of project parameters where 0 = unsure, 1 = not important, 2 = somewhat important, 3 = neutral, 4 = important and 5 = very important.

The degree of internal consistency or Cronbach Alpha scores for the scales used for the various constructs is shown in Table 1. All constructs were found to have statistically high levels of internal reliability, namely Cronbach Alpha values greater than 0.700. The One-Sample T-test when applied to all the constructs showed that the sample means for all items differed significantly from the neutral value of 3.00 at the 99% confidence interval level.

Table 1. Reliability test

Construct	Cronbach Alpha	No of items
Reference to H&S in contracts and documents	0.773	6
Approaches to costing H&S	0.870	13
Importance of project parameters	0.895	6

Respondents were asked to indicate to which extent H&S was addressed or mentioned in the most prevalent standard forms of contract and documents used in the South African construction industry using a 6-point scale where 0 = unsure, 1 = nothing, 2 = limited, 3 = neutral, 4 = somewhat and 5 = extensive. Their responses are shown in Table 2.

Table 2. Reference to H&S in contracts and documents (%) N=42

Document/Contract	0	1	2	3	4	5	Mean	SD
Standard System of Measurement (SSM)	23.8	31.0	11.9	11.9	7.1	14.3	1.90	1.74
JBCC	23.8	33.3	7.1	11.9	11.9	11.9	1.90	1.74
GCC	38.1	16.7	7.1	19.0	2.4	16.7	1.81	1.88
Model Preambles	33.3	28.6	21.4	11.9	2.4	2.4	1.38	1.28
NEC	52.4	21.4	4.8	9.5	4.8	7.1	1.14	1.60
FIDIC	56.1	24.4	9.8	4.9	0.0	4.9	0.83	1.28

It is evident that H&S was either not addressed or mentioned at all or addressed on a limited basis in contracts and documents commonly used in South African construction. Albeit limited relative to mentioning construction H&S, the Standard System of Measurement (SSM) and the Joint Building Contracts Committee (JBCC) suite of contracts with means of 1.90 were respectively the document and the standard form of contract that made the most mention of H&S. This finding is indicative of the dominance of the usage of these documents and contracts in the industry when compared with the other documents and forms of contract. However, more telling is the large proportion of respondents who were unsure about whether H&S was even addressed or mentioned at all (range 23.8% in the case of SSM to 57.1% in the case of International Federation of Consulting Engineers (FIDIC) suite of contracts). It is likely that because H&S was not given prominence or importance in construction contracts and documents that respondents were uncertain about whether H&S was in reality referred to and to what extent by each document and form of contract.

Respondents were requested to indicate for the periods 2013/2014 and 2014/2015 from their experience what percentage of contract documents had in reality included financial provision for H&S and if so whether that provision was in the form of a provisional sum or a detailed H&S preliminaries section. Their responses are shown in Table 3.

Table 3. Form of provision for H&S in contracts N=42

Form of provision	Mean	SD	Kurtosis	Skewness	Inference
Provisional sum – 2013/2014	3.00	3.92	0.23	1.23	<10%
Provisional sum –	3.35	4.15	-0.547	0.966	>10%<20%

2014/2015					
Detailed H&S Preliminaries – 2013/2014	3.19	3.92	-0.276	1.050	>10%<20%
Detailed H&S Preliminaries – 2014/2015	3.48	4.18	-0.802	0.882	>10%<20%

Evidently, there appears to be for each of the respective periods under study a tendency to use detailed preliminaries more frequently than provisional sums albeit marginally so. Further, there is a rising trend for these forms of provision to be more frequently used over time suggesting that the industry is becoming increasingly aware of the need to allow for financial provision for H&S in contracts. However, despite the growing percentage it is still extremely low which is worrisome after 13 years of introducing specific construction H&S requirements in terms of duties, responsibilities and procedures for all parties involved in the construction process from client to worker.

Respondents were presented with a series of 13 statements that covered perceptions of costing and financial provision for H&S using a 6-point scale where 0 = unsure, 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree. Their responses are show in Table 4.

Table 4. Perceptions of costing of and financial provision for H&S (%) N=42

Statement	0	1	2	3	4	5	Mean	SD
A detailed H&S section should be included in the Preliminaries	4.8	4.8	0.0	7.1	45.2	38.1	3.98	1.30
A detailed provisional sum should be provided for H&S in the Preliminaries	4.8	7.1	4.8	4.8	42.9	38.1	3.81	1.42
Contract document enabled financial provision for H&S promotes H&S	14.3	4.8	11.9	19.0	23.8	26.2	3.74	1.04
H&S specifications are project specific	4.8	0.0	9.5	28.6	35.7	21.4	3.55	1.21
H&S specifications highlight hazards	0.0	4.8	16.7	21.4	42.9	14.3	3.45	1.09
Competitive	14.3	4.8	2.4	9.5	40.5	28.6	3.43	1.71

tendering marginalizes H&S								
Competitive tendering without reference to H&S marginalizes H&S	19.0	2.4	4.8	7.1	33.3	33.3	3.33	1.87
Standard contract documentation generally makes cursive reference to H&S	17.1	4.9	0.0	12.2	58.5	7.3	3.17	1.58
H&S specifications are included with tender documentation	9.5	4.8	9.5	23.8	42.9	9.5	3.14	1.41
Existing contract documentation promotes H&S	14.3	7.1	9.5	19.0	38.1	11.9	3.12	1.71
Appropriate contract documentation promotes H&S	0.0	7.1	2.4	19.0	52.4	19.0	2.95	1.61
H&S specifications include designer 'design and construction' method statements	19.5	12.2	14.6	29.3	17.1	7.3	2.34	1.57
Contractors are afforded the opportunity to price items included in H&S specifications on an equitable basis	14.3	16.7	23.8	16.7	23.8	4.8	2.33	1.49

No respondents agreed strongly with any of the statements. Most respondents agreed that a detailed H&S section should be included in the Preliminaries section of Bills of Quantities (mean=3.98), that at least a provisional sum should be provided for H&S in the Preliminaries section (mean=3.81) and contract documents that enabled financial provision for H&S promoted H&S (mean=3.74). Comments of respondents included

"most effective way to implement H&S from the client's side would be to have a detailed H&S specification and a detailed breakdown of the requirements included in the Bills of Quantities",

"good practice if it is mandated that all Preliminaries Section include a detailed breakdown of Occupational Health and Safety (OHS) requirements for all Contractors to price accordingly at time of tender",

"should be a substantial provisional sum"

.

They tended to disagree that appropriate contract documentation promoted H&S (mean=2.95). One respondent commented:

"Would be beneficial to note it on contract documents, ensuring that one is in line with OHS".

Respondents also tended to disagree that H&S specifications included 'design and construction' method statements (mean=2.34) and that contractors were given the opportunity to price items included in H&S specifications on an equitable basis (mean=2.33). Some comments were:

"This will ensure that tenderers don't gain a financial advantage during the tender process by reducing the cost allocated to H&S",

"It would be nice to see a specific line item for this in Tender requests, so that all contractors quote on a level field",

"Must be specified by client in detail so that all contractors can price on the same basis",

"The construction industry is a competitive one with a competitive tendering process that we as Contractors are obliged to follow. The inclusion of Health and Safety costs in some cases puts us at a disadvantage (re: pricing) due to financial constraints in the project budget as some Clients fail to understand the legal health and safety obligations we as Contractors face",

"It would make the tendering process more equitable".

.

Respondents were requested to provide information about whether their organization computed the percentage that H&S constituted of their tender cost estimates and project costs. From Table 5 it is evident that only 38.1% and 33.3% of construction organizations computed the contribution of H&S to their tender cost estimates and project costs respectively. This finding is indicative of the lack of knowledge of the industry of the necessary financial provision for effective management of construction H&S on their projects as well as the need to track these costs. Of concern is the high proportion of respondents that were unsure, namely 40.5% and 42.9% respectively.
According to one of the respondents,

"*financial provision for projects is difficult due to changing circumstances and site conditions"*.

Table 5. H&S contribution (%) N=42

Cost	Unsure	No	Yes	%
Tender cost estimate	40.5	21.4	38.1	3.6
Project cost	42.9	23.8	33.3	5.9

Respondents were requested to rate on a 6-point scale the importance of various project parameters to their organizations, where 0 = unsure, 1 = not important, 2 = somewhat important, 3 = neutral, 4 = important and 5 = very important.

Table 6. Importance of project parameters (%) N=42

Project parameter	0	1	2	3	4	5	Mean	SD
Project quality	4.8	0.0	0.0	0.0	9.5	85.7	4.67	1.10
Project cost	4.8	0.0	0.0	9.5	85.7	33.3	4.67	1.11
Project time (duration)	4.8	0.0	0.0	0.0	14.3	81.0	4.62	1.10
Project H&S	2.4	0.0	4.8	21.4	14.3	57.1	4.17	1.17
Environment	2.4	0.0	9.5	23.8	28.6	35.7	3.83	1.17
Construction ergonomics	7.1	0.0	2.4	26.2	33.3	31.0	3.71	1.33

From Table 6 it is evident that the various project parameters were all regarded with varying degrees of importance. Project H&S (mean = 4.17) ranked behind the traditional project parameters of quality (mean=4.67), cost (mean=4.67) and time (mean = 4.62) in terms of importance. The industry has clearly not made the requisite paradigm shift to accord project H&S equal importance to these traditional parameters.

Given the high internal reliability of the perceptions of costing of and financial provision for the H&S construct, a new H&S perception variable was created and correlated with the various project parameters using Kendall's tau_b one-tail test. The findings are shown in Table 7.

The H&S perception construct was found to be significantly correlated with the environment, construction ergonomics and project H&S but not project cost, quality and time. This finding suggests that the construct predicts the level of importance that construction organizations accord to the various project parameters.

Table 7. Correlation of H&S perception with project parameters (N=42)

Project parameter	Correlation Coefficient	Significance (1-tailed)
Project cost	0.060	0.320
Environment	0.378**	0.001

Construction ergonomics	0.369**	0.001
Project H&S	0.335**	0.003
Project quality	-0.060	0.320
Project time	0.064	0.310

* Correlation is significant at the 0.05 level (one-tail test)
** Correlation is significant at the 0.01 level (one-tail test)

5. **CONCLUSION**

This study found that the dominant standard forms of construction contract and documents used in South Africa make limited reference, if any, to construction H&S. If there is limited reference to H&S in contracts and documents, and industry practitioners are unaware or uncertain of H&S, it is questionable whether they would make any or adequate financial provision for H&S. There appears to be a trend that increasingly financial provision for H&S is being made in provisional sums and detailed H&S preliminaries. The study found that a detailed H&S section should be included in the Preliminaries section of Bills of Quantities or at least a provisional sum should be provided for H&S in the Preliminaries section. These findings are further emphasised by the qualitative responses received from the survey carried out.

The study also identified that existing contracting documentation did not promote H&S, that contractors were not given the opportunity to price items included in H&S specifications on an equitable basis and that H&S specifications did not include 'design and construction' method statements. Very few construction organizations computed the contribution of H&S to their tender cost estimates or their project costs.

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Views of Construction Accident Analysis in Bloemfontein

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ABSTRACT

Purpose: The reported study examined how infographic analysis of construction accidents can uncover unsafe acts and conditions.

Design: The phenomenology study obtained data through 26 semi structured interviews conducted among contractors and health and safety consultants. The study attempts to respond to “what are the causes of accidents and how important is accident analysis in construction”.

Findings of Empirical Research: Unsafe acts appears to contribute more to accident causation than unsafe conditions. Notable accidents reported include hand cuts, hit and fall, electrocution, struck-by objects and caught between objects. However, the use of (infographic) accident analysis is limited even though most of the interviewees occur with its benefits.

Practical Implications: The leading causes of accidents through unsafe acts and conditions that require the attention of stakeholders were highlighted in the study. The use of infographic analysis, which would visually assist all workers should be encouraged in the industry.

Research limitations/Implications: The study is limited to Bloemfontein in terms of primary data.

Conference Theme: Health and Safety

Keywords: Accident, Construction, Contractor, Infographic analysis

1. INTRODUCTION

The construction industry is designated as one of the industries with high accidents rate in many part of the world, when compared to other industries (Nielson, 2013). Construction accident can be defined as an unplanned,

unexpected, undesirable, and uncontrolled event that occurs by chance to a person involved in work on a construction site (Hamid, Majid, and Singh, 2008). An accident could result in fatalities, injuries and damages to the material or equipment, especially those used during the work, and a loss in a production flow (Hamid, et al, 2008). However, these consequences of accidents show that there are numerous factors that contribute to the manifestation of construction accidents. Workers' poor attitude to safety, working at high elevations, failure of workers to obey safe work procedures (SWPs), negligence, operating equipment without safety device, lack of knowledge and skill, failure to use Personal Protective Equipment (PPE), and harsh work operations are some of the factors (Hamid, et al., 2008). However, there are also various acts of God that cause calamity on site. Some so-called acts of God include rainfall, high wind, flooding, earthquake, and landslides (Kediri et al., 2014).

No matter the origin of an accident, it is important to analyse the event for future mitigation purposes. A range of qualitative and quantitative methods are used for such analysis. One of such qualitative tool is infographics. Infographics, also known as information graphics that is defined as a graphic visual representation of information, data or knowledge is intended to clarify and integrate difficult information quickly and clearly (Siricharoen, 2013). Infographic is not a new technology, but was used mostly in the early 1980s to support the field of journalism to accommodate newsletters, magazines, newspapers, and media reports (Siricharoen, 2013). Media journalism has changed a lot and currently is developed to improve the quality of peoples live, they enable people to react quickly to what they visualize rather than the concept they do not visualize or understand. The infographics is often used to present the survey data, simplify complicated data, explain how something works, and to compare two different theories (Siricharoen, 2013).

For example, the Occupational Safety and Health Administration (OSHA) in the United States of America (USA) through its agency of the Bureau of Labour Statistics (BLS) used infographic tools to present the top four injuries that contributed 57% of the fatality rate in the American construction. The four major's injuries described were, falls, electrocutions, caught between objects, and struck by an object. However, 36% of the injuries were resulted from fall. While 10% of injuries resulted from being struck by objects and 9% was from electrocutions and 2% was from being caught between objects. (OSHA, 2012)The representation conveys excellent information with illustrations.

In global terms, an approximated 60000 fatal constructions accidents occur worldwide annually and one worker dies in every 10 minutes (Yilmaz, 2015). Such information when presented in graphics could arrest the attention of the project team and maybe would speed up the process of a positive attitude towards safety management on site. However, this paper explored

the use of information graphics when analysing the causes of accidents on construction sites, specifically under fall protection, electrocution, caught between objects, and struck by an object.

2. CAUSES OF CONSTRUCTION ACCIDENTS

Accidents experienced on construction sites are unexpected, unplanned and uncontrolled events involving the movement of construction workers, objects, and materials, which may result in injuries, damages, and losses to properties or people (Hosseinian and Torghabeh, 2012). The construction industry is therefore a high-risk industry because there is a high risk of accident occurrence (Nielson, 2014). However, majority of the contractors prioritise the subject of period, cost, and quality over the safety of people working in construction. Furthermore, Hamid et al. (2008) explained that many contractors aim to maximum their profit instead of preventing accidents.

Hamid et al. (2008) stated that 99% of accidents on construction sites are caused by unsafe acts and conditions. Unsafe acts can be defined as a performance of works in a construction site in a manner that may threaten the safety of workers (Nielson, 2014). For example, failure to use PPE, or a failure to warn people about hazards inherent in working activities. Unsafe acts are a violation of an accepted safe procedure, which would allow the occurrence of an accident (Hamid et al., 2008). Similarly, an unsafe condition is a condition in construction sites that is likely to cause an accident, for example, fire and explosion hazards with inadequate warning systems.

Accidents on a construction site can be prevented by establishing the root causes of accidents (Hosseinian and Torghabeh, 2012). However, there are big accidents causation theories that were developed to explain the causes of accidents so that proper actions could be taken to make an improvement. Modern theories are the domino theory, which was created by Heinrich in 1930 and multiple causation theory by Petersen in 1971 (Hamid et al., 2008). These theories are concisely explained in this section.

The domino theory was developed by Heinrich in 1930. It suggests that one event leads to another, then to another and so on, ultimately results in an accident. According to Hamid et al. (2008), this theory points two main concepts. Firstly, people are the basic sources of the caused accidents. Accident occurs merely because people do not comply with regulations of safety. Secondly, the management should be accountable for the prevention of the accidents. Management should provide safety measures to prevent workers from hazardous environments. This theory of causation consists of five dominoes which are ancestry and social environment, a fault of a person, unsafe acts and conditions, accidents, and injuries (Hamid et al., 2008).

The multiple causation theory was invented by Petersen in 1971. Petersen believed that unsafe act and unsafe condition are the two primary features of the event which lead to an accident. However, there are more than one ground which contributes to both unsafe act and unsafe condition that produce the occurrence of an accident (Hosseinian and Torghabeh, 2012).

2.1. INFOGRAPHICS IN THE ANALYSIS OF ACCIDENTS

Siricharoen (2013) defined infographics as the use of a computer-supported interactive representation of data to amplify cognition. However, there are so many ways in which infographics can be utilized, for instance; a recruiting tool, presenting survey data, simplifying a complicated concept, explaining how something works, comparison, interesting facts, raise awareness, and so on (Futterman, 2016). The study by Siricharoen (2013) explained that infographic can be used in the construction industry to highlights the survey data, and to bring closure to unforeseen event. For example, the study by OSHA (2012) showed that every day, on average, two construction workers die of related injuries in the USA and the fact is, one in five workplace fatalities are construction related. The results gathered from a survey data of accidents in construction are usually presented statistically. The graphic representation is useful as statistics and numbers can overwhelm the public to the extent that such data may lose much of its importance. For example, according to statistical data on accident's reports Heinrich deduced that 88% of accidents are caused by unsafe acts of workers;10% occur due to unsafe conditions and 2% occur due to acts of God such as natural disasters (Hosseinian and Torghabeh, 2012). The data can be better presented in graphics that will be easy to explain to everyone on a project. If statistics is organized in an infographic format, it becomes easier to draw meaning from data. Figure 1 shows how data is presented in an infographic format.

Figure 1: Four leading causes of worker deaths on construction sites in USA (Source: OSHA, 2012)

3. METHODOLOGY

An in-depth qualitative approach was adopted for this study to discover the causes of accidents in the construction industry of South Africa. A semi-structured interview was conducted among contractors as well as health and safety consultants. The qualitative approach was seeking to answer, 'what are the causes of accidents and how important is accident analysis in construction', as recommended by Tracy (2013). The interviews were conducted to help in understanding the range of construction accidents problems experienced on the construction site. The researcher adopted non- purposive sample to help in selecting the participants interviewed as recommended by (Mezler, 2014). The reason for using purposive sampling was to help in selecting participants who understand the phenomenon under investigation. The interviews between the researcher and the participants took place face-to-face and were recorded using a cell phone. Thereafter, the cell phone recordings were transcribed and the information, which had less impact on the study, was deleted. The sample of the study resulted to 26 out of 35 participants that initially agreed to be interviewed. The demographic information of the study shows that 62% (16 out of 26) were contractors, while 38% (10 out of 26) were H&S consultants.

4. FINDINGS AND DISCUSSION

The data of this study were analysed by eliminating answers which did not answer the research questions. This section presents the results and discussion based on the analysis of the interview transcripts. Twenty-six (26) interviews were conducted to examine the causes of accidents at construction sites so as to determine the significance of infographics in the analysis of construction accidents, and to comprehend how infographics are applied in the analysis of construction accidents. After the transcription of resultant data from the interviews, explanations in the form of themes were developed.

Factors leading to construction accidents

Most of the participants explained that the construction industry is exposed to numerous factors that cause accidents on sites. The results obtained from the participants revealed the crucial factors influencing accidents on site. Such mentioned factors include poor recognition of hazards, lack of communication, lack of management involvement, lack of proper training, improper use of PPE, damaged machinery, not following instructions, working under the influence of substances (intoxication), and working during adverse weather conditions.

When requested to identify the leading causes of accidents in Bloemfontein, the analysis of the interview transcripts suggest that 14 participants agreed that unsafe acts are the major causes of accidents on construction sites, whereas 12 of them were convinced that accidents at construction sites are caused by unsafe conditions. The participants defined dangerous acts as incorrect procedures and work styles performed by the workers in a manner that may threaten the safety of employees. This may be due to the lack of information from the management. Moreover, the extent of knowledge and skills of employees regarding safe working procedures (SWPs) is also crucial to the proper execution of works. The participants defined an unsafe condition as a condition on construction sites that is likely to cause an accident.

A follow-up question asked the interviewees to rate the top four accidents reported by OSHA in the USA regarding their occurrence in Bloemfontein. In general, the rating from the interviewees indicates that the top four accidents experienced in the USA are not prevalent in Bloemfontein. However, 14 of the participants failed to recall if anyone of the four injuries has occurred on their projects while 11 of them were of the view that such accidents are often experienced on their job sites. However, a contractor explained should they experience accidents on their site; they follow steps shown in Figure 2 to investigate the causes of accidents. The first step to be taken is for the safety officer to inform or instruct the workers on site to stop production, determine if there are injuries or fatalities and apply first aid where necessary. Secondly, the safety officer in cooperation with the site manager should inform the health department in case of serious injury or fatality. The area where the serious injury or death took place would be barricaded for investigation of the cause of the incident or injury and or for determination of the contributing factors. Finally, once an investigation has been finished, the incident should be reported to the closest relevant Department of Labour in the province.

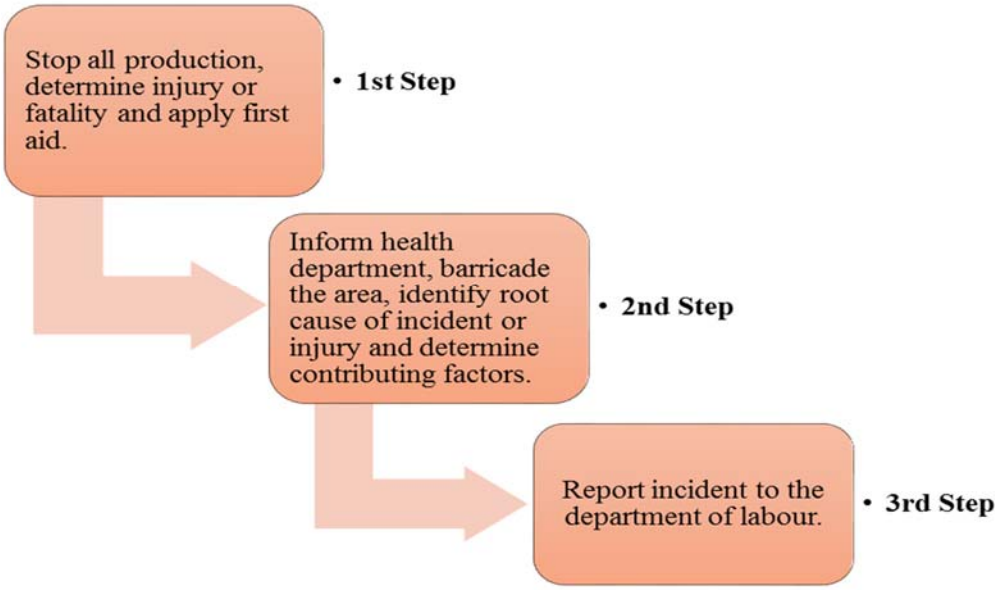

Figure 2: Steps for accident investigation

The follow-up question asked the participants to illustrate the action they are taking should they be exposed to accident. Figure 3 shows a guideline or map which should be followed by the contractors should they be exposed to accidents on construction site. It should be noted that the construction managers are responsible to share information with the safety officer and managers or any person delegated to the management of the project. As stated out in the General Administrative Regulations section 8(3), if an employee is injured on duty, the safety officer or the authorised person must report the incident to the Department of Labour using the WCL2 through fax or email. However, according to the views shared in the interviews, not all injuries or accidents are reported to the Labour Department. Reporting of accidents appears to be influenced by 'compensation'. Most of the participants stated that they only report major accidents and injuries, because such accidents require special treatment and the victims must be compensated, which will involve the Department of Labour.

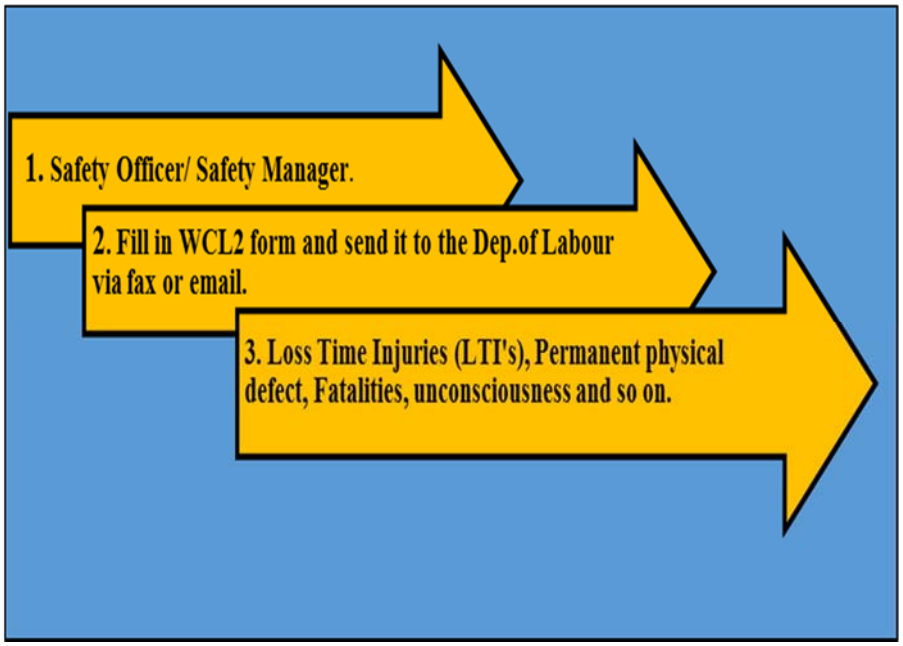

Figure 3: Reporting of accidents to the department of labour

Perceptions of information graphics

It was assumed in this study that a persons' ability to interpret visual images depends on the brain's natural ability to detect objects through processing of shapes, contours, and space. In broad terms, the interviewed participants agreed that infographics on construction sites are very convenient to simplify a complicated concept and explain how 'things' work. The H&S consultants explained that infographics are helpful for carrying out induction training programmes because some of the employees are unable to read or write and relate to work situations; for instance flash reports, induction pieces of training, and toolbox talks. The participants further added that infographics use a combination of images, words, and numbers, and operate in a hybrid system to offer a great opportunity for enhanced effectiveness of a communication. For instance, in construction project event probabilities are simplified to make it easy for workers to interpret up to a point, beyond which further abstraction starts to obscure its meaning.

Furthermore, the participants considered infographics as an essential tool for presenting complicated or complex concepts to workers and public visitors to the construction site. There is numerous type of information that could be presented in a visual format. The information could be spatial, chronological, qualitative, and quantitative. The space information includes

information that describes relative positions and spatial relationships in a physical or conceptual location. Chronological information consists of information that describes following positions and casual relationships in physical or conceptual positions. It should be noted that qualitative information target qualities and information that cannot be measured.

There are also many infographic devices that are utilized in the presentation of various kind of information such as the types. In spatial information, data could be presented using diagrams through icons, sequence, process, timelines and exposition. In chronological information, maps could be used to present data, locator and schematic more likely qualitative information where qualities are presented. Quantitative information could be presented through the application of charts such as flows, bars, and pies.

The participants were asked if they have employed the use of infographics for accident investigations and analysis. It is however notable that most of the participants from the contractors reported that they do not employ the use of infographics for accident investigation and analysis, only a few do it in conjunction with H&S consultants. This was evident in the following response:

> "*Since that, there had been no fatalities occurred in the past few years therefore, there had been no much accidents investigations and analysis. Moreover, infographics are expensive because they require the organisation to have special infographic designers, of which their costs are not normally comprised in the project budgets*".

However, the H&S consultants explained the procedures for the application of infographics in accident investigations and analysis. They clarified that the construction sector is one of the sectors with significant number of illiterate workers, so once a fatality occurs, the workers should be reinstructed based on the recorded accident. Reinstructions could be done through induction trainings and toolbox talks where infographics are presented. The processes, awareness, and warnings with regards to that fatality should be illustrated in a visual format and pasted to demarcated areas on sites. To sum up, the participants contend that communicating induction training information through proficient infographics is the best procedure to eliminate fatalities in construction sites.

5. CONCLUSIONS

This explorative study explored the causes of accidents on construction projects. The paper also went beyond the causes of accidents by highlighting the potentials of infographics in the analysis of construction

accidents. Given that accidents could manifest on a site through a combination of factors that are not limited to poor identification of hazards, lack of communication, lack of management involvement, lack of proper training, improper use of PPE, damaged machinery, not following instructions, and substance abuse, it is essential to communicate with workers and the public with more than one medium. Information graphics has been confirmed to be useful in tool box talks, but its potentials in accident analysis and behaviour modification after an accident should be further explored in the industry.

The construction sector is recognized as one of the sectors where non-educated workers are in a majority, apart from being a multilingual workplace. The use of visual imagery and aids is highly relevant in this context. The use of information graphics would make training sessions convenient and simplified for illiterate workers. The H&S trainings should thus comprise of the combination of text and graphic presentations to optimize communication and to accommodate those who cannot read textual contents. In addition, such combinations of text and graphics are very useful for site trainings. The graphics present the physical context in a specific and precise manner, whereas the textual content complements it with procedural information that would have been less effectively communicated through visual presentation.

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Evaluation of stakeholder influence on affordable housing delivery during production processes

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ABSTRACT

Purpose of this paper
Stakeholder discord has been the main reason for the failure in several instances in the housing production process. Catching and addressing stakeholder interest and participation is fundamental to the success of housing delivery. The fragmented nature of the interest is impeding successful affordable housing delivery. Hence, as interest integration is essential during housing production, there is clear reason for evaluation of stakeholder influence on affordable housing delivery during production process.

Design/methodology/approach
The methodology employed in this study is mixed method approach: Questionnaires were administered to the construction stakeholders in the Western Cape to collect information; data collected were analysed by SPSS version 24, and validated by quantitative interviews.

Findings
Findings obtained revealed several influences on affordable housing: matching stakeholder interest toward requirements; adequate

communication among stakeholders; interaction with stakeholders in a professional and cooperative manner; and the establishment of stakeholder aims, needs and objectives at the planning stage.

Research limitations
Data were collected from construction operators specialising in sustainable affordable housing delivery

Originality and value of paper
Consideration of stakeholder interest at initiation through to the close-out stage for implementation will augment construction cost reduction and the accessibility of housing by the poor. Constant cost reduction will diminish the delay and concomitantly enhance productivity and employment in the construction industry.

Keywords: Affordable, Cost, Housing, Production, and Stakeholders

Theme of the paper is infrastructural design and delivery challenge.

1.0 INTRODUCTION

Stakeholder discord has been the main reason for the flop in several instances in the housing production process. Catching and addressing stakeholder interest and involvement is important to the success of housing delivery. The disjointed nature of the interest is impeding successful affordable housing delivery. Hence, as interest incorporation is indispensable during housing production, there is clear reason for evaluation of stakeholder influence on affordable housing delivery during production processes.

The aim of this study is to establish stakeholder influence on affordable housing delivery during production processes, while the objective of the study is to identify and establish stakeholder influence on delivery of affordable housing within budget.

Identifying stakeholders and understanding their relative degree of influence on the housing production process is critical. Inability to identify these will extend the timeline and raise construction costs substantially. Stakeholders may be interested in monitoring and evaluating housing projects based on their specialised field, making sure that the impact is not greater than what was considered in the planning phase of the housing production process (Wang & Huang, 2006).

Stakeholder engagement for housing delivery is defined as a group of persons or organisations involved in the housing production or whose interest may be positively or negatively affected by the completion of the housing project. Stakeholders may also exert influence over the housing production process, its deliverables, and the team members involved in the housing production process. The management team for housing production

processes is saddled with the responsibility of identifying both internal and external stakeholder involvement. To determine the housing project requirements and expectations of all identified stakeholders involved in the production (El-Gohary, Osman & El-Diraby, 2006; Project Guide 2008).

Stakeholder engagement in housing production are categorised into two groups include *housing provide*r and *users* .The main function of stakeholders is for enhancement of affordable housing production processes through participation in planning, financing, involvement in construction processes, policy formulation, management and self-help processes (Mohlasedi & Nkado, 1999).

Cities of developing nations are urbanising at an unprecedented rate. The population of the people living in urban environments in developing nations is accelerated in concurrent growth, a growth commonly referred to as 'urbanisation of poverty among the people'. Despite the numerous policies implemented by governments, international communities and NGOs, there is still a high proportion of the poor living in cities and towns and as residents in shantytowns. This presents a challenge: decent housing becomes unaffordable. Thus, poor urban households seeking affordable housing are constrained by the high cost of construction. Hence, the proliferation and expansion of compactly populated and overcrowded slum settlements inundated with inadequate amenities threaten residents' health and endangers the environment. Most of the people living in slum settlements are affected by abject poverty and left devoid of employment opportunities (Majale, 2004).

The world is dominated by urbanisation challenges because people believe that jobs are predominantly available in cities. When the hope of finding employment at a particular place or job position is dashed, people suffer disappointment and confusion. Simultaneously, affordable housing becomes a challenge to these poor who are unable to secure a job in the urban area. Consequently, violence and conflict proliferate as a result of urbanization, as idle hands increase in cities. Government and stakeholders of private organisations contribute to this challenging cycle: failure is recorded on the issue of urbanization, then the urban population continues to increase, and then provision of affordable housing and social amenities remains difficult. Worst of all, construction activities, which happen to be drivers of a nation's economy, are partially neglected through inefficiencies of various stakeholders (Muggah, 2012).

Planning starts at a stage when a stakeholder acquaints himself with acres of land available in or surrounding a city and begins to plan for its development for the benefit of local people, including the provision of social amenities. The constant increase in urban population will gradually be cared for in this way. However, there are significant factors that need to be considered by stakeholders for effective planning in urban areas, including the following: quantity and quality of housing, quality water, good roads with effective linkage, industries availability, economic development, productivity increase and income increase for the poor (Levy, 2015).

Hoekstra *et al.* (2010) explained that a housing boom in both developed and developing nations has caused a serious setback in terms of the availability *and* affordability of housing. That young and the poor people pay high prices for housing delivery, despite the constraints of income, is a benefit to developers and homeowners in urban areas around the world. However, it is now time for stakeholders to re-define their planning toward the availability and affordability of housing for low income earners. Still ensuring that, stakeholder interest will be protected.

Despite management support policies established for urban growth by governments of developing nations, lingering problems concerning the development of affordable housing for millions of people remain. Many organisations allege that instruments put in place for the management of growth adversely affect affordable housing delivery. While the effect of growth management on housing affordability has been a subject of considerable research by scholars in planning and economic development, nevertheless, no consensual solution has been reached regarding affordability housing delivery (Down, 2004).

This fact emerged from a comprehensive review of relevant literatures coupled with a preliminary investigation conducted on a construction site revealing that stakeholders' constant involvement in construction activities is substantial to cost effective production. Similarly, conflicts of interests which frequently ignite arguments on site, founded on neglect of interest of stakeholders by contractors, pose serious challenges to effective productivity. This study will endeavour to establish and integrate stakeholder interest for affordable housing delivery within specified budget to consequently improve the availability of housing.

2.0 STAKEHOLDER MANAGEMENT INFLUENCE

Construction stakeholders' negative attitudes can impair effective management of housing production and severely obstruct the effective implementation of construction constraints for affordable housing delivery. Subsequently, the obstruction will result in time and cost overrun as a result of controversies surrounding project design and implementation. The evaluation of stakeholder demands and influence is a compulsory and significant step toward planning, implementation and completion of affordable housing production processes (Olander & Landin, 2005).

Affordable housing delivery attracts the interest of various stakeholders who consequently expresses their needs and expectations. Demand for fulfilment of these needs and expectation stirs conflict among the stakeholders and contractors to the point that individual request will likely remain unfulfilled. The stakeholder management process involves evaluating the needs and expectations of stakeholders in relation to the established objectives at the planning stage of housing production processes. This is of paramount significance for effective output. The

analysis of stakeholder interest at the preliminary stage of housing production will assist construction operators to establish stakeholder interest and formalize the management of stakeholder interest toward affordable housing delivery (Olander, 2007).

Bounne and Walker (2005; cited in Olander, 2007) explained that the ability of construction operators to understand the ubiquitous hidden power and influence of various stakeholders is a critical skill for successful housing production processes. And to the contrary, the inability on the part of construction operators to attend to the needed requirements of end users and the diverse range of interest of stakeholders, means the housing project will not be acclaimed as successful, even if the housing project remains within time and budget specifications.

Stakeholder influence on the housing production process is a crisis threatening the construction industry. The identification and management of stakeholder influence will enhance efficient housing production processes. The promotion of open communication and cultivation of personal interaction with the most influential stakeholders are practical functions of construction operators toward delivery of affordable housing. As constant comparison of needs and interests of stakeholders raises issues that debilitate effective performance of construction operators, adequate communication with stakeholders and consideration of individual interests will curb unnecessary conflict which causes delay and abandonment of housing projects (Pajunen, 2006).

Olander and Landin (2008) clarified that it is natural that stakeholders will wish to influence implementation of housing projects in line with their individual concerns and needs. However, this action poses serious challenges to effective housing production processes. Thus, effective communication should be encouraged among stakeholders to dialogue on the most influential interests and consider the most appropriate interests for enhancing productivity toward affordable housing delivery.

3.0 METHODOLOGY

This research study aims to establish the effect of stakeholder influence on affordable housing delivery during production processes. To this end, relevant literature was reviewed for gathering secondary data and identifying gaps. A preliminary investigation was conducted to collect information concerning the involvement of stakeholders on housing production processes. The methods used to achieve the objective of the study are mixed quantitative and qualitative techniques. The population engaged for the collection of relevant information and data includes project managers, quantity surveyors, contract managers, architects, contractors, site engineers, and a quality assurance manager.

Eighty pilot-tested quantitative questionnaires were administered by hand to construction operators working in the Western Cape to probe

their knowledge and experiences concerning challenges inflicted by stakeholder influence on affordable housing delivery during production processes. Thirty one completed questionnaires were retrieved from construction operators, with five questionnaires voided as a result of errors. Twenty-six questions were analysed, with obtained findings indicating that most of the factors are very important to affordable housing delivery. The findings obtained were used for the main study.

More literature was reviewed in order to gather further information concerning the study; in addition to the pilot study, 456 quantitative questionnaires were administered to construction stakeholders working in the Western Cape of South Africa. Each of the stakeholders was solicited to rank the itemised factors known as a 'challenge influence' to affordable housing delivery in a sequence of 'most challenging' to 'least challenging' for affordable housing production processes on Likert scale ranging from 1-strongly disagree, 2-disagree, 3-agree, and 4-strongly agree.

Seventy-one questionnaires were retrieved. To control the quality of the retrieved questionnaires from the respondents, nine questionnaires were voided. Sixty-two were eventually analysed by SPSS software 24, using descriptive and frequency statistics. Quality control was performed on the questionnaires by employing the techniques of Cronbach's Coefficient Alpha to test for the reliability of data collected. Alpha ranging from 0 to 1: the higher a question's Alpha values, the higher the reliability of that question.

The Cronbach's Coefficient Alpha of sixteen factors considered is 0.7, signifying that the data are reliable (Table 1). Findings obtained were validated by qualitative methods to determine if the instruments used actually measured what they are intended to measure.

3.1 Reliability test result

Table 1: Reliability test

Cronbach's Coefficient Alpha	No. of item
0.7	16

Research limitations

Data were collected from construction operators who specialise in sustainable affordable housing delivery

4.0 DATA ANALYSIS AND DISCUSSION OF FINDINGS

4.1 Respondent position

Critical examination of the findings obtained (as shown in Table 2) depicts that activities on housing projects are primarily between the quantity surveyor and project manager, as ascertained by the percentage of participants; nevertheless, other participants are also significant in the process, all depending on the position of responsibility assigned. This implies that at the planning stage of housing projects, the quantity surveyor and project manager will offer a significant contribution toward proper budgeting for stakeholder needs and interests, through to implementation stage. The inverse is the also case: if young professionals are given the responsibility of managing housing estimates at the planning stage, considering the consequence of stakeholder influence will be a challenge. Subsequently, stakeholder needs and interests will suffer significantly in terms of implementation. Since young professionals who have little experience with affordable housing delivery are the most prevalent on site. Involvement of the most experienced professionals is critical for affordable housing delivery, considering the analysed results.

Table 2: Position of respondents taking part in the survey

Profession of the respondents	No. of participants	Percentage recorded
Quantity surveyor	24	38.7%
Project manager	20	32.3%
Site engineer	6	9.7%
Contract manager	5	8.1%
Contractor	3	4.8%
Architect	2	3.2%
Quality assurance manager	2	3.2%

Findings obtained (Table 3) suggest that the respondents with 1-5 years' experience are young graduates, dynamic professionals within the construction industry. If these young professionals remain in the construction industry, there is a strong probability that these young professionals will gradually acquire more experience and efficiency over time towards improving the productivity of housing projects. Adequate observance of the effect of stakeholder influence on housing production will assist these young professionals to mitigate the challenges that arise frequently during production. However, to afford more stability of efficiency for housing production on site, a significant need exists for more experienced professionals to mentoring the young ones with greater length

of experience – ranging from 11-20 years – to occupy strategic management positions on site. Then the effect of stakeholder influence will be adequately addressed, from the planning stage all the way through to implementation.

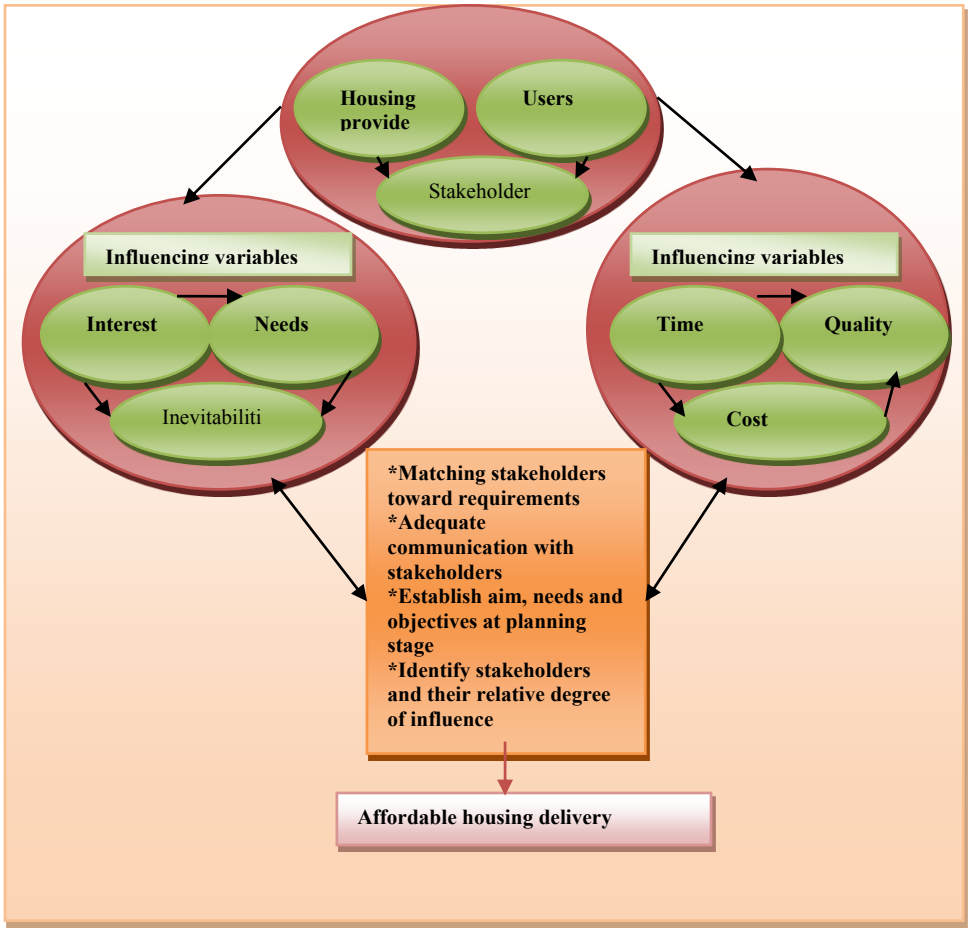

Figure 1 Stakeholders influence on variables of affordable housing delivery during production processes

Table 3: Years of experience in current position

Years in current position	No. of participants	Percentage recorded
1-5 years	34	54.8%
6-10 years	15	24.2%
11-15 years	9	14.5%
16-20 years	4	6.5%

Table 4 presents the analysed data pertaining to factors that affect stakeholder influence on affordable housing delivery during production processes. The Likert scale used for the research study is as follows: 1-strongly disagree, 2-disagree, 3-agree and 4-strongly agree. These results arranged in descending order of importance for stakeholder influence on affordable housing delivery during production. The five highest ranked factors are: matching stakeholder interest toward requirements; adequate communication with stakeholders; interaction with stakeholders in a professional and cooperative manner; establishing stakeholder aims, needs and objectives at the planning stage; and identifying stakeholders to comprehend their relative degree of influence. These mean values of the main factors only vary between 3.80 and 3.22. However, all sixteen factors are significant toward affecting stakeholder influence on affordable housing delivery, since the identified factors' mean scores are all above 3.0.

4.3 Discussion of findings

A *stakeholder* is defined as a person, group of communities or social group that has a stake in activities for designing and producing a product; hence, priority must be given to stakeholders to satisfy their needs and interests. In other words, stakeholder interest can influence the objectives of a project either negatively and positively. The fulfilment of stakeholder interest during housing production is pertinent to cost effectiveness, quality delivery and meeting the time specified for delivery. Those factors identified to impact stakeholder interest and needs are as follows: matching stakeholder interest with housing specification will ultimately achieve delivery of required social amenities; adequate communication amongst stakeholders is essential for the fulfilment of interest and productivity (Figure 1); it is imperative to adequately establish stakeholder aims, needs and objectives at the planning stage of the production process to achieve cost effectiveness (Figure 1). To achieve success in housing production, it is necessary to identify both internal and external stakeholders involved in housing project and understand their relative degree of influence on the formation of project objectives and implementation. Thus, establishment of criteria to measure success in housing production is relative to stakeholder interest from implementation through to close-out of production. Similarly,

Olander (2007) explained that it is essential to institute stakeholder interest at the planning stage of production for implementation of project objectives to be positive.

Table 4: Factors affecting stakeholder influence on affordable housing delivery during production

Significant factors	NO	Strongly disagree	Disagree	Agree	Strongly agree	Means value	Std, d	Rank
Matching stakeholder interest toward requirements	62	1	3	36	22	3.80	3.93	1
Adequate communication with stakeholders	62	0	2	37	23	3.33	0.54	2
Interacting with stakeholders in professional and cooperative manner	62	0	4	34	24	3.32	0.59	3
Establishing stakeholder aims, needs and objectives at the planning stage	62	0	4	37	21	3.27	0.57	4
Identifying stakeholders and understanding their relative degree of influence	62	0	4	40	18	3.22	0.55	5
Establishing degree of influence on time line and increasing construction cost substantially	62	0	2	45	15	3.20	0.48	6
Change cost of production	62	0	4	41	17	3.20	0.54	7
Monitoring and evaluating housing project impact in relation to initial planning	62	0	5	40	17	3.19	0.56	8
Has varying levels of responsibility and authority	62	0	6	38	18	3.19	0.59	9
Impact on requirements	62	0	3	44	15	3.19	0.50	10
Sponsoring of housing project	62	0	11	29	22	3.17	0.71	11
Adequate handling area of specialisation toward implementation	62	0	5	42	15	3.16	0.54	12
Assessment for production process	62	0	6	40	16	3.16	0.57	13
Provide administrative support	62	0	8	37	17	3.14	0.62	14
Conflict of objectives during production	62	0	2	49	11	3.14	0.43	15
Establishing criteria to measure success in relation to stakeholder interest	62	0	12	31	19	3.11	0.70	16

4.4 Qualitative interview
Validation of results obtained through qualitative interview

Interview with respondents A and B

Project manager A and quantity surveyor B, working on a construction site, were solicited to comment on how to *match stakeholder interest toward requirements, and on the impact of adequate communication with stakeholders during housing production.* The project manager explained that objectives of establishing housing projects must be matched with stakeholder interest at the initiating stage through to implementation of housing production to achieve the requirements and necessary amenities. However, achieving requirements basically pivoted on adequate communication amongst contractors and stakeholders, thus influencing affordable housing delivery within cost, time, quality and scope, factors which are the major concern to stakeholders during production. The conflicting of objectives during production can be avoided if there is clarity concerning individual requirements needed in housing.

Respondent B, functioning on the same site with project manager A, explained that achieving stakeholder needs and interests starts at the planning stage when all requirements and interests are considered with budget, time of delivery and quality all specified. Accomplishing positive stakeholder influence can *only* happen if the gap of effective communication is minimised, allowing freedom of expression of interest on the site: This will definitely augment cost effective housing delivery.

5.0 CONCLUSION AND RECOMMENDATION

This study established that stakeholder needs and interests can be positively impacted in many ways: matching stakeholder interest with requirements; adequate communication with stakeholders; interaction with stakeholders in a professional and cooperative manner; establishment of stakeholder needs, aims and objectives at production planning stage; identifying stakeholders and understanding their relative degree of influence; establishing the degree of influence on timeline and on substantial increase in construction cost; and establishment of criteria to measure success in relation to stakeholder interest. Therefore, considering stakeholder interest at the initiating stage through to close-out stage for implementation will augment construction cost reduction, thereby increasing accessibility of housing by the poor. Constant cost reduction will diminish delay while enhancing productivity and employment within the construction industry.

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Feasability of active design

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ABSTRACT AND KEYWORDS

Purpose of this paper
The purpose of the study is to investigate the need for active design and to provide a suitable solution to overcome weight- and health related issues which may influence the profitability of corporate and public spaces. Spaces should be designed in such a way that the active choice will become the most attractive choice (Price, Fenton, 2015: Online).

Design/methodology/approach
Sources of this study will include: books, electronic sources, academic articles, documentation, magazine articels. The Empirical study involved questionnaires sent out to respondents in order to gather information related to their knowledge of active design, the incorporation of active design into current buildings and the personnel contribution of the respondents to maintaining a healthy lifestyle.

Findings
Active design can be incorporated into corporate and residential buildings as well as into open spaces. The main incentive for active design is the global health epidemic or as otherwise stated, the “globesity epidemic”. Through the research it is evident that the factor that has the biggest influence on the lack of active design implementation is ignorance.

What is original/value of paper.
Through the empirical study it was found that information regarding active design is a problem. In contrast to the lack of information is the willingness of participants of this study to partake in healthcare- and reimbursement programmes in their organisations. The main finding is thus that people are positive about the implementation of active design despite ignorance.

Keywords: Active Design; Built environment; Innovation; Quantity Surveyor.

1. INTRODUCTION

Active design is an approach to the development of buildings and communities in such a way that daily activity become more inviting to the public and occupants of the building. Active design will encourage people to be more active in various ways (Burney, 2013: Online).

Active design can be incorporated into corporate buildings as well as public spaces. Workplace health programs can increase productivity. Workplace health programs can also reduce "presentism" – the measurable extend to which health condition and symptoms affect individual work productivity. A workplace health program can lead to big cost savings on absent employees, training programs for replacement employees and overtime costs. With planning and research it can be a feasible and profitable option for any organisation (CDC: Centres for Disease, Control and Prevention, 2005: Online).

Design should make a positive contribution to a normal day in the average person's life. Spaces should be designed in such a way that the active choice will become the most attractive choice (Price, Fenton, 2015: Online).

2. ACTIVE DESIGN

Active design is summarised in the theory that design in the built environment plays a direct role in public health. The architect, building owner, quantity surveyor, landscape architect, etc. focuses on four ways to introduce healthier lifestyles to the public: active recreation, active buildings, alternative transportation methods, and better access to healthier nutrition.

Alternative transportation can involve the design of safer, easier to use cycling routes where active buildings make use of stairs in the place of elevators or lifts (Yaghooti, AIA, AP, 2013: 4). Interior designers and architects can introduce activeness to the public and occupants through increased stair usage. This can be done by the placing and design of the stairs. It is important to make the stairs usable as well as attractive. Building functions can also be located in such a way that mail and lunch rooms requires some walking through appealing and supportive walking routes.

Providing centrally visible active spaces like bicycle storing rooms, fitness centres, showers, locker rooms and drinking fountains will encourage occupants to participate in physical activity. Standing workstations can be incorporated where staff can select to use them if tired of sitting. The shape and layout of the building can be used to support social communicating in the workplace, while water stations can contribute

to the typical “water cooler moment”. Climate, layout and orientation will have an impact on the design of circulation areas, which will have an impact on the type of activeness being participated in within the building (Unknown, 2014: 1).

Despite a continuous effort by health practitioners to encourage people to acknowledge and adopt a more active lifestyle most of the population still are not active enough to achieve maximal, or any, health benefits (McCormack, Shiell, 2011: Online). Physical activity benchmarks can take on many forms. Together with sport and exercise, carrying heavy groceries, gardening and taking the stairs can be as effective as the “white elephant” itself. In many cases thus, this choice need to be taken for the individual. Empirical studies have shown that there is a link between the built environment and physical activity (McCormack, Shiell, 2011: Online). Sport England and Public Health England have drawn up ten principles of active design to create environments that will promote physical activity and healthy lifestyles. These principles can be applied to any form of development. Although not all of the principles will be relevant to the specific choice of application, it will contribute to the approach of a healthier lifestyle when incorporating all of the active design (Price, Fenton, 2015: Online). The ten active design principles include:

Active spaces - parks and open spaces should enable the need to be active and promote activity to those who do not want to be active.

Creating communities that walk - walkable communities should be created by active traveling between schools, corporate businesses, shops and open spaces.

Connected walking and cycling routes - safe, welcoming and well-maintained walking and cycling routes between reachable destinations should invite and prioritise usage.

Co-location of facilities - retail, community and other uses should be co-located. This will create more than one reason to visit a specific destination. This will minimize the number and the length of the trip and make the user more aware of opportunities for participating in physical activities.

Open space networks - a multifunctional space or network should be created across communities to support activities like sport, recreation and play.

Good quality streets and open spaces - flexible, well designed streets and spaces with high quality material and street signage support a broader variety of users and physical activities.

Infrastructure - infrastructure that supports and enables physical activities should be provided in workplaces, public spaces and sport and recreation facilities.

Active buildings - the internal as well as the external building (layout, design and use) should be inviting to physical activities. Opportunities for physical activities must be provided within and outside the building.

Management, maintenance, monitoring & evaluation - the viability, long term maintenance and management of buildings and public spaces should be considered within their design. The success of active design can

be assessed through monitoring and evaluation. This process must be of high standards to ensure future success.

Promoting activity - The importance of participation in sport can be used to promote physical health and wellbeing. Health promotions and local champions should be used to encourage participation is physical activity. The community, stakeholders' ambitions and leadership need to math up to physical measures (Price, Fenton, 2015: Online).

In the UK 1 out of every 6 deaths is the cause of inactivity (Fenton, Price, 2015:3)

Research has shown that physical activity can boost children's education, it improves workplace productivity, reduces absence due to sickness and can also lower crime rates and anti-social behaviour, in fact it is said that just 10 minutes of activity at a time, can deliver health benefits unknown to most (Fenton, Price, 2015:3).

There are certain key elements that need to be considered when colliding activeness and design, these elements include cost, modification, co-location, visibility, site constraints, context, accessibility, comprehensive health approach and regional goals. The cost of active design will determine the feasibility thereof, thus each key element must be considered before any major actions can take place.

3. ACTIVE DESIGN FEASABILITY AND THE QUANTITY SURVEYOR

A Quantity Surveyor, Cost Analysis or Cost Engineer. All of these names represents the same factor namely: cost.

The main question throughout this research still remains the same; is active design feasible? Economical efficient buildings will be more likely to be feasible (Fowler, 2009:12).

Quantity Surveyors provide cost advice and feasibility studies during the inception stage of a project. Feasibility studies provide the client with:

- Accurate cost advice to enter the project with confidence,
- Knowledge about the viability and expected cost of a project,
- Initial costs and budgets related to historical data,
- Knowledge and advice on the layout, construction methods, size and materials to achieve the best quality while being the most economical option (Visser, 2009:18).

An extensive investigation is key when considering a new development. Because of the expensive nature of property development, it is advisable to appoint a Quantity Surveyor in assisting with cost estimating and cost planning (Visser, 2009:18). A feasibility study is conducted to estimate the costs and financial risks that form part of any new development.

With the help of a feasibility study, the Quantity Surveyor can advise and inform his client of the cost of a project and with that, alternative options that the client can look into. A feasibility study is important to distinguish between anticipated risk and real risk for a future project

(Visser, 2009:19). Financial viability is determined through a feasibility study (Visser, 2009:19). Financial viability means that the development will produce inflow that is sufficient in balancing operating cost, outflows and risks to achieve expectations in the short term (Hayes, 2013: 1). A feasibility study will thus confirm the financial viability of the project and provide a financial benefit, in the end, when conducted properly (Visser, 2009:20).

A client must investigate potential risks related to his development to make a decision on the financial viability of the project. A feasibility study must thus be conducted before the project starts. When detailed design has been done, the cost associated with change or variation to those plans will be so big that it will have a negative influence on the feasibility of the project (Visser, 2009:20).

Surplus income, profit and the return periods thereof will be evaluated by the Quantity Surveyor through the feasibility study. The total expense of the project as well as loans, equities and grants will be investigated and the cash flow will be determined. These will all give an indication regarding the financial viability of a project (Visser, 2009:20).

A feasibility study forms part of the project initiation stage within project scope management. A feasibility study will be conducted before the project starts. The project feasibility study consists of three aspects; technical feasibility, economic feasibility, financial feasibility. Technical feasibility refers to the availability of land infrastructure, technological information, management and operational teams' competency, etc. Economic feasibility refers to the positive cost ratios of different technological options. It can also give an indication of the rate of return for the project over its lifetime. Financial feasibility refers to the availability of funds, the cost of money when borrowing it from somewhere else and so forth (Khan, 2006: 12).

4. RESEARCH METHODOLOGY

A qualitative and quantitative research methodology were used to conclude the study and compile the research questionnaire. The questionnaire is based on entry-level questions, marking the relevant box ranging from strongly agree to strongly disagree, testing the knowledge of the participants in respect of active design.

Data was analysed through percentages regarding basic elements of active design to make recommendations. The questionnaire contained 13 questions regarding active design. The first set of questions involved the respondents' knowledge and interest regarding active design. The second set involved the work environment. The aim was to evaluate if the current work environment have implemented active design principles or not. The third set of questions involves personal contribution, the respondents' personal effort to be healthy and the level of importance of a healthy lifestyle were tested.

Due to the fact that active design is new and relatively unknown to South Africans, the questionnaire is based on basic princilples of active design. The response rate was 80% and questionnairs were send to a convient sample of professionals in various industries and sectors to determine the level of knowledge and importance of active design in corportate buildings and open spaces.

5. RESEARCH FINDINGS AND DICUSSIONS

Section A
Section A of the questionnaire tested the knowledge on active design among respondents. 31.25% of the respondents indicated that the are familiar with active design, 37.50% had either heard of active design or had a neutral feeling regarding their knowledge of active design. 31.25% of the respondents had never heard of active design and have no knowledge regarding active design principles.

Question three directly relates to the level of interest of participants to learn more about active design, 93.75% of the respondents showed interest in learning more about active design. This directly relates to fact of the lack of information regarding active design and ignorance in general public, this might be regarded as the key problem in the lack of implementation of active design in corporate and public spaces. Without valuable information and relevant data, active design might not be implemented effectively and efficiently in the built environment. If people are not educated on this topic, the benefits will stay unknown.

Section B focus on the work environment. Questions relating to the internal outlay and other active design principles such as rooftop gardens were used to determine the level of importance that different professions link to healthy employees. The first question (The building has stairs) was to determine if some sort of physical activity is taking place in the building, 72.73% of the respondents indicated that their buildings do have stairs. This represents a positive contribution to active design.

The second question has an indirect focus on the stair usage, it was asked if the particular building has more lifts or escalators than stairs, only 4 buildings have more lifts or escalators than stairs. This represents only 36.36% of the total buildings in this survey, which is another positive contribution to the physical health of employees and employers. Question 4 was to determine if the building offers any form of outside physical activity, only four out of eleven buildings reported a positive answer on this question. This is thus a negative contribution. A question related to health and reimbursement programmes was also included to determine if any connection with profit and health are being made.

56.25% of the respondents indicated that the organisation they work for does offer health care or reimbursement programmes for the participation in physical activity, the other 43.75% reacted negatively to this question.

36.36% buildings had more attractive stairs, leading to more active usage of the stairs. 45.45% questionnaires represented a neutral feeling regarding the attractiveness of the stairs, with the remaining 63.46% that disagreed or strongly disagreed on the attractiveness of the stairs.

In **section C**, personal contribution of the respondents were evaluated. The respondents were asked questions regarding their personal contribution to a healthy lifestyle and to evaluate if they regard a healthy life style to be important.

Question 1 is related to healthy food choices, when asked if the respondents take a healthy lunchbox to work, 12.5% of the respondents had a neutral feeling, 12.5% disagreed and 75% agreed that they do take a healthy lunchbox to work.

Another important aspect is the willingness of individuals to partake in health and reimbursement programmes. Without participation, no active design principle will have any impact on the user. Question 3 of section C addressed the willingness of the participants. Only 6.25% of the respondents not care at all for health and/or reimbursement programmes, 6.25% had a neutral feeling and 87.50% were willing to participate in health care programmes or the like.

Although information on the benefits of active design is still lacking, 81.25% of the participants realize that healthy buildings are important. The other 18.75% still have a neutral feeling regarding the importance of healthy buildings. The last question represents the participants personal experience with using active design principles in the workplace with a positive result, 50% reported a positive experience, this is a remarkable result.

6. CONCLUSIONS AND RECOMMENDATIONS

Throughout this research, the benefits of being active, even if it is just for 30 minutes per day, has been emphasised. The ways in which active design can be implemented sure brought some eye opening options to the table. From the placing of stairs to something as simple as a motivational quote has been proven to be beneficial to the human body. Active design can be incorporated into corporate- and residential buildings as well as into open spaces. The possibility of active design strategies are endless. The main incentive for active design is the global health epidemic or as otherwise stated, the “globesity epidemic

Physical activity has proven itself to reduce stress, improve self-esteem, improve self-respect, improve return on investment and increase profit.

Through this research the factor that has the biggest influence on the lack of active design implementation, is the lack of information thereof being distributed to the public. Only a few truly understands the impact of active design, the cost thereof and the difference it can make.

The quantity surveyor will conduct a feasibility study regarding active design. The feasibility study will have a vast influence on the implementation thereof. When architects, developers and stakeholders can see the costs involved in active design it will change their perception on active design. The feasibility study will also make the “go, no-go” decision.

Through the empirical study it was found that information regarding active design is one of the biggest problems that must be acknowledged. Without the relevant data and information, no organisation will be overly excited to implement active design strategies in their buildings and organisational structures. In contrast to the lack of information is the willingness of participants of this study to partake in health care and reimbursement programmes in their organisations. Most of the participants also felt that healthy buildings are important. Through this realization, many progress can be made. Active design can most definitely be feasible when implemented effectively.

The main finding is thus that people are positive about the implementation of active design, the only thing standing between a profitable organisation and healthy employees are the lack of information.

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Mainstreaming Social Sustainability into Infrastructure Delivery Systems: Are There Any Benefits? A Stakeholders' Perspective

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ABSTRACT

Purpose of this paper
This study seeks to explore the benefits of incorporating social sustainability into the delivery of infrastructure projects within South Africa, albeit from the stakeholders' worldviews.

Design/methodology/approach
This phenomenological study relies on semi-structured interviews for data. Interview transcripts were subsequently analyzed, thematically. Pre-set themes were utilized to ensure construct validity- a critical component for enabling credibility in qualitative research.

Findings
Findings reveal the utility of the social sustainability, when mainstreamed into the delivery of projects, in enabling the successful delivery of projects. However, the costly and time-consuming nature of the consultation processes-an integral part of social sustainability- was highlighted by stakeholders as a shortcoming.

Research implications

This exploratory study contributes to the development of a common definition for social sustainability within South Africa's infrastructure delivery landscape. Further studies will attempt to attain statistical generalization of its findings through the use of questionnaire surveys for a truly representative sample.

Original/value of paper
This study's novelty stems from its bid to explore the benefits accruable from the integration of social sustainability into infrastructure delivery processes.

Keywords
Infrastructure delivery, Phenomenology, Social sustainability, Stakeholders

1. INTRODUCTION

The adverse effect of the anthropogenic activities inherent in the construction industry on contemporary society's quest to achieve sustainable development (SD) has been elucidated (Kibert, 2007). Such effects are more prevalent within the developing economies context as the need to bridge the glaring infrastructural deficit experienced therein has led to the commissioning of several greenfield infrastructure projects, all of which would have an impact on the attainment of sustainable communities. Considering that the relationship between the availability of sufficient infrastructure stock, improved productivity and local economic growth has been buttressed in relevant literature (Esfahani & Ramírez, 2003), countries within this context are most inclined towards improving on their infrastructure stock, a move which would leave unsustainable footprints on the societal landscape.

Although substantial efforts are being made presently to ensure that processes leading to the delivery of new infrastructure assets or the modification of existing ones are aligned with the SD principles. It appears that these efforts have focused on the environmental and economic dimensions of sustainability to a large extent (Dempsey, Bramley, Power, & Brown, 2011; Valenzuela & Albarosa, 2017). Such efforts have given rise to the new taxonomies like '*sustainable construction,'* '*responsible sourcing*,' '*sustainable procurement*,' '*green construction*' etc. The neglect of the social sustainability (SS) dimension in these attempts has been observed. Scholars have buttressed this notion, attributing it to the misunderstood and indefinable nature of SS (Peterson, 2016).

In South Africa, construction industry stakeholders have made attempts to integrate SD dimensions into their respective projects (Du Plessis, 2002). Going by the plethora of literary sources available on this subject matter, it does appear that the country has fared differently from its peers in the developing world by focusing immensely on the environmental, social and economic dimensions during the procurement and eventual delivery of assets (Bolton, 2006; Watermeyer, 1999; Watermeyer, Gounden, Letchmiah, & Shezi, 1998). However, most of the studies into the implementation of sustainability dimensions in the construction industry seem to lay emphasis on the overt concentration of the implementing stakeholders on the environment and economic aspects of sustainability. Implications is a neglect of SS implementation during various phases of the

project delivery lifecycle in the South African context, its mention in existing legislations and policy guides/charters, notwithstanding.

This study seeks to contribute to the emerging body of knowledge on Social Sustainability (SS) dimensions within the construction industry and developing country context respectively by exploring the benefits of its integration into infrastructure delivery systems in South Africa. It relies on the lived experiences of representatives of certain stakeholder groups in the construction industry. Upon the elucidation of the benefits of this dimension on optimal infrastructure delivery, the expectation is that more stakeholders would have cause to adopt and integrate it into every facet of the delivery activity.

To achieve its objective, the paper is structured into the following sections, namely; a review of the relevant literature regarding the relationship between SD and infrastructure delivery systems (IDS) on the one hand, and the realization and operationalization of SS in infrastructure delivery systems. These will be followed by a discussion of the research methodology applied in this study, a presentation and discussion of the findings as well as the conclusion.

2. SUSTAINABLE DEVELOPMENT AND INFRASTRUCTURE DELIVERY SYSTEMS

Discourse in the 21st century. It has been described as connoting the developmental strategies or processes required to attain a desirable utopian state for the present and future society (sustainability) (Boström, 2012). The Bruntland report, published under the auspices of the World Commission for Environment and Development, three decades ago, has been acknowledged as having contributed to the renewed interest in this concept and its tenets. Since then, the uptake of ideals associated with the drive for a sustainable society has intensified.

However, buy-in into this concept in developing economies only grew significantly after the United Nations World Summit on Sustainable Development (WSSD) in 2002 (Rydin, 2012). This summit brought about increased awareness, especially among African nations, concerning the critical nature of SD. Significant frameworks like the millennium development goals (MDG) and its successor, the sustainable development goals (SDGs) were developed and adopted to guide implementation and execution performance measurement, respectively. The latter is expected to govern the actualization of a sustainable society between 2015 and 2030.

Having become a major policy and academic issue, concerns have arisen as to its operationalization within various economic sectors like the construction industry. Such concerns have been premised on the seeming vagueness of the concept. Such vagueness has led to a varied interpretation of what the concept actually means for different stakeholders within different contexts. As part of policy, the desire to achieve SD needs to be premised on the existence of a commonly shared ontology among

various stakeholders. In the absence of this, then its implementation would remain an onerous undertaking.

One area where policy makers believe they can leverage upon to achieve SD is through the delivery of sustainable infrastructure. This implies the procurement, delivery and maintenance of infrastructure assets and services in a sustainable manner. Already, Tawiah and Russell (2005) and Simkoko (1992) have identified project (infrastructure) delivery systems as being pivotal to the success or failure of any policy implementation endeavour. Contributing, Lahdenperä and Koppinen (2009) admit to the significance of effective infrastructure delivery systems in the attainment of a client's objective. They describe a project (infrastructure) delivery system as a type of organizational framework which elaborately sets out the control systems available as well as the relationships between actors and incentives within a particular domain. Expanding on this definition, Awuzie and McDermott (2015) posit that the IDS consists of a representation of all types of interorganisational and multi-layered relationships existing between various stakeholder organisations during the procurement and subsequent delivery of a particular infrastructure asset and the attendant mechanisms for controlling, and coordinating such relationships toward the attainment of project/policy objectives. For a better insight into the relationship between policy and the IDS, see Figure 1. Policy in this case can be the attainment of SD.

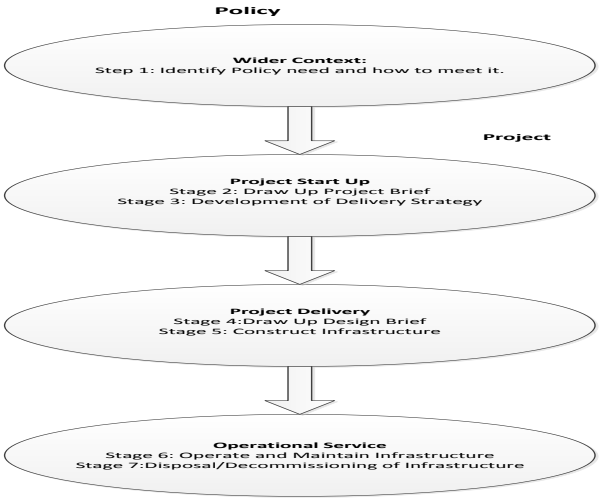

Figure 1: Generic Seven Stage Model for Infrastructure Delivery
Source: UK National Audit Office

Based on the foregoing, the significance of the IDS in the implementation of policies relating to SD attainment can be deduced. Therefore, there is need for effective integration of SD dimensions into the IDS to engender optimal implementation performance. Presently, a cursory

look at the progress reports on various IDSs across South Africa seems to reiterate the dominant nature of the environment and economic dimensions. The SS dimension seems to be neglected due to factors such as its indefinability and lack of parameters/indicators for assessing its impact on project performance. There is a possibility that stakeholders might have been integrating SS into their respective projects unknowingly, due to this indefinability and context-specific nature. Accordingly, this study shall seek to identify and highlight the numerous benefits accruable from the optimal integration of SS dimension into IDSs in South Africa, from stakeholders.

2.1 Integrating Social Sustainability into Infrastructure Delivery Systems

The SS dimension evolved from the broadly accepted categorization of the sustainability into three pillars to enable the operationalization of the concept (Elkington, 1999). Prior to this categorization, sustainability as a concept had remained vague, being used by politicians and policy makers to score cheap political points(Christen & Schmidt, 2012; Sneddon, Howarth, & Norgaard, 2006). However, whereas the economic and environmental dimensions have been accorded significant attention by society, SS is only starting to get some attention (Boström, 2012; Peterson, 2016). Missimer, Robèrt, and Broman (2017) reiterate the non- integration of SS into the Framework for Strategic Sustainable Development (FSSD), a renowned framework for driving SD.

Defying any commonly accepted definition, SS has been considered context-specific unlike other pillars (Dempsey et al., 2011; Littig & Grießler, 2005; McKenzie, 2004). Besides contributing to the attendant vagueness and interpretative flexibility associated with the concept, this indefinability has adversely affected its realization and operationalization in economic sectors like construction (Boström, 2012). According to Abdel-Raheem and Ramsbottom (2016), practicing green construction (environmental sustainability), results in savings in the operation cost on the long run (economic sustainability), and provide healthy work environment for the workforce (social sustainability). Scholars like Dempsey et al. (2011) allude to the dynamic nature of SS, insisting that what connotes SS within a particular context is likely to change over a particular duration. Boström (2012) categorizes these obstacles which exist in relevant literature into two broad categories namely; theoretical and practice-oriented obstacles. Whereas the theoretical obstacles encompass the notion of how to define and understand the concept of social sustainability, the latter is concerned with how to effectively operationalize and integrate the concept into projects.

Also, scholars have evolved different ways of approaching SS. For instance, whereas Magis and Shinn (2009) view the concept from the human well-being, equity, democratic government and democratic civil society perspective, Murphy (2012) opines that SS rests on four dimensions, namely: equity, awareness, participation and social cohesion.

Boström (2012) categorizes SS aspects into substantive aspects- *aspects dealing with what SS goals to achieve in a particular context*; and procedural aspects- *aspects dealing with SS elements that foster sustainable development*. Accordingly, he reiterates that the challenges confronting the incorporation of SS in projects resulted from the lack of attention by stakeholders to the extant synergy between these aspects. Whitton, Parry, Akiyoshi, and Lawless (2015) posit that SS involves aspects such as community cohesion, human well-being, effective dialogue, and access of citizens to decision making levels within their respective communities. Weingaertner and Moberg (2014) explore SS from urban development, companies and products perspectives and conclude that there seems to be a common understanding of what SS entails across these sectors. They provide, three themes for developing such understanding, namely: social capital, human capital and well-being. Also, Vallance, Perkins, and Dixon (2011) attempt to provide clarity in the description of SS by proposing three paradigms namely, development, bridge, and maintenance sustainability respectively. Development sustainability focuses on the satisfaction of tangible or intangible needs of humans whilst bridge sustainability focuses on transforming negative societal behaviour towards the environment and bringing about stronger environmental ethics. Maintenance sustainability pertains to understanding how the social and cultural preferences and features are maintained over a certain duration in a certain context.

From the foregoing, it is evident that a lack of consensus concerning the SS concept still persists within the extant body of knowledge. No doubt, this has further affected the development of a concise set of indicators for measuring the performance of SS integration in projects and thus, its optimal integration along with its peer pillars.

The construction industry, both globally and locally, is by no means immune from the import of the vagueness associated with SS. Valdes-Vasquez and Klotz (2013) attest to this, decrying the absence of a comprehensive and empirical framework for defining SS within the context of construction projects owing to its indefinability. Herd-Smith and Fewings (2008) propose that SS in construction be used to refer to the engagement among employees, local communities, clients, and the supply chain to ensure meeting the needs of current and future populations and communities. Yet, Valdes-Vasquez and Klotz (2013) observe that an understanding of this definition was contingent on stakeholder type and the project's lifecycle phase. They posit that one perspective of SS entails the estimation of the impact of construction projects in relation to where users habit, work and engage in various activities, a perspective usually catered for during environment impact assessment. Also, the application of corporate social responsibility (CSR) objectives by construction firms and client organizations was identified as another approach to SS. Other perspectives highlighted therein bother on design initiatives for engendering social inclusion for under-represented groups, and elimination of safety hazards from the work site, impact of temporary users like workforce and vendors as well as extant social interactions etc.

Furthermore, they insist that SS was process-oriented, reiterating six key themes for exploring the incorporation of SS processes in the planning and design phase of the construction process. These key themes include stakeholder engagement; user considerations; team formation; management considerations; impact assessment, and; place context. Similarities were observed between the themes provided by Valdes-Vasquez and Klotz (2013) and those espoused by Sourani and Sohail (2005), Abdel-Raheem and Ramsbottom (2016), Herd-Smith and Fewings (2008).

It is pertinent to note that this particular study aligns itself to these views as espoused by Valdes-Vasquez and Klotz (2013) pertaining to SS as consisting of a set of processes required to improve on the construction industry's contribution to the SD agenda. These key themes mentioned in Table 1 are not peculiar to any type of construction project but transverses the entire domain which comprises of infrastructure delivery. Therefore, improved knowledge concerning the aspects of SS integration and their commensurate benefits need to be explored and disseminated to ensure successful integration. South Africa is known for its apartheid struggles in the pre-1990 era. In the post-apartheid era, which also marked the escalation of the SD mantra, efforts have been made to achieve improved levels of social inclusion of hitherto under-represented groups in the country. Cross-sectoral efforts have led to promulgation of policies by government and stakeholders to curb agitations for social inclusion. Such policies have sought to provide economic emancipation for certain groups, provide increased access to employment opportunities, skill development, social housing, education, healthcare, etc. (Bolton, 2006). In the construction industry, the use of preferential procurement practices and the integration of social benefits in the decision making processes for new projects has been noted (Jacquet, 2002; Rogerson, 2012; Watermeyer, 1999). However, it does appear that these efforts have not been operationalized at the project delivery level, especially as it concerns SS, as a paucity of studies has been observed.

3. RESEARCH METHODOLOGY

This study adopted a phenomenological research design. The rationale behind the adoption of this design can be attributed to the desire of the authors to explore the worldviews of representatives of the various stakeholder groups who have a direct influence on the workings of the IDS. A phenomenological research design avails a researcher the opportunity to carry out detailed discussion hence providing the opportunity for the facilitation of the revelation of salient issues which are of importance to the interviewee (Chell, 2004). Furthermore, Creswell (2007) opines that this research design is effectively utilized when there is need to describe the essence of a lived phenomenon based on the narratives of those who have shared such an experience. In the context of this study, interviewees were

sought for based on their having experienced the phenomenon (integration of SS) being understudied.

Based on this, the interviewers decided that phenomenology would serve the purpose of exploring the perceptions of the benefits which certain groups have experienced through the integration of SS into project delivery programmes as depicted by the IDS. Relying on subsystems and stakeholder groups inherent in the IDS as identified in Awuzie and McDermott (2015), the authors purposively selected representatives of various stakeholder groups. These stakeholder groups consist of the regulatory agencies, the project owners, contractors, consultants and end users. However, in this study, the representatives of the regulator were not available to participate in the interview sessions as emails and reminders sent to them were not replied. A total of thirteen interview sessions with an uneven distribution among the four remaining stakeholder groups. Whereas the client stakeholder group was represented by three interviewees, (CLI-3), the contractor group had four representatives (CON1-4) interviewees. Also, two consultants (CONS1-2) and four interviewees (EU 1-4) were selected from the end user community based on a mixture of purposive and convenience sampling. It is necessary to state this study is the first of two studies into this phenomenon. A subsequent study would deploy questionnaires to a wider audience to extrapolate the findings of this preliminary study. It is expected that this would engender the attainment of statistical generalization.

Semi-structured interviews were deployed as a suitable data collection technique. The choice of this type of interviews was predicated on its provenance as a reliable data elicitation technique which provided the interviewer with considerable levels of flexibility in his/her desire to explore the worldviews of interviewees concerning a particular phenomenon (Bernard & Ryan, 2009). Such flexibility was reflected in the use of similar and not identical questions thus enhancing the interviewer's ability to take the interviewer's level of experience into consideration in the choice of questions.

Interview sessions spanned an average of thirty minutes, each. The sessions were recorded with permission of interviewees and subsequently transcribed, verbatim. Questions asked during the interviews were centred on their understanding of the SS concept as applied in infrastructure delivery systems and their perceptions of benefits derived therefrom. Thematic analysis was applied in making sense of the data (Kulatunga, Amaratunga, & Haigh, 2007). The emergent data is presented and discussed in subsequent sections.

4. PRESENTATION AND DISCUSSION OF PRELIMINARY FINDINGS

4.1 Benefits

Although a plethora of benefits were identified from the data emanating from the interview sessions, only a few of these benefits which resonate

among the various stakeholder groups would be highlighted and discussed here as the study is still in its early stages.

4.2 Improved job creation opportunities for locals through alignment of contracting strategies to SS objectives

Contracting strategies have been described as enablers of SS integration in construction projects and the construction industry in general (Hawkins & Wells, 2006; Watermeyer et al., 1998). The choice of which contracting strategy to utilize in the realization of a construction project should be aligned to the SS criteria being sought to be achieved by the project owners and end users. Evidence of this abounds within the South African context wherein the use of targeted/preferential procurement policies and work packages such as unbundling has been used in getting hitherto underrepresented communities in the construction industry. Interviewees narrated scenarios where they had applied preferential procurement strategies to assist contractors who were members of a particular community to tender, win and execute work packages in their respective organizations. The interviewers were further inundated by an interviewee (CL1) on how his department had initiated training programmes for a select group of novice contractors from the local area. Such programmes which were referred to as *Vukuphile* (wake up and live) and *Mangaung Community plumbers* respectively were meant to develop technical, administrative and financial management competencies among contractors. In the aftermath of their tutelage, these individuals are availed opportunities on work packages owned by the directorate. It is beyond the scope of this study to ascertain the success of these schemes. However, it is pertinent to note that this instance highlights the nexus between social and economic sustainability from the client's perspective.

4.3 Increased societal acceptance of infrastructure projects

The incorporation of the views of stakeholders as well as the ensuring that tenets relating to respect for people is achieved during the early stages and subsequent stages of an infrastructure asset delivery lifecycle has been described as capable of inspiring high levels of societal acceptance by such stakeholders (Raven, Mourik, Feenstra, & Heiskanen, 2009; Suopajärvi et al., 2016; Whitton et al., 2015). They state that such levels of acceptance served as an operating capital for client organizations to proceed with their delivery exercise without hindrance hence resulting in improved levels of productivity and project performance. Furthermore, they affirm that effective management of social acceptance for new projects prevented the rise of potential problems. During the interview sessions, interviewees shared their experiences regarding how the consultation processes which are an essential part of the environmental impact

assessment processes in South Africa for potential infrastructure projects enhanced the relationship between the local community, relevant stakeholders and the project delivery team. According to an interviewee, CON3, community participation in the early stages of their projects culminated in optimal project performance. According to EU2, the consultation process made them feel like they were joint owners of the infrastructure asset being delivered and this propelled them to support such projects. Summarily, interviewees were unanimous on the benefits of effective consultation processes- a significant SS aspect.

4.4 Emerging Issues

During the course of data analysis, certain realities were thrown up to the authors. One of such realities is highlighted below.

4.5 Lack of awareness and common understanding about the concept of Social Sustainability

During the course of the interview sessions, it was discovered that a vast majority of the interviewees were oblivious about what the term 'social sustainability' entailed. There was a continued attempt on their part to use it interchangeably with economic dimensions to SD. This was the case with the end-users and contractors who argued that SS benefits were not far-reaching enough based on proposed economic indices such as the percentage of work reserved for local contractors. Such statements obviously resulted from the lack of awareness or understanding of what SS was about. As if to buttress this point, prior to the commencement of the interview sessions, the authors had to explain the concept of SS to a majority of the interviewees. For instance, the interviewees overlooked issues such as respect for persons through non-discrimination of female or migrant workers on construction sites, the provision of safe working environments etc. Rather they seemed to more enthused with the notion that they were not benefiting financially from the siting of projects within their vicinities. Whereas this study understands the need to integrate the three dimensions of SD during implementation within project delivery environments as suggested by (Vallance et al., 2011), it believes that the stakeholders within a particular context should be able to develop a common understanding about the components of each of these pillars to be able to their optimal integration. It must be stated that most of the project owners/ consultants and contractors have actually integrated significant aspects of SS at different stages of their work as explained during the interviews but they did not know that such aspects were actually.

5. CONCLUSION

The optimal mainstreaming of sustainability ethos through the SD frameworks continues to be heralded as a viable medium for achieving a

sustainable society. The construction industry and the infrastructure delivery subsector, in particular, have been identified as possessing the potentials to undermine this objective. However, it is worthy of note to see that the efforts are being made by policy makers, practitioners and academics in South Africa and beyond towards ameliorating the impact of such systems on the attainment of societal goals.

Yet, it appears that such efforts are focusing mainly on the environmental and economic dimensions of the SD tripod. The neglect of the social dimension has been attributed to several factors including its indefinability and its context-dependent nature. However, the impact of effective integration of SS into projects within extant construction literature appears to have been under-investigated. Proper rendition of SS aspects, their applicability within project delivery systems and the benefits accruing from their integration is necessary to stimulate interest among stakeholders in the infrastructure delivery system. This is what this study set out to do.

Whilst this study should be regarded as a preliminary one to identify the benefits of the mainstreaming of SS into various activities inherent in delivery systems by relying on the views of representatives of various stakeholder groups, it should be noted that data analysis is still on-going and that the views expressed are areas where common ground has been identified amongst the various representatives interviewed. Furthermore, the study does not make any attempt to laying claim to the generalization of its findings as the number of interviewees utilized cannot support that. Yet, a second part of this study will focus on extrapolating the views obtained by the interviewees to a wider respondent base. This will not only enable statistical generalization but engender the development of a common context-dependent definition among all stakeholder groups. Such determination will contribute to the validation of the benefits identified and subsequent prioritization of such benefits through a proper ranking approach.

Summarily, this study contributes to the emerging discourse on the effective integration of SS into the SD framework, especially within the construction industry in South Africa, an area hitherto neglected by policymakers, practitioners and academics alike. Also, it provides a platform to unravel the vagueness associated with the SS concept during the implementation of SD framework.

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Prevalent types of errors in Construction Contract Documents

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ABSTRACT AND KEYWORDS

Purpose of this paper
The objective of this study is to investigate the prevalent types of error in construction contract documents.

Design/methodology/approach
The mixed (questionnaire survey and interview) research method was adopted for this research and the study was conducted in South-western Nigeria. The sample size for this study is 161 contracting firms and 275 consulting firms. The two-stage stratified random sampling technique was adopted for this study. In addition to the sample size, 51 interviews were conducted on consultants, contractors and project managers on projects they executed in the last three years.

Findings
The study found that the prevalent types of errors in contract documents are conflicting information in documents, errors in design, dimensional error, errors in mechanical and electrical symbol, ambiguous/wrong description in specifications, over/under measurement in bill of quantities, use of wrong units for measurement and omission in bill of quantities.

Research limitations/implications (if applicable)
The implication of this research is that the Nigerian construction industry still has a long way to go since all the documents investigated in this are characterized by errors and many other countries have really gone past this level.

Practical implications (if applicable)
The study concludes that the prevalent types of errors in contract documents identified in this study should be published for designers and consultants so that they can know the errors to guard against during contract documentation. Government should also enact documentation policies to prevent error occurrence.

What is original/value of paper: What is new in the paper is that prevalent types of errors in contract documents are scarce in literature, so this paper has added to existing body of literature and x-rayed the backwardness of the Nigerian construction industry in contract documentation

Keywords: Construction industry, Consultants, Contractor, Contract document, Design error, Project performance.

1. INTRODUCTION

The construction industry is an important part of any nation as it contributes immensely to the growth and development of such nation (Dang & Low, 2011). However, the industry has been battling with perennial challenges of cost, time and quality deviations; thereby reducing its input in the economies of those nations (Aibinu & Jagboro, 2002). One of the highly rated causes of this underperformance is errors in contract documents of construction project (Ade-Ojo & Babalola, 2013). This was buttressed by Mohammed (2007) who noted that errors in contract documents are the major reasons construction projects are not completed within budgeted cost, scheduled time and prescribed quality. Love, Edwards, & Han (2011) linked cost and time performance to errors in contract documents. Okuntade (2014) affirmed that errors in contract documents account for more than 82% of all construction errors committed. Ade-Ojo and Babalola (2013) and Mukaka, Aigbavoba and Thwala (2014) also noted that errors in contract documents are the major factors affecting the cost and time performance of building projects.

Although Dosumu and Adenuga (2013) noted that error entails different meanings depending on how it is conceptualized; Love, Edwards and Irani (2008) described it as an unintended deviation from acceptable standard. With these definitions, error in contract documents may be defined as any unintended deviation from acceptable standards during the preparation of contract documents (architectural drawings, structural drawings, specifications, and bill of quantities among others). For this study, the contract documents investigated are drawings (structural and architectural), specifications and bill of quantities. These are the main documents prepared by construction consultants, particularly in Nigeria. Other documents either have templates or they are standard documents.

Many researchers (Palaneeswaran, Ramanathan & Tam, 2007, Barkow, 2005) have worked on the causes, effects and remedies of design errors/errors in contract documents. These researches have not yielded much result as errors in contract documents are still prevalent and their effects on construction projects are equally grave. The reason for this situation may not be far from the fact that, studies that have classified errors into its types are scarce to find. Consequently, this has inhibited the identification of the prevalent types of errors in contract documents. This study argues that, without identification of the prevalent types of error in contract documents, it may be difficult to prevent poor project performance as the errors to be mitigated would remain obscure. Therefore, this study empirically investigates the prevalent types of errors in construction contract documents so that the professionals preparing the documents will know the errors to prevent when preparing contract documents.

2. LITERATURE REVIEW

Farinloye, Ogunsanmi, Mafimidiwo and Ajala (2010) and Memon, Rahman and Azis (2011) worked on the factors responsible for cost and time overrun and the result showed that design related issues are prominent. However, the types of the design related errors that affect project performance were not probed further. Furthermore, Babalola and Idehen (2011) and Amiruddin, Towhid, Amir and Majid (2012) noted that variations are as a result of errors and omissions in designs, conflicting documents and change in design by consultants. The issues not addressed by these studies are the types of errors in the contract documents of the projects investigated. There this study focuses on the investigation of the prevalent types of errors in contract documents

Classification of error was not done in many literatures and this may be because of its relativity to different disciplines. However, Saurin, Formoso and Cambraia (2008) classified error into non-intentional errors and violation. Atkinson (1999) classified error into latent and active error. Latent errors are undiscovered errors that exist while active errors are discovered and treated errors. Mason (2001) stated that slips and lapses, mistakes and violations are the three classes of human errors. Lee, Barnes and Hardy (1983) noted that errors can be classified into slips, lapses, rule-based mistakes and knowledge based mistakes.

While Lee*, et al. (1983)* believed that slips, lapses, rule-based and knowledge-based mistakes are classifications of errors, BPS (2007) and Mason (2001) believed that they are mere types of errors. This indicates that classes of errors are different from types of errors. Lee*, et al.* (1983) further expatiated that human errors have four categories which are error of omission, error of commission, sequential error and time error. This exposition has added sequential and time error to error of commission and error of omission that was popularly recognised by BPS (2007). BPS

(2007) recognised and buttressed Lee et al (1983) categorisation by adding timing/rate and sequence error as two other classifications of errors.

A distinct opinion emerged when Love *et al.* (2009; 2011) noted that mistakes, slips and lapses of attention and omissions are neither types of error nor classifications but reasons for the occurrence of errors. The types of errors according to Ortega and Bisgaard (2000) are insufficient knowledge, underestimating influences, ignorance, carelessness, negligence, forgetfulness, errors, relying on others, unknown situations, unclear definition of responsibilities, communication selection of low quality and others. From the literatures reviewed, it appears difficult to categorize errors.

Juszczyk, Kozik, Lesniak, Plebankiewicz and Zima (2014) classified errors in contract documents in three ways namely; according to place of occurrence (documents), person responsible for the error and the type of error. When error is classified according to documents, the documents implicated are technical descriptions (specifications), engineering drawings (all contract drawings), calculations and bill of quantities. Classification according to persons responsible for error indicates that investors, architects and discipline specific designers are the people involved. Classification according to type of error indicate that discrepancy in designs, discrepancy within design documentation, lack of information, incorrect or incomplete information and errors in designing are the types of errors involved.

3. RESEARCH METHOD

This study adopted the mixed (questionnaire survey and interview) research method. The research area is South West, Nigeria. South west, Nigeria consists of six (6) states which include Lagos, Ogun, Oyo, Osun, Ondo and Ekiti states. These states have many construction works going, especially Lagos State which is the economic hub of Nigeria. Lagos State is also transforming into a mega city. Fortunately, other neighbouring states share part of the development of Lagos State. Therefore, for an effective research on a study of this nature, it is wise to pick the Southwestern states ahead of others.

The population of this study consists of contracting and consulting firms in Southwest, Nigeria that were engaged on building projects between 2012 and 2016. The consultants' opinions are required because they prepare the contract documents of building projects. The opinions of contractors are required because they make use of the documents prepared by consultants and they discover the errors in them. Years between 2012 and 2016 were selected to ensure that projects used for the study are recent. The list of contracting firms is collated from the Federation

of Construction Industry (FOCI) and states tender boards of the six states in Southwest, Nigeria. There were situations where companies appeared in both sources; a unified list was therefore prepared to take care of repeatedly listed firms.

Hence, 275 contracting firms were collated from the six states in the geopolitical zone. The consulting firms used for this study are those obtained from the directories of professional/regulatory bodies such as the Architect Registration Council of Nigeria/Nigerian Institute of Architects (ARCON/NIA), Council of Registered Builders of Nigeria/Nigerian Institute of Building (CORBON/NIOB), Quantity Surveyors Registration Board of Nigeria/ Nigerian Institute of Quantity Surveyors (QSRBN/NIQS) and the Council for the Regulation of Engineering/Nigerian Society of Engineers (COREN/NSE). Hence, the consulting firms used for this study are (128 Building firms, 369 Engineering firms, 166 Quantity Surveying firms and 323 Architectural firms respectively) 986. Based on this explanation, the population for this study is 275 building contractors and 986 construction consultants.

The sampling technique used for this study is the two-stage stratified-random sampling technique. The first stratum is the consulting and contracting firms and the second is the categorisation of consulting firms into architecture, building, engineering and quantity surveying. In addition, 51 interviews were conducted on contractors, project managers and consultants on the projects they were involved and can equally identify the causes of errors in the contract documents of such projects. In order to calculate the sample size for the study, the formula proposed by the Creative Research System (2001) was adopted. Thus:

$$SS = \frac{Z^2 * P * (1-P)}{C^2}$$

Where: SS = Sample size, Z = Z-value at 95% confidence level (1.96), P = probability of selecting a population member (0.5), C = Margin of error at 95% confidence level (0.05)

Using the formula, the sample size for contracting firms is 161 out the 275 collated and that of consulting firms is 275 out of the 986 collected (36 Building, 103 Engineering, 46 Quantity Surveying and 90 Architectural firms). Table 1 shows the distribution of the population and sample size for this study

Table 1: Population and sample size of the study

LOCATION OF PROJECT	CONTRACTING FIRMS		CONSULTING FIRMS							
			ARCHITECTS		BUILDERS		ENGINEERS		QTY. SURV.	
	POP	SS	POP	SS	POP	SS	POP	SS	POP	SS
Lagos	122	71	120	33	70	20	148	41	54	15
Ogun	61	36	46	13	23	6	71	20	32	9
Oyo	32	19	46	13	16	5	49	14	23	6
Osun	25	15	44	12	11	3	35	10	22	6
Ekiti	14	8	36	10	-	-	36	10	17	5
Ondo	21	12	31	9	8	2	30	8	18	5
Total	**275**	**161**	**323**	**90**	**128**	**36**	**369**	**103**	**166**	**46**

POP = population, SS = sample size, Qty. Surv = Quantity Surveyors

4. DATA ANALYSIS

Table 2 shows the types of errors in the contract documents (drawings, specifications and bill of quantities) investigated in this study. The joint agreement of the respondents are that dimensional errors in drawings (3.18), conflicting information in documents (3.33), errors in electrical/mechanical symbols (3.23), omission of details/items in drawings (3.08), errors in designs (3.07) and violation of codes (2.75) are the prevalent types of errors in contract drawings. Also, ambiguous/wrong description in specifications (3.05), conflicting information in contract documents (3.05), incomplete/inadequate specifications (3.05) and omission/absence of specification (3.12) are the prevalent types of errors in specifications. Finally, the prevalent types of errors in bills of quantities are over/under measurement in bill of quantities (3.39), omission of items in bill of quantities (3.29), use of wrong units/quantities for measurement (3.15) and wrong description of items in bill of quantities (3.14). It can be observed from Table 2 that omission in documents is common to all the documents investigated in this study. This could have informed the reason why omission error is the focus of many authors of design errors.

Table 2: Types of errors in contract documents

Types of errors in contract documents	Consultants Mean score	Contractors Mean score	Total Mean score	Rank
Types of errors in drawings				
Conflicting information in contract document	3.29	3.35	3.33	1
Errors in electrical/mechanical symbols	3.12	3.33	3.23	2
Dimensional errors in drawings	3.55	3.04	3.18	3
Omission of details/items in	3.14	3.03	3.08	

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drawings				4
Error in designs (e.g. Loading error)	2.95	3.18	3.07	5
Violation of codes and regulations	2.69	2.81	2.75	6
Types of errors in specifications				
Omission/absence of specifications in documents	3.36	3.29	3.12	1
Ambiguous/wrong description in specifications	3.12	3.00	3.05	2
Incomplete/inadequate specifications	3.13	2.99	3.05	2
Conflicting information in contract documents	3.12	3.00	3.05	2
Types of errors in bill of quantities				
Over/under measurement in bills of quantities	3.58	3.23	3.39	1
Omissions in bill of quantities	3.33	3.24	3.29	2
Wrong unit/quantities used for measurement	3.12	3.17	3.15	3
Wrong description of items in bills of quantities	3.08	3.18	3.14	4

Note: F = Frequency, TS = Total score, MS = Mean score.
Key:1 =Not Prevalent, 2 = Slightly Prevalent, 3 = Moderately Prevalent, 4 = Prevalent, 5 = Very Prevalent.

Table 3 shows the types of errors in contract documents based on the interviews conducted. Thirteen (13) types of errors were identified by the interviewees and they were classified according to documents under four headings of errors in drawings, errors in bill of quantities, errors in specifications and co-ordination error. The classification was based on the review of literatures especially that of Mohammed, (2007).

Table 3: Frequency of the types of errors in contract documents

Category of errors in Contract documents	Types of errors in contract Documents	Individual frequency	Individual (%)	Category (%)
Errors in drawings	Errors in design (e.g. loading error)	58	18.88	43.56
	Dimensional errors in drawings	27	8.86	
	Errors in electrical/mechanical symbol	8	2.62	

	Omission of items/details in drawings	31	10.20	
	Violation of building code, laws and regulations	9	3.00	
Errors In Bill of Quantities	Over/under measurement of bill of quantities	27	8.88	28.65
	Omission of items in bills of quantities	36	11.84	
	Wrong units/quantities for measurement	15	4.93	
	Wrong description of items in bill of quantities	9	3.00	
Errors in specifications	Omission/ absence of specifications	16	5.27	17.20
	Ambiguous/wrong description in specifications	18	5.92	
	Incomplete/inadequate specifications	18	5.92	
Co-ordination error	Conflicting information in contract documents	32	10.60	10.60
	TOTAL	**304**	**100**	**100**

The analysis of the interview indicates that by category, error in drawings (43.56%) is the most prevalent type of error, followed by error in bills of quantities (28.65%), error in specifications (17.20) and then coordination problem (10.6%). The interview further clarified that the prevalent types of errors in contract documents according to individual contributions are omission in documents (add all omissions together) (27.31%), errors in designs (18.88%) and conflicting information in documents (10.6%). This indicates that the result of interview is in tandem with the questionnaire survey on omissions and conflicting information in contract documents. This result is particularly alarming because it is a pointer to how far Nigeria needs to go before she can attain the level of other construction industries around the world.

5. DISCUSSION OF FINDINGS

The study adopted questionnaire and interview methods to investigate 184 and 51 building projects respectively. It is important to note that apart from Juszczyk, *et al* (2014) and Mohammed (2007) that only identified types of errors in contract documents, many of the authors on design errors have only

worked on causes and effects of errors on construction projects. This precludes the identification of the prevalent types of errors in contract documents of many countries. From the inferential statistics of this study, the prevalent types of errors in contract documents are; over/under measurement in bills of quantities, mechanical/electrical abbreviation error, over/under reinforcement in structural design, ambiguous/wrong description in specifications, omissions of items in bills of quantities and drawings, dimensional errors in drawings, conflicting information in documents and use of wrong units/quantities for measurement.

According to Mohammed (2007), the prevalent types of errors in contract documents are designers' errors, omissions in bills of quantities, incomplete details of contract document (additional views/details needed), incorrect or missing details, missing or incorrect notes on the drawings, co-ordination problem within and among disciplines. These results show that dimensional errors in drawings, human errors, conflicting information in contract documents and omissions in bills of quantities are the prevalent types of errors in contract documents of Nigeria and Saudi Arabia.

6. CONCLUSIONS

Based on the findings of the study, the study concludes that the prevalent types of errors in contract drawings are conflicting information in documents, errors in electrical/mechanical symbols, dimensional errors, omissions and errors in designs. The prevalent types of errors in specifications are omission/absence of specifications, ambiguous/wrong description in specifications, incomplete/inadequate specification and conflicting information in documents. The prevalent types of errors in bills of quantities are over/under measurement, omission in bills, use of wrong quantities for measurements and wrong description of items in bill of quantities.

Based on the interviews conducted, the study also concludes that according to contract documents, drawings have the highest number of occurrence of errors, followed by bill of quantities and then specifications. However, when error is examined according to their individual contribution, omissions in all the documents investigated have the highest frequency of occurrence, followed by error in design and conflicting information in contract documents. The implication of this research is that the Nigerian construction industry still has a long way to go since all the documents investigated in this study are characterized by errors and many other countries including developing countries have really gone past this level.

In practical terms, it is worthy to state that all the contract documents investigated in this study contain errors and this is not good enough for the Nigerian construction industry because most countries around the world

have moved beyond documentation error by using different control measures like Building information modelling, lean construction techniques and modular construction techniques among others. These countries have moved to the era of sustainable design and construction, industrialized system building, lean construction and light gauge steel construction to mention a few. This study advises the professionals in the Nigerian construction industry to quickly move with the trend of construction around the world in order to bridge the current practice gap that is being created. The backwardness of the construction industry is taking its toll on the academic world in Nigeria as the current trend of construction researches around the world is hard to implement in Nigeria because there are hardly case study projects or situations in the country that can be used to support the conduct of such studies. The academia travel wide to understand and practice the current trend of construction but such knowledge is impracticable on the Nigerian soil. One major reason for this situation is the unwillingness of the practicing professionals to adapt to change. This has brought about a huge gap between research and practice in Nigeria. The study recommends that the government should come in by way of policy statements and award of contracts to practitioners that can use modern design and construction techniques. The study also advises the academics to engage in construction practices and participate in the activities of the professional bodies. These will go a long way to bridge the gap between academics and practice.

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The extent of practice of Total Quality Management (TQM) in the maintenance of university buildings in South Africa

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ABSTRACT

Purpose

The purpose of this paper is to investigate the extent to which TQM is practiced in the maintenance of school buildings in South Africa.

Design

Available literature in Total Quality Management was thoroughly reviewed. A quantitative approach was adopted where a questionnaire with closed-ended questions was distributed to purposively sampled maintenance workers in a tertiary institution. Respondents proffered their perceptions on the practice of TQM during their building maintenance activities. Descriptive data analysis comprising of mean, and percentages was used to analyse the data.

Research limitations

The study was built upon an available sample of practicing maintenance workers in a university. There is a probability that other school categories in the country were not represented. A larger sample extended to other tertiary schools can be used for future studies.

Findings
A total of 54 respondents participated in the study. The findings obtained indicated that all the TQM practices were implemented. People involvement was the most implemented TQM practice. Process approach, customer focus and system management were also found to be frequently practiced. For the practice of leadership, the development of clear objectives by top management to guide maintenance activities was low, likewise the development of effective strategies to guide maintenance activities.

Practical implications
This study shows that top maintenance management is expected to develop clear objectives and effective strategies to guide and control maintenance activities and systems should be well managed in order to contribute to the effectiveness of the maintenance department.

Value to conference theme
This study adds to existing literature by bridging the gap and revealing the importance of practicing TQM in maintenance. The study also provides research information on the Total Quality Management process in the South African school building maintenance system and evaluates the extent to which it is being practiced.

Keywords: Maintenance, University buildings, South Africa, Total Quality Management.

1. INTRODUCTION

The idea of Total Quality Management (TQM) is to make sure that attempts to gain the required level of quality are well planned and organised. The implementation of TQM is identified as one of the most effective ways to monitor and maintain facilities and also enhance continuous improvement in the management of facilities in order to meet customer needs (Ashworth, 1994). According to Ater (2013), TQM is perceived as a step to realizing the deliberate changes that will bring about the necessary changes in proper management and maintenance of buildings.

TQM principles and framework has received a lot of popularity with most organizations using it as a tool to achieve competitive advantage. The adaptation of TQM principles have been beneficial to not only service and manufacturing organizations, it has also had a significant impact in healthcare, government agencies and educational institutions. While quality has become a universal concern, universities are challenged with maintaining existing physical facilities within acceptable quality standards. Arguably, maintaining buildings within acceptable quality standards is one of the most important aspects in education, government and business.

According to Olawunmi (1992), the consequences of neglecting the aspect of quality management in the maintenance of facilities and buildings results in high cost of maintenance and low building performance, wasted energy and effort, and inadequate management of maintenance. However, the issues stated above could be rectified by applying the principles of Total Quality Management (TQM), which is the basis upon which this study is conceptualized. Since the TQM principles proffer solutions to such problems. Therefore the objective of the study was to investigate the extent to which the school's maintenance department practiced TQM in the maintenance of school buildings.

2. LITERATURE REVIEW

2.1 Evolution of TQM and its contextual definition

TQM came into existence during the 1970s, as at this time the progression of quality shifted from quality control to a better approach of quality in order to deal with the growing concern for quality. Quality management has evolved from quality inspection, to quality control, to quality assurance then to Total Quality Management. A number of authors identify three periods in the TQM evolution process and others propose four stages of evolution.

Steeples (1992) suggests three periods in TQM evolution: quality control, quality assurance, and total quality management. Meanwhile, Garvin (1998) argues that four stages exist in the evolution of TQM, which are inspection, statistical quality control, quality assurance, and strategic quality management.

2.2 TQM in maintenance of university buildings

According to Council on Higher on Education (2011), South Africa has twenty three public universities, eleven of which are traditional universities, six universities of technology and six comprehensive universities. Zakaria and Wan-Yusoff (2011); Sukirno and Siengthai (2011); Tirronen and Nokkala (2009) explain that universities develop the intellectual capacity and employability of a citizens of a country. Therefore accelerates a country's economy and promotes development of a country. For universities to meet all these objectives effectively, buildings are important. Olanrewaju, Khamidi and Arazi (2010) state that buildings are regarded as the most important facility of a university. In order for university buildings to provide a conduce environment that supports research, learning, teaching and innovation, maintenance is required. Olanrewaju *et.al* (2010) further explain that a university building should enable the transfer of knowledge. Therefore, for a university achieve its major objective of promoting

academic activities, it important for its building facilities to be adequately maintained (Zakari & Wan-Yousoff, 2011).

The relationship between quality and maintenance, though not totally missing, has not been addressed adequately in literature (Ben-Daya & Duffua, 1995). It is crucial to note that most of the literature in existence and which is reviewed seems to have less focus on TQM practice in the maintenance of tertiary school buildings. Not much attention is paid to the extent to which TQM is practiced in the maintenance of school buildings. The issue of quality practice in maintenance practice has been very rare. Ben-Daya and Duffuaa (1995) realise a fracture in knowledge of understanding the issue of quality in the aspect of maintenance.

Abdul Azeez, Abass and Mansur (2014) stress that the building maintenance team has a significant impact on the outcome of maintenance operations in any educational institution because management is a living force and it is the force that gets things done to acceptable standards.

Yasin, Alavi, Kunt and Zimmerer (2004) clearly stipulate that the rate at which service organizations are reluctant to practice TQM is alarming, especially considering the high importance of the service sector to global economies and that service organizations are straggling in the aspect of the effective application of total quality management (TQM) practices towards the achievement of its strategic goals. Au and Choi (1999) further explain that service organizations are still sauntering behind their counterparts in the aspect of their commitment to TQM practices.

2.3 Dimensions of TQM practice

Previous empirical studies on TQM confirm that TQM practices have been described by various researchers in different ways although they are inter-related. From the principle of TQM, and its theories, it is apparent that the TQM practice is shaped towards the philosophy of waste reduction and continuous improvement, aimed to achieve a common goal, and customer satisfaction. TQM practices are a set of beliefs which are fundamental and comprehensive aimed at improving an organisations performance over a long period of time by placing focus on its customers in the process of addressing its stakeholder needs (Hoyle, 2001). According to Obaid (2005) eight TQM practices that have been perceived as fundamental to the management of quality are illustrated by the ISO 9000(2000). They are as follows:

Customer focus

Customer focus is concerned with the achievement of customer satisfaction through the conformance to its requirements (Obaid, 2005). According to ISO 9001(2000) standard, customer focus is reflected through the requirements addressing concerns with customer communication,

management commitment, appointment of a management representative and the resolution of customer needs and expectations.

Leadership

For effective leadership, leaders must develop clear objectives to guide maintenance activities. It is the responsibility of top management to lead employees to be more efficient at their jobs (Rahaman, 2014).The appropriate management structure should be established and employee participation through empowerment should be encouraged (Oakland, 1997). Al-Khalifa (2000) states that leadership by top management that supports the objectives and vision of the organization is crucial in the TQM process. Management should consistently pay attention to their employees and monitor their progress (Obaid, 2005).

People involvement

The participation of everyone in the maintenance activities, from the top executives to the low level management assists in increasing productivity which means getting benefits (Obaid, 2005). According to Galgano (1994), the involvement of the workforce is important as it is one of the conditions to an organizations ultimate success.

Process approach

According to Hoyle (2001) desired results are more effectively when related activities and resources are managed as a process. It entails the management of processes which have clearly defined objectives based on the needs and interests of all parties involved.

System Management

Ludwig-Becker (1999) proposes that identifying, understanding and managing a system of interrelated activities, processes or a given objective contribute to the effectiveness and efficiency of the organisation.

Continuous improvement

It is the driving tool of TQM because it ensures consistent quality delivery to customers by involving everyone in the organization. This propels an organization to be both creative and logical in searching for ways to become productive and more effective at meeting stakeholder expectations. Organisations are required to develop a programme for upgrading processes in order to achieve competitive advantage (Obaid, 2005).

Factual approach to decision making

Management needs to continually take decisions. Hoyle (2001) suggests that for an organisation to determine how well it is performing, data on performance measures are important. TQM requires that an organisation continually gather and analyse data in order to improve the accuracy of its decision making, reach a consensus and allow prediction based on past occurrences (Westcott,2013).

Supplier relationship

A mutually favourable relationship between the organisation and its suppliers amplifies the potential of the organisation to create value (Hoyle, 2001). Regular supplier audits should be carried out and it should be ensured that suppliers maintain quality standards.

3. METHODOLOGY

The quantitative research approach was adopted for this study. Quantitative research is the systematic and objective process of using numerical data from a selected subject of population to carry out a study (Maree & Peterson, 2007). A detailed conveniently selected single case study of a university was carried out from four universities situated in the Western Cape Province, South Africa. A purposive sampling method was used to select workers of the maintenance department who participated in this survey. These workers comprised of the maintenance department's top management, supervisors, foremen, clerk of works, technicians, administrators and labourers.

Five point Likert scale closed-ended questions were formulated to get the perceptions of respondents on the extent to which TQM was practiced in the maintenance of their buildings. The questionnaire was hand-delivered to each respondent. SPSS version 24.1 was used to capture and compute the data. The descriptive analysis consisting of means, percentage and standard deviation was used to analyse the data. Reliability is mostly used as regards to the question of whether the measures that are formulated for concepts in the study are consistent. To ensure reliability of this study, the Conch Bach's co-efficient alpha was used to test the consistency of the obtained.

4. FINDINGS

4.1 Research participation

Questionnaires were administered to workers across five campuses of the university including Bellville, Cape Town, Mowbray, Wellington and Mowbray. Table 4.1 shows that 11.2% (6) of the respondents occupy the top management position, 16.9% (9) of the respondents occupy the position of supervisor, 16.9% (9) of the respondents occupy the position of foreman, 9.4% (5) of the respondents work in the position of clerk of works, 24.3% (13) of the respondents occupy the position of technician, 14.9%(8) respondents occupy the position of labourer and 7.5% (4) respondents occupy the position of administrator. 16.2% (9) respondents have less than 10 years' experience, 65.1% (35) have between 11 and 20 years' experience, 17.0% (9) have between 21 and 30 years' experience, 1.9 %(1) has between 31 and 40 years' experience. Table 4.1 indicate that 9.3% (5) are female and 90.7 % (49) are male.

Table 4.1 Profile of participants

Profile of participants	Bellville		Cape town		Mowbray		Wellington		Granger bay		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
Position												
Top Management	2	3.7	0	0	0	0	1	1.9	3	5.6	6	11.2
Supervisor	3	5.6	3	5.6	1	1.9	1	1.9	1	1.9	9	16.9
Foreman	1	1.9	5	9.3	0	0	1	1.9	2	3.7	9	16.8
Clerk of Works	1	1.9	3	5.6	0	0	0	0	1	1.9	5	9.4
Technician	5	9.3	5	9.3	1	1.9	1	1.9	1	1.9	13	24.3
Labourer	3	5.6	0	0	4	7.4	1	1.9	0	0	8	14.9
Administrator	2	3.7	1	1.9	1	1.9	0	0	0	0	4	7.5
Work Experience												
0-10	4	7.5	2	3.8	0	0	2	3.8	1	1.9	9	16.2
11-20	9	16.8	12	22.0	6	11.2	3	5.7	5	9.4	35	65.1
21-30	3	5.7	3	5.7	1	1.9	0	0	2	3.7	9	17.0
31-40	1	1.9	0	0	0	0	0	0	0	0	1	1.9
Gender												
Female	2	3.7	1	1.9	1	1.9	1	1.9	0	0	5	9.3
Male	15	27.8	16	29.6	6	11.1	4	7.4	8	14.8	49	90.7

4.2 Reliability

The reliability of scaled questions was tested with the use of Cronbach's alpha coefficient. Table 4.2 shows a summary of the reliability test for questions 1 and 2. The Cronbach's co-efficient for the scaled questions was 0.76, which satisfies the reliability test requirements.

Table 4.2 Summary of reliability test

Question No	Questions	Number of items	Cronbach's alpha coefficient
1	Perception on the practice of TQM	14	0.73
2	Extent of TQM practice	31	0.78
	Total questions	45	0.76

4.3 Perception on the practice of TQM

From Table 4.3, respondents were required to respond along a 5-point Likert scale where; 1= strongly disagree, 2= disagree, 3= somewhat agree, 4= agree, 5= strongly agree. This section sought to explore the knowledge of the respondents about the practice of TQM. An overall mean score of 4.58 was obtained. It is evident that appropriate corrective measures should be carried out was raked first with a mean score of 4.83 followed by department focuses on stakeholder satisfaction and appropriate preventive procedures should be carried out with mean scores of 4.79. Activities are done right the first time was ranked the least with a mean score of 4.18. An overall mean score of 4.58 was obtained. This indicates TQM is practiced in maintenance of tertiary learning buildings. This is consistent with the findings of Mukherjee (2006:42). It was highlighted that eight internationally recognized building blocks should be practiced together for the effective implementation of TQM.

Table 4.3 Practice of TQM

Statement	1	2	3	4	5	Total	Mean	SD	Rank
	%	%	%	%	%				
Appropriate corrective procedures should be done	0	0	3.7	9.3	87.0	54	4.83	0.46	1
Department focuses on achievement of stakeholder satisfaction	0	0	0	20.4	79.6	54	4.79	0.40	2
Appropriate prevention procedures should be done	0	0	1.9	16.7	72.2	54	4.79	0.45	3
Everyone should be involved in the execution of activities	0	0	1.9	20.4	77.8	54	4.75	0.47	4
Department understands stakeholder needs	0	0	0	25.9	74.1	54	4.74	0.44	5
More focus should be placed on prevention	0	0	5.6	22.2	72.2	54	4.66	0.58	6
Development of relationship with stakeholders is vital	0	0	0	35.2	64.8	54	4.64	0.48	7
Mistakes should be analysed	0	0	7.4	20.4	72.2	54	4.64	0.61	8
Efforts should be made to satisfy all stakeholders	0	0	9.3	22.2	68.5	54	4.59	0.65	9
All parties should be satisfied	0	0	13.0	27.8	59.3	54	4.46	0.71	10
Cost of resources consumed is measured	0	0	5.6	46.3	48.1	54	4.42	0.60	11
Value is added to maintenance processes	0	0	5.6	50.0	44.4	54	4.38	0.59	12
Mistakes are eliminated to save time and cost	0	1.9	18.5	24.1	55.6	54	4.33	0.84	13
Activities are done right the first time	0	1.9	13.0	35.2	46.3	54	4.18	0.99	14
OVERALL						54	4.58	0.59	

4.4 Extent of TQM practice

Table 4.4 required respondents to indicate the extent to which TQM was practiced in their maintenance activities using a 5- point Likert scale, where 1= never; 2= rarely; 3= sometimes; 4=often; 5= always. Scale means and standard deviation were used to analyse the data for this study.

Table 4.4 Extent of practice of TQM

TQM practices	1	2	3	4	5	Total	Mean	SD	Rank
	%	%	%	%	%				
Process approach									
Related maintenance activities are managed effectively	0	1.9	11.1	11.1	75.9	54	4.61	0.76	1
Resources are managed as a process	0	0	14.8	11.1	74.1	54	4.59	0.74	2
Objectives are clearly defined	0	0	14.8	20.4	64.8	54	4.50	0.74	3
Processes based on interest of all parties are effectively managed	0	13.0	22.2	44.4	20.4	54	3.72	0.94	4
OVERALL							4.25	0.79	1
People Involvement									
Satisfaction of workers are measured regularly	1.9	1.9	18.5	24.1	53.7	54	4.25	0.95	1
Maintenance department contributes to the safety of workers	1.9	5.6	9.3	33.3	50.0	54	4.24	0.97	2
All workers are involved in the maintenance process	0	3.7	11.1	44.4	40.7	54	4.22	0.79	3
Everyone participates in the execution of activities	3.7	3.7	16.7	42.6	33.3	54	3.98	0.99	4
OVERALL							**4.17**	**0.92**	**2**
Customer focus									
Stakeholder inputs are encouraged	0	0	11.4	24.1	64.8	54	4.53	0.69	1
Stakeholder needs are effectively disseminated and understood	1.9	1.9	7.4	44.4	44.4	54	4.27	0.83	2
Stakeholder expectations are considered	0	1.9	33.3	29.6	35.2	54	3.98	0.87	3
Regard stakeholders as the focus	5.6	0	44.4	24.1	25.9	54	3.64	1.04	4
Satisfy stakeholders by conforming to specification	20.4	11.1	9.3	22.2	37.0	54	3.44	1.57	5
OVERALL							**3.97**	**1.00**	**3**
System Management									
Clear instructions are available	1.9	1.9	29.6	18.5	48.1	54	4.09	1.01	1
Systems and maintenance processes are well identified and understood	1.9	0	18.5	70.4	9.3	54	3.85	0.65	2
Activities are managed in order to contribute to effectiveness	1.9	5.6	20.4	53.7	18.5	54	3.81	0.87	3
OVERALL							**3.91**	**0.84**	**4**

TQM practices	1	2	3	4	5	Total	Mean	SD	Rank
Continuous improvement									
Continuous improvement of all services and processes is practiced	3.7	3.7	27.8	27.8	37.0	54	3.90	1.06	1
Programs for upgrading the continuous improvement process is implemented	1.9	14.8	13.0	48.1	22.2	54	3.74	1.03	2
Improvement teams are available in all departments	3.7	5.6	29.6	46.3	14.8	54	3.62	0.93	3
OVERALL							**3.75**	**1.00**	**5**
Supplier relationship									
A mutually favourable relationship exists between the department and suppliers	0	3.7	25.9	51.9	18.5	54	3.85	0.76	1
Maintenance department ensures all suppliers can maintain quality standards and meet specifications	3.7	14.8	24.1	38.9	18.5	54	3.53	1.07	2
Regular supplier audits are conducted	3.7	22.2	24.1	33.3	16.7	54	3.37	1.12	3
OVERALL							**3.58**	**0.98**	**6**
Leadership									
Top management consistently pays attention to members	3.7	0	7.4	29.6	59.3	54	4.40	0.92	1
Top management encourages members through empowerment	1.9	3.7	9.3	27.8	57.4	54	4.35	0.93	2
Maintenance department puts in place appropriate management structures	0	3.7	16.7	27.8	51.9	54	4.27	0.87	3
Contingency plans are developed to control maintenance	3.7	14.8	22.2	27.8	31.5	54	3.68	1.17	4
Top management develops clear objectives	31.5	16.7	5.6	27.8	18.5	54	2.85	1.57	5
Effective strategies are developed to control maintenance	27.8	20.4	14.8	18.5	18.5	54	2.79	1.49	6
OVERALL							**3.58**	**1.20**	**7**
Factual approach to decision making									
Statistical methods are used to analyse data	1.9	7.4	40.7	29.6	20.4	54	3.59	0.96	1
Data to improve decision making is continually analysed	1.9	11.1	44.4	22.2	20.4	54	3.48	1.00	2
Ensure data on performance measures is gathered	3.7	31.5	33.3	18.5	13.0	54	3.05	1.08	3
OVERALL							**3.37**	**1.01**	**8**

4.4.1 Process approach

As regards the sub-practices, related maintenance activities are managed effectively was ranked first with a mean of 4.61. Resources are managed as a process was ranked second with a mean score of 4.59. Table 4.4 shows respondents indicated that all the practices for process approach were frequently observed. Respondents ranked process approach as the second most implemented TQM practice with a mean score of 4.25.

4.4.2 People involvement

The mean scores for the sub-practices ranged from 4.24 to 3.98. From the mean scores for the sub-practices for people involvement, it is evident that respondents perceived TQM as highly practiced. People involvement was ranked the second most implemented TQM practice with an overall mean score of 4.17.

4.4.3 Customer focus

Respondents indicated that the maintenance department regards stakeholders as the focus of their maintenance activities (3.64) was the most practiced sub-practice followed by satisfaction of stakeholders (3.44). A mean score of 3.97 was obtained for customer focus.

4.4.4 System management

Systems and maintenance processes are well identified and understood was ranked the most implemented sub-practice with a mean of 3.85 followed by activities are managed in order to contribute to effectiveness with a mean of 3.81. For system management, a mean score of 3.91 was obtained.

4.4.5 Continuous improvement

It is obvious from the mean scores of the sub-practices that continuous improvement of activities and processes had a mean of 3.90 followed by programs for upgrading the continuous improvement process with a mean of 3.74. Continuous improvement had a mean score of 3.75.

4.4.6 Supplier relationship

It is evident that mutually favourable relationship exists between the department and suppliers with a mean of 3.85 were the most implemented sub-practice. Maintenance department ensures all suppliers can maintain quality standards and meet specifications were ranked second with a mean score of 3.53. A mean score of 3.58 was obtained for supplier relationship.

4.4.7 Leadership

top management consistently pays attention to members was ranked as the most implemented sub-practice with a mean score of 4.40 followed by top management encourages members through empowerment with a mean of 4.35A mean score of 3.58 was obtained for leadership.

4.4.8 Factual approach to decision making

Factual approach to decision making was ranked the least implemented TQM practice with an overall mean score of 3.37. With regards to sub-practices, statistical methods are used to analyse data was ranked first with a mean of 3.59 followed by data to improve decision making is continually analysed with a mean of 3.48.

5. CONCLUSION

The results obtained from the survey indicated that university maintenance departments practiced TQM in their maintenance activities. Results showed that people involvement, process approach, customer focus and system management were the most implemented TQM practices. These findings are supported by literature. Department of Trade and industry (2011) reveals that the involvement of people, core management of systems and processes and satisfaction customers form the basis of TQM However, complete and thorough TQM components were practiced and all practices conformed to the principles of TQM. This indicates that all workers are involved in the maintenance process and the maintenance department contributes to the safety of workers. It is also demonstrated that satisfaction of workers are measured regularly. In addition everyone participates in the execution of activities.

6. RECOMMENDATIONS

All the components of TQM are important. A comprehensive TQM program comprising all the key TQM components should be practiced, rather than implementing limited portions. Further studies should be carried out in other higher learning institutions for better understanding of TQM practices.

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A field study investigating the role of talent management as a novel approach for developing innovative solutions for Egyptian heritage communities' development

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ABSTRACT

Purpose of this paper

This paper aims to analyse the results of a field study, conducted by the authors, to investigate the implementation of Talent Management (TM) as a novel approach in Architectural Design Firms (ADFs) towards developing innovative solutions for Egyptian heritage communities' development.

Design/methodology/application

To achieve the abovementioned aim, a research methodology is designed to accomplish three objectives. Firstly, reviewing literature related to the research topic including heritage communities' development, creative industries, ADFs and TM. Secondly, presenting and analysing three case studies to support the acquired knowledge on the research topic. Thirdly, assessing the effectiveness of TM on architects' ability to develop innovative solutions for the Egyptian heritage communities. This is achieved through a survey questionnaire with a representative sample of ADFs in Egypt.

Findings
ADFs have high awareness about TM yet there is lack of implementing the strategy. There is lack of provision of innovative solutions in a different manner than the conventional approaches to bridge the gap between tangible and intangible heritage innovatively.

Research limitations
TM-related reviewed literature was limited to literature from the last decade. This research focused only on ADFs and heritage communities in Egypt. However, the results are useful to countries that share the same characteristics of Egypt.

Originality/Value
The research work presented in this paper is novel as investigating the implementation of TM in ADFs and its role towards developing innovative solutions for heritage communities' development has not been studied before, specifically in Egypt. In addition, this paper contributes towards achieving the Egyptian Vision 2030 Strategy for providing sustainable development in Egypt.

Keywords: Community Heritage Development; Creative Industries; Architectural Design Firms; Motivation; Talent Management.

1. INTRODUCTION

Historic sites are unique, varied and constitute the world's heritage. They have the ability to enrich the sense of wonder of people and enhance their curiosity (Feilden, 1982). Sustaining the seven millennium Egyptian history, which resisted changing over a very long time and became a visual architectural reference nowadays, is paramount (Shaw, 2000). This could be achieved through preserving current heritage sites and enhancing surrounding communities that gain their identity from these unique heritage places (Issawi, 2012). True preservation developments would not consider the physical heritage only, but intangible heritage as well. Intangible heritage encompasses believes, values, stories and behaviours (Bennett et al., 2014). However, it was found to be highly diverse (Blake, 2000; Bell, 2013) due to its reliance on transmission from a generation to another (Alvizatou, 2012). Thereafter, Characteristics of a family varies from a neighbourhood to another and as well from an individual to another within the same neighbourhood (El-Ansary and Al-Ibrashy, 2014). The deep development is more effective than surface development in considering the surrounding environment (Appleyard, 1979) including the intangible heritage. Studies showed that built space design has a relationship with social life characteristics and people's psychological state and behaviour towards places (Farahat, 1999). Current architectural facilities around

heritage sites achieved lower order needs as protection and physiology yet ignoring higher order needs as belonging and self-actualization (Mittelman, 1991; Taha, 2012). People who live in hazardous poverty would have sense of belonging and satisfaction (Tay and Diener, 2011). Therefore, innovation required to preserve the diverse intangible heritage does not require much luxury and investments, but creative ideas. In this regard, ADFs' role in developing innovative architectural facilities is of essence. Architecture is a creative and talent-based industry (Galloway and Haniff, 2015); therefore, architects as creative talents need a talent-related management system. The reason is that the working nature at ADFs causes demotivation to architects and prevents creative development (Amabile, 1993; Oyedele, 2013). TM is one of the novel approaches to manage talented people to achieve work-life commitments balance, reduce demotivation, achieve creative development and organizational success (Deery, 2008; Kehinde, 2012; Vural et al., 2012). The aim of this paper is to analyse the results of a field study, conducted by the authors, to investigate the perception and application of TM in Egyptian ADFs as a novel approach for developing innovative solutions for Egyptian heritage communities.

2. RESEARCH OBJECTIVES AND METHODOLOGY

To achieve the abovementioned aim, a mixed research methodology of qualitative and quantitative methods is designed to accomplish three objectives. Firstly, build a comprehensive knowledge about heritage and development, creative development and talents and TM. This is achieved through qualitative literature review. Secondly, investigate the role of TM in developing innovative solutions and the positive outcomes of TM. This is achieved through presenting and analysing three case studies qualitatively. Finally, assess the effectiveness of TM on architects' ability to develop innovative solution for Egyptian heritage communities. This is achieved through a distributed survey questionnaire to a representative sample of ADFs in Cairo region and is analysed quantitatively and qualitatively.

Reviewed literature about TM was limited to recent decade's international journal papers, conference proceedings and books while heritage literature was reviewed mainly from Egyptian academic sources. Studied cases are international, non-biased and explanatory to investigate the relationship between innovative heritage development and TM and the role of the last towards talents development. The survey questionnaire sampling targeted ADFs that are registered in the Egyptian Engineers Syndicate, Cairo region. Forty-four ADF represented the population while the calculated sample on a distribution of 50%, confidence level of 95% and margin of error of 5% considered no bias and resulted with a sample of 40 ADF.

3. LITERATURE REVIEW

3.1 Heritage and the Need for Innovation

Heritage is a valuable credit for any society and it has two types. Firstly, physical tangible heritage that is defined as what ancestors have built from monuments and landmarks. It could be comprehensive spatial urban places, comprehensive locations, visual compositions and iconic buildings (Al-Raies, 2010). Secondly, Intangible heritage that is defined as cultural aspects that are more ephemeral than the physical heritage, but forms important part of the culture as well. It could be poetry, spoken stories, music, arts, memories, believes and traditions (Bennett, et al., 2014). Intangible heritage transmits among generations (Alvizatou, 2012). Therefore, previous findings that it is hard to identify this type are valid (Blake, 2000) since it could change over time. It leads to marginalization of communities to divergent associations where identities become highly different (Bell, 2013). Hence, the identities contradict with each other and with the identity of the physical heritage. Thereafter, findings by Issawi (2012) that human-related deterioration to the built environment is an attempt to meet certain needs assert on that contradiction. According to Appleyard, (1979), developments of such heritage communities could be surface developments concerned only with the physical heritage or deep development concerned with the physical heritage and its surrounding environment including intangible heritage. The deep development requires creativity and innovation to preserve both types of heritage considering the high diversity of the intangible heritage.

3.2 Architecture as a Creative Industry and the Demotivating Nature

Creativity means producing novel useful ideas in any form in multiple ways as part of entrepreneurial activities (Hotho and Champion, 2011). Workers who produce creative ideas are referred to as ‘creative-talents’ (Oakley et al., 2008). On one hand, a cultural industry is a talent-based industry concerned with production, creation and commercialization of cultural creative intangible content. On another hand, a creative industry is ‘talent based’ (Galloway and Haniff, 2015) as well, but include activities of intangible cultural activities as well as tangible productions such as architecture (UNESCO, 2010). The difference between personnel and creative talents in such industries lies in employment type and motivation (Miege, 2011). Even if motivation existed as extrinsic or intrinsic or even if personality traits as openness to experience and self-efficacy helped in unleashing creativity (Prabhu, et al., 2008), current demotivation factors in ADFs as stressful nature of projects, miscommunication and lack of day-to-day work freedom (Oyedele, 2013) prevent creativity (Amabile, 1993). Therefore, there is a need for a talent-based management system that provides adequate working conditions to enhance creative development.

3.3 Talent Management as a Novel Approach to Enhance Innovation

The word 'talent' could refer to performance in function of ability and motivation 'object approach' or individuals who are valuable, scarce and hard-to-replace 'subject approach' (Gallardo-Gallardo et al., 2013). According to Meyers and van Woerkom (2014), talents as individuals are managed with four approaches. Firstly, inclusive/stable approach in which all employees are considered talents, but no development is required. Secondly, inclusive/developable approach in which all employees are considered talents and their skills need development. Thirdly, exclusive/stable approach in which certain group of employees has inborn talents, but no development is required. Lastly, exclusive/developable approach in which certain group of employees have inborn talents and their skills need development. In either case, Schiemann (2014) defined TM as the management of the talent lifecycle, which is a representation of the relationship between talents and their organization. The talent lifecycle includes attracting, acquiring, on-boarding, training, developing and retaining talents. Hence, it is could that the development phase would be excluded from the cycle in cases of any stable approach.

Early development of TM considered all positions in the organization as talent based and should have high-performing employees, but failed to indicate the sufficient number of sources required to uncover their talents (Lewis & Heckman, 2006). Thereafter, a strategic TM model asserted on the need to identify the most pivotal position then developing the talent pool in accordance (Collings and Mellahi, 2009). TM has a vital role in achieving economic and non-economic values on individual, organizational and societal levels (Thunnissen, et al., 2013). Most importantly, TM balances work-life commitments and enhances creativity (Deery, 2008; Khalil et al., 2017). According to Tafti, et al. (2017) barriers of implementing TM are categorized over four categories. Firstly, structural factors related to integration of both HR and TM in the strategic alignment. Secondly, environmental factors related to external conditions. Thirdly, behavioural factors related to cultural, mental and cognitive conditions. Lastly, managerial factors related to cooperation and support of managers. Success factors are categorized in the same manner excluding the behavioural category.

3.3 Relationship between Heritage Development, Creativity and TM

From the reviewed literature, the perception of heritage became broad to not just consider the intangible heritage as well as the physical heritage, but considering the diversity of the intangible heritage. The change in the intangible heritage from a generation to another led to a reduction of sense of belonging towards the identity of the physical heritage. Thereafter, the human-related deterioration to the physical heritage is an attempt to achieve the individuals' higher order needs as sense of belonging through changing the character of the physical heritage. Since built environment

has a vital role in affecting the behaviour of its occupants, ADFs have a vital role towards providing creative solutions that bridge the gap between identities of the physical and intangible heritage. However, the demotivating nature in ADFs acts as a barrier that prevents creativity. TM is privilege in balancing talents' work-life commitments to enhance creativity. It achieves mutual values for the individuals, organization and the society as well. However, there are certain barriers as well as success factors that could affect integration of TM. Therefore, the aim of this paper to analyse the results of a field study, conducted by the authors, is of essence as it is not only seeking investigation of barriers and success factors, but perception, implementation and practices discussed in the literature.

4. CASE STUDIES

4.1 Snøhetta Architects

The firm is specialized in architecture, interior design and landscape architecture. The firm's aim is enhancing identity and sense of place. Creativity is ensured through exploration of digital technology and handicrafts. The workplace itself enhances interaction and collaboration with ease flow of information. Employees share one table for lunch breaks to promote social values. It can be reserved anytime outside lunch hours as well to avoid demotivation caused by stress. The firm relies on focus groups and workshops to generate creative ideas from each participant where unexpected directions are generated. The firm adopts a strategy called 'Trans positioning', which means roles changing to understand complexities and opportunities of other participants. An innovative project developed by the firm is King Abdul-Aziz Centre for World Culture in Saudi Arabia that integrates the past, present and future of the country's culture as shown in Figure 1 ("Snohetta Process," 2016). The firm was ranked first in the list of most innovative ADFs in 2010 after designing this project (Tischler, 2011).

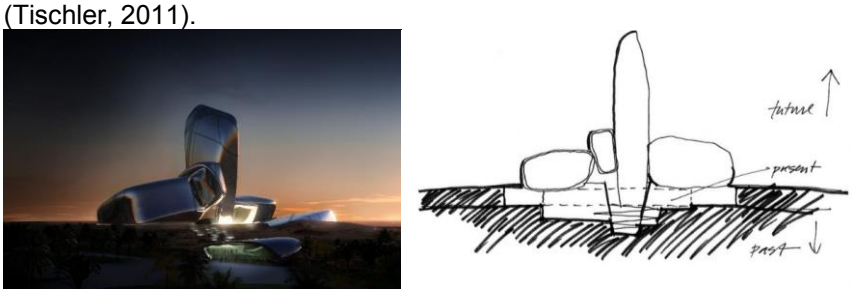

Figure 1 King Abdul-Aziz Centre for World Culture (Left) with past, present and future integration concept (Right) (Snohetta Projects, 2016).

4.2 Bjarke Ingels Group (BIG)

BIG is a group of architects, designers, builders and thinkers working in architecture, interior design, landscape design, urbanism, research and product design (Fisher, 2015). The firm believes that utopian architecture is beyond conventional boxes where the firm mixes leisure, living, working and parking with an overlap between utopia and pragmatic ("Bjarke Ingles Group," 2016). The firm has proper balance with their business structure of creative culture and talents where everyone is assigned with what fits ones capabilities best. All shares reward yearly without individual competition. BIG ensures the work environment makes their talents enjoy working and spending a lot of time. Direct communication is important because of the understanding of the value of every talent in the firm (Fisher, 2015). The 'Mountain' project facilitated providing a high-rise building with dwelling units with gardens, shown in Figure 2, which was considered a very novel approach to solve the project problem. BIG refers to their theory as the 'Bigamy' theory, which means taking several elements that do not fit together to form new genre (Winston, 2015).

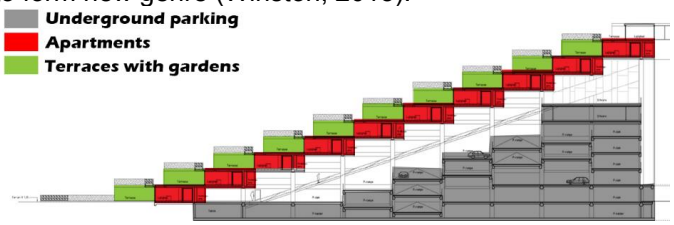

Figure 2 The Mountain project section ("Mountain Dwellings," 2009). Edited by: Authors.

4.3 DP Architects

The firm aims to deliver architecture of excellence with considerations of built environment, human experience and spirit. The firm uses TM strategy at three main phases. Firstly, attracting graduate talents because developing talent pool with foreign labour costs $3,300/month for getting an employment pass, which represents 30%-60% extra money of monthly salary. Moreover, number of architects graduating each year is not high, so the firm funded 30% of study costs for talented undergraduates while the Building and Construction Authority covers the rest. Secondly, development through the DP academy in addition to the in-house trainings are provided. Thirdly, retention is achieved through making everyone feels a part of a big family. It is achieved through a 'PHD philosophy' that refers to Purpose, Hunger and Drive. Each talent has sense of purpose or the talent will be following motion. Acquired young talents are hard to be retained, therefore, the firm has the 'DP DNA', which means making everyone grow and find him/her-self in the place. The firm balances work and life commitments through an on-board yacht for staff members at any time. It is free for

talents to communicate together or with minimal fees for any talent and his/her family (Majid, 2014). The firm won Best Company to Work For in Asia (BCWFA) in 2015 (“DPA clinches,” 2015).

4.4 Review of Findings

Adoption of TM strategy was common among the three case studies although each case highlight different aspect of the TM implication. For Snohetta, the firm has a cooperative and flexible workplace and considers the needs of the talents to reduce demotivation as well as balance work-life commitments. It was achieved through encouraging social interaction at the workplace and giving freedom to have leisure time with co-workers. The trans-positioning concept indicates an inclusive TM approach. In addition, the firm successfully preserved the intangible heritage in a creative manner. For BIG, the firm reduced the stressful nature that causes demotivation through their distinctive workplace ‘organism’. Although not much details are available, but it asserts the success factor at Snohetta. BIG privileged in creating self-directing opportunities, lack of competition and team reward, which enhanced sense of belonging on behalf of their talents who are managed inclusively as in Snohetta. Therefore, full potential for creativity was given. For DPA, a clear understanding of the architectural role as key position led to developing a proactive strategy in acquiring, developing and retaining talents when there was a gap between supply and demand of talents. Moreover, the provision of recreational facilities enhances work-life balance and sense of belonging, which in turn enhance the performance. It is clear that architects are perceived as developable talents.

4.5 Value of Talent Management

The previous analysis of case studies highlighted the value of TM in multiple manners. Firstly, TM enhances the ability of architects to develop innovative solutions. Secondly, TM has successful contribution to attraction of talents. Thirdly, TM has the ability to develop talents in different manners through either training or discovering each person’s role through starting from the beginning. Last, but not least, TM has positive role in retaining talents through enhancing belonging to the firm and provision of recreational activities.

5. DATA ANALYSIS

Quantitative and qualitative approaches are adopted in analysing the data collected from a distributed survey questionnaire to total population of 44 ADFs that were registered in the Egyptian Engineers Syndicate, Cairo region. The objective of the quantitative data is building knowledge on

existing status through numerical data where analysis are conducted with diagrams and statistics. Likert scale questions were analysed through measurement of central tendency, measurement of dispersion and relative importance index (Bernard, 2000). Close-ended questions analysis is presented graphically. The analysis revealed close measure values, which refers to a homogenous and qualitative data. Qualitative data analysis aim to establish an understanding of specific phenomenon from the participants' perspective (Creswell, 2003). Open-ended questions' responses in the survey questionnaire were analysed qualitatively. Respondents' answers represented perceptions about specific issues. Professional titles of respondents ensured the validity of information to be considered in the analysis.

5.3 Response rate

Although the calculated sample was 40 Egyptian ADFs, the total population of 44 Egyptian ADFs were sent a copy of the survey questionnaire to complete. However, only 36 ADFs completed the survey questionnaire, which represents a response rate of 81.8% that is high to support the research findings.

5.4 Discussion of results

5.4.1 Talent Management

The answers of the survey questionnaire showed that 83% of respondents asserted on their perception about the TM strategy, therefore, it indicates the maturity of the surveyed ADFs. The respondents were asked if they adopt TM strategy where 56% mentioned that their firm adopt TM strategy. That raises a question of why 44% of firms are not adopting TM strategy although the majority have high understanding about TM. 47% of the firms who adopt the TM strategy follow the inclusive/developable approach while 13% followed the inclusive/stable approach. 31% follow exclusive/developable approach for architects and 6% follow exclusive/developable approach for a group other than architects. 69% of firms who adopted TM strategy follow a non-economic perspective while 31% focus on profitability. 81.3% of firms who adopt TM strategy indicated that it helped balancing the work-life commitments of their talents. Top managers' belief, commitment and support was considered the highest factor for the success of TM adoption with Relative Importance Index (RII) of 0.89 while the prevention of external pressures that obstruct talents acquisition received the lowest RII of 0.49. Lack of understanding of TM role in shaping careers and capabilities of employees was scored with RII of 0.85 as the highest barrier of implementing TM strategy while expectations of elected talents received least RII of 0.34.

5.4.2 Creative development

86.1% of respondents confirmed their perception about architecture as a creative industry. 64% of them indicated that architects have high level of energy, commitment and creativity, 19% indicated there is lack of motivation while 17% indicated that architects are demotivated. 72% of respondents answered that their firm seeks developing innovative solutions and consider architecture as a creative industry. Employees' personal traits received 42.5% as the success factor for creative development while extrinsic motivation received 30% and intrinsic motivation received 27.5%. Financial rewards received 41% as the adopted strategy to enhance creativity while certificates of appreciation received 18%, flexible working hours 15%, balancing commitments 21% and other responses as participation in competitions and trainings 5%. Respondents who develop innovative projects were asked for examples, but the majority lack different perspective than conventional ones. Respondents who did not seek creative development rated the stressful nature of projects 37% as a barrier followed by lack of freedom in day-to-day work 32%, miscommunication 21% and resistance to change and lack of restrictions 11%.

5.4.3 Heritage communities' development and sustainability

91.4% of respondents asserted on the responsibility of citizens' about the deterioration of the physical heritage. 42% of the respondents answered that their firm work in developing heritage sites' surrounding environment. 53.3% of them answered that architects have intermediate association to heritage and its development and sustainability, 26.7% mentioned that architects have high association while 20% are desperate from heritage and sustainability means sustaining their arts and employment. 53% of them answered that designing commercial, health and touristic projects is a priority, 13.3% have priority of refurbishing heritage buildings and 33.3% have priority of designing projects that preserve the intangible heritage. Firms who have the priority of the physical heritage mentioned that the barriers for preserving intangible heritage are profitability from land uses 31.8%, high cost of development to preserve intangible heritage 27.3%, difficulty in identifying intangible heritage 22.7%, external pressures 13.6% and 4.5% as current projects failed to do so. Firms who aimed to preserve intangible heritage had the objective of enhancing citizens' behaviour with 60% of responses to the question. However, 3/5 of them failed to identify an example when asked to do so, but 2 mentioned conventional examples of museums and cultural centres that preserve intangible heritage as a whole without consideration of its diversity. 11/20 of firms who did not work in heritage development related the barriers to the client, 5/20 related barriers to the firm, 1/20 to the government, 1/20 to the heritage citizens and 2/20 failed to identify barriers.

5.4.4 TM and heritage communities' development

The research hypothesis named 'Integrating TM in ADFs would enhance developing innovative solutions for Egyptian heritage communities' was tested in the survey questionnaire. 42% of respondents strongly agreed 5/5 that TM could be a successful approach to enhance developing innovative solutions while 36% agreed 4/5. ADFs were asked about their willingness to change their management system. 56% of them revealed their willingness to change while 44% disagreed to change. Additional information provided in the last section indicated that profitability as a priority by the client acts as a main obstacle that causes stress in working and strict schedules that prevents creative development. However, one response indicated that in his/her firm, talents give their best without expecting rewards; therefore, they were able to deliver innovative and cost-efficient solutions. All of the respondents showed interest in learning more information about TM, which indicates the effectiveness of the strategy even for ADFs who did not adopt it.

6. CONCLUSION AND RECOMMENDATIONS

This paper investigated the role of TM in Egyptian ADFs towards developing innovative solutions for heritage communities' development. The case studies showed successful relation between TM, innovation and attraction, development and retention of talents. The results of the survey questionnaire showed a gap between TM role and innovative development for heritage communities. Many respondents showed their adoption of TM and development of creative solutions. However, they lacked development of projects around heritage sites. Several firms related this to lack of interest in participation, lack of specialization to identify the diverse intangible heritage of individuals in a community and developers/client interest in profitable projects. Three of the total respondents adopted TM, have creative development and preserve intangible heritage projects around heritage sites. However, lacking identification of clear examples show that the value is not delivered yet. ADFs that adopted TM strategy successfully balanced work-life commitments and enhanced motivation for their talents, which promotes the value of the research. Inclusive approach was mostly adopted and top managers' support and commitment was identified as the most successful factor that facilitated successful implementation. Firms who did not adopt TM stated the reason as there is lack of identification for TM role towards shaping employees' careers. As a result, talents did not find it appropriate to work in such ADFs. Therefore, the adopted TM strategy needs to be refined or reintroduced to have the original outputs of TM that were successfully implemented before in other firms.

6.1 Recommendations for ADFs

- An awareness programme that lets ADFs accept cultural change is essential as a first step in the development process.
- ADFs should align their business strategy with the value of TM. In this case, development of heritage communities would be a priority.
- Workshops and brainstorming sessions for a design process is of essence, but the client should be a participant to understand the value of development of heritage communities.
- Public participation surveys should take place in early stages of the design process to understand the diverse intangible heritage.
- Understanding TM role towards achieving mutual values for individuals, organization and society.
- Managers who successfully contributed to the adoption of TM should integrate all levels of management into the process of promoting the strategy.
- Benefits for clients in other investments could be provided in case of providing projects that preserve intangible heritage, which will have a positive outcome on the long run.

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Case Study on the quality of tenders submitted by Occupational Health and Safety Professionals in the South African built environment

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ABSTRACT AND KEYWORDS

Purpose of this paper

The purpose of the paper is to provide an overview of the current state of tenders submitted by Occupational Health and Safety (OHS) professionals in terms of functionality criteria

Design/methodology/approach

The research design is based on a case study. The data was collected from responses by OHS professionals to a Request for Proposal (RFP) issued by the CSIR. Data was collected through a two stage evaluation, where tenders were firstly evaluated for functionality. Those tenders meeting functionality criteria were to be evaluated on the basis of price and preference

Findings

Findings indicate that many OHS professionals did not meet the necessary functionality requirements enabling them to progress to the second stage. It would appear that the OHS professionals were inadequately prepared to submit successful tender documentation based on functionality criteria. This may be a result of a lack of understanding on the part of OHS professionals about functional requirements and performance.

Research limitations/implications
The data is sourced from 14 tenders submitted which might be too small a number to derive conclusive findings.
The data reflects tenders submitted for an unconventional project and might not represent industry wide trends.

Practical implications
Understanding the challenges facing various built environment professionals during procurement will significantly contribute to the improvement of procurement and bid documents. This is particularly in order for consulting companies to remain competitive.

Original value of paper.

Analysing bid submissions will provide insight into how the bidding success rate of OHS professionals can be improved. It would also assist in the preparation of bidding documents. This paper responds to the "Public Sector Procurement and Contracting" and "Construction Education, Training and Skills Development" themes in the conference.

1. Introduction

The quality of tenders submitted by professionals in the South African built environment is crucial to the successful award of contracts in the construction industry. This is because built environment professionals working in the South African built environment typically have to submit tenders in a response to a call for tenders in order to provide services to the public sector (CSIR, 2016). The same applies to the Occupational Health and Safety Consultant.

The involvement of the Occupational Health and Safety (OHS) professional in the client's professional team was not always common practice (PwC, 2014). Typically a team of built environment professionals appointed by the client includes; consulting engineers such as mechanical, electrical, civil and structural; architects; construction project managers and quantity surveyors. However, the introduction of new Construction Regulations in February 2014 compels clients to appoint OHS professionals as part of their professional team (PwC, 2014; Government Gazette, 2014). Although the regulation does not specifically mention OHS professionals, there are certain Health and Safety obligations attributed to the client. The client might not have the capacity or expertise to undertake these obligations and, as such, will have to appoint a professional in order to comply with the regulation (Government Gazette, 2014).

The case study which this paper is based on evaluated the quality of tenders submitted by OHS professionals. The evaluation resulted in provided an overview of the functional quality of tenders submitted by OHS professionals and how this aspect of their tendering practices can be improved. In order to provide a point of departure, the paper will provide a

brief overview to the procurement environment in South Africa and the status of the OHS profession in the built environment.

1.1. Procurement of Professional Services in the Built Environment

1.1.1. Selection Methods and Criteria

Most consultancies providing professional services to the built environment acquire work from submitting tenders (Jafaar, et al., 2008). The selection of consultants who adequately qualified and experienced is detrimental to the quality, cost and time of a project. As such selection methods and criteria must be developed with the aim of appointing the right consultants. The criteria and methods selected are usually dependent on factors such as the complexity of the project and the objectives of the organization (Oluwatayu, 2014; International Federation of Consulting Engineers, 2011; Ng, 2004). Popular recommendations are that selection methods look beyond price as a deciding factor. In fact Australian Procurement and Construction Council (2006) International Union of Architects (2001) and International Federation of Consulting Engineers (2011) recommend that ideal selection methods should either be value based or qualification based.
Table 1 provides an overview of criteria some publications and authors have found to be crucial to the effective selection of consultants. The top ten criteria which include response to the project brief, adequacy of proposed work plan and proposed methodology, organization, logistics and support resources, availability of resources and workload, qualifications and competence of the key staff, demonstrated experience in similar projects, communication/ facilitation skills, sound knowledge of the client's policies or work procedures

Table 1: Selection criteria for consultants

(Australian Procurement and Construction Council , 2006)	**(International Federation of Consulting Engineers, 2011)**	**(Cheung, et al., 2002)**	**(Ng, 2004)**	**(The International Bank for Reconstruction and Development/ The World Bank , 2002)**
Consultants Understanding of the project objectives	Professional competence	Background of firm	Consultant's experience	Specific experience of the consultants
Methodology	Managerial ability	Past performance	Organisation and staffing	Adequacy of proposed work plan

Resource strategy	Availability of resources	Capacity to accomplish the work	Methodology and resource planning	Qualifications and competence of key staff
Value adding strategy	Professional integrity	Project approach	Approach to cost effectiveness	Suitability of training
Fees			Response to brief	Participation of country's citizens
			Quality assurance and control	
			System assurance	
			Partnering	

Criteria recommended for the selection of consultants typically revolves around the consultants interpretation of the project. This can be evaluated scrutinizing the methodology presented and resources allocation to the project. Other important selection criterion revolve around the experience of the company and key personnel in similar projects and the capacity of the organization to accomplish the work. It can be assumed that failure to include evaluation criteria as outlined in Table 1 will result in the selection of incompetent consultants who do not understand the project.

1.1.2. Selection Methods and Criteria in a South African Context

The public sector relies heavily on open tenders as a result of the legislative framework. The legislative framework in South Africa requires any procurement activities undertaken by a state entity or government department to be transparent, fair, equitable, competitive and cost-effective (CIDB, 2015). As such; it is often very difficult to justify a direct negotiation approach for procurement. In order to encourage compliance with the various legislations governing procurement, the Construction Industry Development Board (CIDB) has developed a Standard for Uniformity in Construction which outlines procurement strategies specific to the construction industry (CIDB, 2015). The standard also applies to the procurement of professional services in the construction industry. Professionals must be cognisant with such standards

The CIDB Standard for Uniformity in Construction proposes that a procurement strategy can either follow a negotiation procedure, competitive selection procedure or competitive negotiation procedure. The CIDB regulation is indeed in favour of selection and evaluation methods which regard functionality and quality ahead of price. This is in line with recommendations as outlined in Table 1 (CIDB, 2015).

The CDIB (2015) recommends that evaluation should be on the basis of price and preference or functionality, price and preference. For services, works or goods between R 30 000 and R1 000 000 in value, tenders will either be scored on an 80/20 preference point system. In this evaluation method 80 % of the points will be for price and 20% will be allocated to

Broad Based Black Equity Empowerment (BBBEE). The 90/10 point system will apply to works, service or goods exceeding R 1 000 000. Bidders must score below a minimum threshold before they can be evaluated on price. Detailed evaluation methods for the tenders is outlined in the Standard. The selection criteria and the weighting of the selection criteria is recommended to be in line with project objectives.

1.2. Occupational Health and Safety in the South African Construction Industry

The Occupation Health and Safety Act has been in effect since 1993, however compliance in construction has been low (PwC, 2014). The worrying number of health and safety incidents on South African construction sites has seen the signing of the safety accord in 2012 and the introduction of the Construction Health and Safety regulation in 2014 (PwC, 2014). In addition to health and safety legislation the South African Council for the Project and Construction Management Professions (SACPCMP) has been prescribing the registration of Construction Health and Safety officers and Construction Health and Safety professionals since August 2013 (SACPCMP, 2014). The SACPCMP has been approved by the department of labour as the only statutory body recognised to register Construction Health and Safety professionals
In order to register with the SACPCMP one must have one of the following qualifications (SACPCMP, 2014):

- A programme in OHS or construction health and safety which is equivalent to a NQF Level 3-5
- Learner ship in OHS or construction health and safety
- A national diploma in safety management
- A Bachelor of Technology in safety management
- A Bachelor of Commerce in operational risk management
- A Master of Science in Construction Health and Safety Management

Several universities and universities of technology run programs for construction health and safety qualifications. Some qualifications can also be acquired from Further Education and Training colleges (CSIR, 2016; SACPCMP, 2014).
Recent efforts to increase the regulation of the OHS profession in construction means that the profession is not as well established as that for consulting engineers or architects. In fact, unlike engineers or architects, OHS professionals do not have a fee guideline prescribed by the statutory council (CSIR, 2016; SACPCMP, 2014). These factors may well be impacting negatively on the pricing proposals submitted to prospective clients.

2. Problem in context

Due to the implementation of the Construction Regulations in 2014 the client is now mandated to appoint an OHS professional for undertaking construction projects. However, the OHS professional is a relatively new

addition to the professional team and the general overview of the quality of tenders they submit is not available.
Having provided a background to the procurement environment in the South African construction industry and the OHS profession, this paper will seek to provide an overview of bidding trends of OHS professionals

3. Research Methodology

The research design followed a case study where responses to a request for proposal issued by the CSIR were evaluated. The request for proposal was aimed at consulting engineers, architects, quantity surveyors and OHS professionals to provide professional services for a construction project in rural Eastern Cape. The aim of the study is to evaluate the OHS professional's responses to the functionality component of the request for proposal. The criteria for the functionality evaluation included methodology, key personnel experience, company experience, local presence, and experience in green or innovative building projects. The weight of each functionality criterion was determined by the number of key aspects allocated to the criterion. The respondents had to demonstrate capability in the areas outlined as follows:

I. Methodology: the respondents were required to show how they propose to undertake the project given the scope and innovative nature of the project. The methodology was allocated a weighting of 10.
II. Key personnel experience: respondents must show that the personnel assigned to the project have at least five years' experience in that profession and are registered with relevant statutory council and/or voluntary council. The criterion had three key aspects and was therefore allocated a weight of 30.
III. Relevant company experience: respondents must show that the company has adequate experience in the industry, registration with voluntary associations, adequate personnel to undertake the project and infrastructure support. Infrastructure support refers to the availability of offices, printers and software. The criterion for company experience was 40.
IV. Local presence: The respondents must show that they have functional offices in the Eastern Cape. This criterion was allocated a weighting of 10.
V. Experience in innovative building technology projects or green projects. This criterion was allocated a weighting of 10.

The above criteria were scored on a scoring matrix. In order to score bidders, the evaluation committee discussed each bidder's submission against the functionality criteria and allocated them a score out of ten. The maximum score is 100. In order to qualify for the next round of evaluation, bidders must score a minimum of 70 in the functionality evaluation.
The matrix is illustrated in Table 2: Functionality matrix used for evaluating OHS professionals.

Table 2: Functionality matrix used for evaluating OHS professionals

Functional Criteria	*Weight*	*Supplier 1*	*Supplier 2*	*Supplier 3*	*Supplier 4*	*Supplier 5*
Methodology	10					
Relevant Company Experience	40					
Relevant key personnel experience	30					
Local presence	10					
Completed projects (experience in IBT or green projects)	10					
Total (note: total weight should not exceed 100)	**100**					

The request for proposals was placed on the national treasury website as is required from government or state owned entities. None of the bidders passed the functionality evaluation and a second round of proposals was requested from bidders who responded the first time and any other respondents who had not responded in the first round.

4. Findings

The first round of requests for proposal received 10 responses. Six of the respondents were part of a consortium or multidisciplinary consultancy. None of the respondents qualified for the next round of evaluation.

Table 3: Scoring matrix for functionality evaluation (round 1)

Functional Criteria	Supplier 1	Supplier 2	Supplier 3	Supplier 4	Supplier 5	Supplier 6	Supplier 7	Supplier 8	Supplier 9	Supplier 10	Average score
Methodology	7	7	1	5	0	5	5	0	5	10	5.5

Relevant Company Experience	6.25	6.5	4.25	5.75	0	2.5	6.75	0	4.75	5	4.2
Relevant key personnel experience	6.67	2.33	3.33	3.33	0	6.67	3.33	0	3.33	10	3.9
Local presence	5	5	5	5	10	5	5	5	0	0	4.5
Completed projects (experience in IBT or green projects)	5	5	5	5	0	5	5	0	0	1	6.1
Total as a %	**62**	**50**	**38**	**46**	**10**	**40**	**52**	**5**	**34**	**61**	**48.4**

From Table 3, one can conclude that the companies who had submitted responses meet at last half the criteria for a well set out methodology and have completed an appropriate number of IBT or green projects.
Data for key personnel indicated that there is a lack of experience in the industry as can be seen by the average score of 3.9.
The average score for company experience is 4.2, which is marginally lower than the average score for the key personnel experience criteria.
The second round of requests for proposal received eight responses, of which, four had submitted in the first round. The respondents who resubmitted have been allocated the same supplier number in Table 4 as they had in Table 3.

Functional Criteria	Supplier 11	Supplier 4	Supplier 7	Supplier 2	Supplier 12	Supplier 13	Supplier 6	Supplier 14	Average score
Methodology	7	5	7	7	5	10	7	5	6.63
Relevant Company Experience	4.25	5.25	6.7	5	5	7.5	5	7.5	5.78
Relevant key personnel experience	6.67	6.67	5.6	6.67	0	5	9	10	4.95
Local presence	5	5	5	5	0	0	0	5	3.12
Completed projects (experience in IBT or green projects)	5	10	10	0	5	5	5	10	6.2
Total as a %	**54.01**	**61.01**	**65.6**	**52.01**	**30**	**30**	**59**	**80**	**53.36**

Table 4: Scoring matrix for functionality evaluation (round 2)

The second request for proposal specified that respondents must show that they are registered with the SACPCMP and required fewer completed projects. Only one respondent was part of a consortium. Only one respondent qualified for the next round of evaluation.

The second round of responses resulted in a higher average score overall. The four respondents who had resubmitted from the first round improved their submissions. The following improvements are represented in Table 4:

- Two respondents improved their original score in company experience
- All four resubmissions showed an improvement in the key personnel criterion
- Two respondents improved their methodologies

The average scores increased significantly; however the scores for relevant company experience, relevant personnel experience and local presence are still low

5. Discussion

The selection criteria outlined in the RFP are in line with those recommended in literature. These include criteria such as methodology, background and qualifications. However, the RFP included a Local Presence criteria because the area in which the project has to take place is fairly rural and it would be impractical to have consultants travelling for two

days to reach the site. Evaluation of tenders followed CIDB regulations functionality, price and preference process.
The findings in this study are not sufficient to draw concrete conclusions, however a few insights can be drawn:

5.1. Quality of tenders from multidisciplinary consultancies

The two rounds of requests for proposals revealed several interesting trends. Firstly, OHS services in a multidisciplinary consultancy or consortium of various disciplines receive minimal attention when bidding for work. This can be seen by the overall low score in the first RFP and the marginal improvement of submission in the second round. In the first round, 60% of the responses were from multidisciplinary companies or consortiums. The consortium that resubmitted in the second round only improved their score by 2 points. This could be because they had an opportunity to focus their efforts on OHS discipline the second time around. The improvement of overall functionality score can be because companies who provide exclusive construction health and safety services responded to the request. These companies accounted for seven out of eight (88%) responses.

5.2. Quality of OHS methodology descriptions

Once again the methodologies submitted by the respondents indicated an improvement in the second round. This could be because of the level of specialisation by the second batch of respondents. Because consultancies in the second batch of respondents specifically worked in the health and safety sector, they were able to develop a more detailed and well laid out plan. Nonetheless the average score of 6.63 is below the threshold requirement of 7. This is disturbing as one would expect that professionals should be able to set out their approach to a project.

5.3. Relevant company experience, relevant personnel experience and completed projects

Lack of experience for the company and personnel in both rounds of responses was low. This could be because the profession is relatively new, as can be seen by the date which Contraction Regulations were put in place. There is an improvement in the second round; this could be attributed to amendments made to the tender document. The second request for proposal specially asked that key personnel be registered with the SACPCMP. The first round of requests did not specify requirements for OHS professionals specifically; instead the request took a general approach for all disciplines.
Interestingly enough, the score for completed projects did not change significantly in both rounds. This shows that even though companies have not been in operation for a significant number of years, they have undertaken sufficient innovative or green projects. This could be because clients who are keen on green building or innovation are more inclined to comply with health and safety regulations.

5.4. Local presence

Local presence scores in both rounds are low because none of the respondents in both rounds were based within in at least 100km radius of the project. Once again, this could relate to the newness of the profession. Established OHS practices are also more likely to be located in larger metropolitan areas.

6. Limitations

The data is sourced from 14 tenders submitted which might be too small a number to derive conclusive findings.
The data reflects tenders submitted for an unconventional project and might not represent industry wide trends.

7. Practical implications

Understanding the challenges facing various built environment professionals during procurement will significantly contribute to the improvement of procurement and bid documents. This is particularly important in order for consulting companies to remain competitive.

8. Conclusion

Literature suggests that consultants' tenders be evaluated on the basis of their methodology, experience and capacity to deliver on the objectives of the projects. CIDB Standard encourages this same approach to the evaluation of tenders submitted by professionals in the built environment. However, the requirement for an OHS consultant in the professional team is relatively new in South Africa. This is because implementation of the Construction Regulations only began in 2014 and the requirement for statutory registration with a professional body in 2013. The newness, in terms of legislative framework, of the profession may be the biggest contributor to the poor bid responses received from OHS consultants compared to more regulatory established professionals such as Architects, Civil Engineers and Quantity Surveyors. The relative newness of the profession may also be a contributor to how clients draft specifications in bid documents. Clients may have a poor understanding of the OHS's role in the project.

9. Recommendations for future research

The evaluation of responses to requests for proposals provided insights with respect to how OHS professionals respond to tenders and how this can be improved. An investigation into multidisciplinary companies regarding their perception of the construction health and safety discipline should be undertaken. This investigation will reveal how these companies view this professional area and their level of dedication towards developing professionals that are suitable to be registered with the SACPCMP. Perhaps including modules on bid preparation at tertiary institutions will improve the quality of tenders submitted by OHS professionals

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Effects of Cash Flow on Project Delivery in the Nigerian Construction Industry

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ABSTRACT AND KEYWORDS

Purpose of this paper
This is to evaluate the effect of cash flow on construction project delivery with a view to establish effective cash flow management in the construction industry.

Design/methodology/approach
It is a desktop-based review and questionnaire distributed for the reasons for cash flow problems, effects and ways of improving cash flow in construction project delivery in the construction industry.

Findings
Many of the methods used to improve cash flow as a subject concern are not adopted by some firms.

Research limitations/implications (if applicable)
Most of the prior research carried out was unreliable, little has been written on ways to improve cash flow on construction project delivery and how it will help to improve infrastructure development and management.

Practical implications (if applicable)
Improvement of cash flow management in construction project delivery could be impacted and helped to improve infrastructural development and management if stakeholders effectively engaged recommended methods of improving cash flow.

What is original/value of paper. An overview on the contribution made by the construction industry, how quantum of unmanaged cash flow has disrupted the prospect of effective project delivery, proffer what is currently being implemented to curb cash flow problem in the construction project delivery in the Nigeria construction industry. Methods and possible solutions were implemented to deal with this problem.

Keywords:
Cash Flow, Cash Flow Forecasting and Management, Construction Industry, Project Delivery and Management, Stakeholders.

Sub Theme:
Infrastructure Design and Delivery Challenges

1. Introduction

Delivery of projects by the Nigerian construction industry is notable for abandonment and delay at different stages. It is a situation that is partially connected with the irregular or delay of cash flow over the construction industry.

The Nigerian construction industry generally operates in a business atmosphere that is notable for high levels of inflation. Therefore, during the time of inflation, there is a need to forecast cash flow in order to avoid awkward cash deficits during the completion of a project (Onkwube, 2005). If cash flow is not properly forecast, the construction industry could be prone to a high incidence of insolvency. One of the reasons for insolvency is insufficient working capital (Akinola, 2010).

Shogo (2005) indicated that the delivery of cash in the required amounts and when needed is a vital aspect of managing a construction project. The preparation of cost-value reconciliations together with the monitoring of cash flow will provide the contractor with proper financial control for the performance of a contract.

According to Ward (2000), cash flow analysis is the study of business cash inflows and outflows which aid in sustaining an acceptable cash flow for the organisation, and is a precondition for cash flow management. The timing of the cash flow is significant.

Therefore, the management of cash flow is vital for any company operating in the Nigerian construction industry. When cash is well managed it tends to generate positive rather than negative cash flow. This is crucial to the survival of any construction company, and failure could lead to insolvency.

Meaning of cash flow

Cash flow is of great importance, because of the need to meet liabilities when they fall due. Cash flow involves the transference of money into and out of an organisation. It is vital that a company has sufficient working capital to pay its creditors, suppliers, subcontractors, and employees and may be reliant on payments in by clients to cover these items (Lowe and Moroke, 2010). The significant of cash flow is related to cash as the primary source of every construction project.

Cash flow is of particular importance to the contractor as it is the only feedback that is likely to be received by the company on the financial performance of the site management team, at least before the contract is completed and the final account settled. This could be many years in the future. Understanding of the cash flow will enable the contractor to identify problems in the running of contract in time to take corrective action if required.

Cash inflows and cash outflows

Cash inflows mean money coming into the company stemming from its operating, investment and financing activities such as: receipt of a bank loan, increased bank overdrafts, shareholder investment, and interest received from savings and investments and payment for goods or services from customers.

Cash outflows are the monies paid out from a company such as payment of wages, salaries, rent and daily operating expenses, purchase stock, raw material and supplies, dividend payments or servicing any debt held. In addition, there may be loan repayments and the reduction of overdrafts, maintenance and income tax and other taxes. Finally, there may be the purchase of fixed assets including plant, machinery, vehicles, office furniture etc.

Cash flow problems

Onukwube (2005) stated that the following reasons among others lead to cash flow problems:

- Insufficient cash flow analysis where there is poor assessment of cash inflows and outflows. When this occurs it will jeopardize the company from achieving its aims of the delivery of projects.
- Delay in payments of clients to contractors of the amount due to them could result in cash flow problems. This occurs when clients do not honour interim certificates when due, thereby reducing the amount of cash resources to carry on with the work.

- Problems of contractors in obtaining financial support. Contractors may not be able to present an organised cash flow projection needed to organise its budget for a period of time. This may make it difficult for the contractors to get financial assistance in the form of bank loans and overdrafts when they need funds. In some cases, this could ultimately lead to insolvency.
- Poor budgetary control. Construction projects need proper budgetary control. This requires a coordinated plan of financial control for the operations of the firm for a specific period of time. Improper budgetary control will inevitably lead to cash flow problems.

Effects of cash flow on construction project delivery

Reh (1997) and Aashwin (2006) classified cash flow effects on construction project delivery into positive and negative cash flow. Positive cash flow implies company cash inflow exceeds its outflow. It may provide an indicator that the company are in good financial health. Money is flowing in and is available to pay accounts and wages. Negative cash flow occurs when the company cash outflows surpass its cash inflows. This could be as a result of too much or obsolete inventory and poor collections on accounts receivable.

Effects of positive or regular cash flow on construction project delivery

Reh (1997) and Aashwin (2006) identify the followings effects of positive cash flow on construction project delivery:

1. Planning and execution of project. A well organised project with proper planning and monitoring with timely funding will help with successful project delivery. The extent to which any kind of project is executed in a timely manner governs the extent to which the project's anticipated cash flow and other benefits are realized.
2. Positive cash flow will ensure that there is adequate funding for the procurement of labour, materials, plant etc. This will apply especially for materials that have to be ordered in advance such as specialist materials, prefabricated units, and those to be sourced overseas. Therefore, delays attributable to inadequate funding will be eradicated.
3. Reliability indicator for lending institutions. A track record of adequate finance stemming from regular cash flow will suggest the contractor is of good status and find it easier to access a loan or overdraft when necessary.
4. Good management of finance will allow the contractor to have control of their working capital. This can be used to fund projects when needed or invested elsewhere when not. This will enable the contractor to optimise their financial arrangements.

5. Timely completion is a vital element. Time is one of the most critical aspects of project success. Positive cash flow management is important to an organisation for timely completion of project under practical and encouraging condition.
6. Better working relationships. Regular cash flow in a project will usually bring a good contractor-client relationship and healthier long term business relationship.

Effects of irregular cash flow on construction project delivery

Reh (1997) and Aashwin (2006) highlighted the following as effects of negative cash flow:

Delay in Completion Time

Irregular cash flow could pose a threat to a project causing delay in completion of a project. The problem of delays in the construction industry is a global phenomenon. Many contractors find it very challenging to stand the heavy regular cash outflows when the payments are overdue. When there is inadequate cash flow work progress on site can be delayed due to late payment in order to cope with construction outlays particularly for those contractors who are not financially buoyant (Mahamid et al. 2012).

Additional Costs

Instability in labour and materials cost, differences in quantities, design changes, extension of completion time, non-availability of specified materials etc. may result in increased costs of a project which could stretch the working capital of the contractor and act as a catalyst for irregular cash flow.

Capital Lock-up

This is a major fall-out of negative cash flows on a project resulting in contractor either having to borrow money to meet their obligations or removing funds from the company's reserves thereby depriving the interest-earning capability of the cash. The replacement of retention on construction contracts with bonding has led to improvements in other countries.

Insolvency

PriceWaterhouseCoopers (2009) described insolvency as when "individuals or businesses have insufficient assets to cover their debts, or are unable to pay their debts when they are supposed to". When contractors are active on site and the client is persistently not honouring payment certificates, the contractor could run out of cash which may make them insolvent. Lowe & Moroke (2010) found that insolvency in the UK construction sector was largely related to cash flow problems rather than poor profitability.

Litigation/Arbitration
Failure of client to honour payment certificate(s) as and when due will deprive the contractor of money. When such rejection is unconnected with claims of different kinds, the contractor can call for litigation or an arbitration proceeding against the client to ensure settlement of disputes under contention.

Abandonment
Abandonment or failed projects are predominant in the public sector. Irregular cash flow, poor or ineffective project finance arrangement, poor planning, difficulty in payment to contractors due to company and client bureaucracy etc. are amongst the various reasons for abandonment of projects in the Nigerian construction industry.

Research Process

Introduction

Cash is the primary involvement desired to keep one's industry running on a constant basis. Irregular or delayed cash flow has a weakening influence on Nigerian construction project delivery: including; project delay, low quality, reduction in profit margin, capital lock-up, litigation/arbitration, additional cost, overhead costs, and total abandonment of work by the construction stakeholders.
Cash has time value which is related to the interest rate. If a project runs into cash flow deficit, either working capital will be required to be borrowed and involve interest outlays or the contractor's own capital will be used involving opportunity costs. When there is a shortage that is far off the expected level which the bank cannot cover it will pose a danger of insolvency resulting in negative cash flow. The resultant effect of this should it occur, is that the contractor may be incapable of paying wages for materials or subcontractors. It will also reduce the sources of income, possibly leading to insolvency as well lead to the termination of contract(s).
In reality, for the period of construction there are countless issues that could disrupt the cash flow in the industry such as; time delays, cost overruns, change orders, profit margin, retention condition, credit arrangements with suppliers (Park Hyung-Keun, 2004) and many more. All of which need the collective efforts of the managerial ability of the parties to the contract otherwise this could hamper the ease or regular flow of cash in and out of construction industry.

Aim and objectives

The aim of the study is to evaluate the effect of cash flow on construction project delivery with a view to establish effective cash flow management in construction industry. To achieve this aim, the study will focus on the following objectives;

- Identify the perceptions and descriptions of cash flow.
- Evaluate the perceptions of the key players on the effects of cash flow as related to construction project delivery.

Methodology

Data were obtained from primary source using a structured questionnaire. This was done with respect to completed projects, which gives the respondent the chance to take account of all problems. The score for the implications of cash flow problems and their effects on construction project delivery were given using a five-point scale Likert type.
A total of 136 structured questionnaires were delivered personally to the selected construction firms' sites. Of the completed questionnaires, 96 (71%) were found suitable for analysis. Statistical tools such as mean score method were employed as ordinal data of analysis. The stated hypothesis was tested using a Chi-square test.

Data Analysis

Data presentation

The main results are presented in Table 1 below (where M= Methods; N= Numbers of respondents; MS= Mean Score):

Table 1. Reasons for cash flow problems during construction project.

M	N	MS	Rank
DP	96	4.72	1
DF	96	4.61	2
IB	96	4.54	3
PC	96	3.80	4
IS	96	3.74	5

Table 1 indicates that: DP = Delay in payment to contractor with mean score 4.72, DF = Difficulty in obtaining financial aid (4.61), IB = Inadequate budgetary control (4.54), PC = Poor credit control (3.80) and IS = inadequate supplier management (3.74) were ranked 1st, 2nd, 3rd, 4th and 5th respectively. This shows that the client delay in payment to contractor cause delay in project delivery.

Table 2. Effects of positive cash flow on construction project delivery.

E	N	MS	Rank
AP	96	4.23	1
AS	96	4.20	2
TP	96	4.15	3
PC	96	4.03	4
RL	96	4.01	5

Table 2 indicates that: AP = proper planning and well-coordinated project will result in positive cash flow on project delivery as shown above with a mean score of 4.23. AS = Availability of sufficient cash to meet demands (4.20), TP = Timely completion of project (4.15), PC = proper utilization of cash resources (4.03), and RL = Reliability indicator to lending institutions came with the lowest mean score of 4.01.

Table 3. Effects of Irregular cash flow on construction project delivery.

E	N	MS	Rank
CL	96	4.28	1
DT	96	4.24	2
AP	96	4.19	3
RP	96	4.14	4
AC	96	4.07	5
LA	96	4.02	6
LI	96	3.78	7

Table 3 indicates that: CL = Capital lock-up was ranked highest with a mean score of 4.62, DT = Delay in completion time (4.52), AP = Abandoning of project (4.19), RP = Reduction in profit margin (4.14), AC = Additional cost (4.07), LA = Litigation/Arbitration and LI = Lack of incentive was ranked sixth and seventh with a mean score of 3.94 and 3.78 respectively.

Table 4. Efficiency of cash flow improvement methods.

M	N	MS	Rank
RV	96	4.61	1
TF	96	4.54	2
IC	96	4.48	3
RS	96	4.10	4
AV	96	4.06	5
PC	96	3.88	6
DS	96	3.85	7
AF	96	3.76	8
CP	96	3.47	9

Table 4 indicates that: RV = regular submission of valuations will serve to improve cash flow problems as it was rated highest as 4.61. TV = Taking full advantage of credit facilities (4.54), IC = insisting on accuracy in valuations and certificate (4.48), RS = Reduction of altogether stock of materials of 4.10, AV = Adequate assessment and inclusion of variation as 4.06, PC = Pursuing valid claims as 3.88, DS = Discount and retention monies properly claimed against nominated subcontractor and suppliers as 3.85, AF = Agreeing final account of 3.76, and CP = Carrying out maintenance promptly is 3.47.

Test of hypothesis

Ho: There is no difference in the perception of stakeholders on the effects of cash flow on construction project delivery.
H1: There is difference in the perception of stakeholders on the effects of cash flow on construction project delivery.
The Chi-square test was carried out and the results are tabulated below:

Table 5. Positive effects of cash flow.

	PefApe	PefPur	RefRili	PefAd	PfT
Chi-square	7.75	3.94	.063	7.94	7.31
Degrees of freedom	2	2	2	2	2
Assumed significant	0.021	0.140	0.969	0.019	0.026

From table 5, PefApe = Adequate planning and execution of project, PefPur = Proper utilization of cash resources, PefRili = Reliability indicator for

lending institutions, PefAd = Availability of sufficient cash to meet demand, PfT = Timely completion of project.

Since χ^2 calculated >χ^2 tabulated we conclude that there is a difference in the perception of stakeholders on these positive effects of cash flow on construction project delivery.

Table 6. Negative effects of cash flow

	NfD	NfRm	NfA	NfC	NfP	NfLa	NfLi
Chi-square	9.44	4.94	3.06	11.44	6.75	3.06	6.94
Degrees of freedom	2	2	2	2	2	2	2
Assumed significant	0.009	0.082	0.216	0.003	0.034	0.216	0.031

NfD = Delay in completion time,
NfRm = Reduction in profit margin,
NfA = Additional cost
NfC = Capital lock up
NfP = Abandoning of project
NfLa = Litigation/Arbitration
NfLi = Lack of incentive

Since χ^2calculated > χ^2tabulated we conclude that there is a difference in the perception of stakeholders on these negative effects of cash flow on construction project delivery.

Summary of results

The research revealed the fact that inflation affects the firm's projected cash flow and has adversarial effects which includes;

- Cost/time overruns
- Capital lock-up
- Insolvency and liquidation.

Also, it was discovered that there is a difference in the perception of stakeholders on the positive effects of cash flow on construction project delivery and that there is a difference in the perception of stakeholders on the negative effects of cash flow on construction project delivery.

Conclusions and Recommendations

Main conclusions

Conclusions were made based on the analyses and the results obtained from the data collected as follows:

- The construction firms examined in this study are faced with cash flow difficulties, in which their major reason for such problems are;

delayed payments, difficulty in obtaining financial aid, poor budgetary control, and poor planning.

- The sources of funding that are frequently used by construction companies to resolve their cash flow difficulties are; bank loan, bank overdraft and financial reserves from retained profits.
- It was deduced that firms' anticipated cash flow is affected by inflation, which triggers significantly irregular effects on project delivery. These include; insolvency, cost/time overruns, and capital lock-up.
- The disturbance of the original intentional project programme was often a consequence of cash flow problems. These include; difficulty in obtaining financial aid, inadequate budgetary control, delays in payment to contractors, poor credit control, and inadequate supplier management.
- The following practices are being used to improve cash flow; regular submission of valuation, insisting on accuracy in valuations and certificates, pursuing valid claims, carrying out maintenance promptly, taking full advantage of credit facilities, agreeing the final account, and reduction of stock of materials.

Recommendations

Based on the conclusion, the following recommendations that might result in improvements are made:

- Continuous professional development for key staff using lectures/seminars should be organized by the educational and research establishments in order to raise awareness of the benefits by means of cash flow analysis to plan and manage their projects.
- The contractual arrangements should require the clients to honour interim certificates as and when due so as to avoid late payments.
- Contractors should organise advance finance from bank such as overdraft or loans to be repaid as soon as possible.
- The need for frequent checks, to monitor and appraise the construction programme is to be recommended.
- Fluctuation clauses should be included as part of the conditions of contract by the construction companies before the signing of any contract where inflation is likely to present a problem.
- The initiation of variations and introduction of inefficient use of resources with the attendant cost and time overruns made some changes in the construction programme; therefore, the contract forms should be structured to reduce the incidence of variations.

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It's good for you don't worry: A comparison of South African and the UK consultation protocols

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ABSTRACT AND KEYWORDS

Purpose of this paper
Not a week passes by in South Africa without a major public protest at the local municipality level being shown on national television. This research sought to run a comparison between South Africa and major democracies to see if consultation protocols in South Africa are either adequate, misdirected, inappropriate or not inclusive enough.

Design/methodology/approach
A case study of Gauteng Highway Improvement Project (GFIP) was utilised to assess the consultation because of its sheer size, reach and centrality.

Findings
The South African consultation processes could be amended to compare well with international practices especially as they are bolstered by a very democratically advanced constitution which dictates a very inclusive governance at all levels. The implementation of the consultation processes is weakened by a lack of robust monitoring regimen and elaborately prescriptive and frequentative directive(s) to ensure the elimination of box ticking and superficiality in implementation.

Research Limitations/Implications
The research uses one case study and its findings might be contestable but the observations are insightful enough to provide some pointers on the weaknesses of the current approach.

What is original/value of paper
The study challenges the commitment of the state on consultation and proposes a very robust consultation regimen.

Keywords: grassroots, consultation, public resistance, marginalization, democracy

1. INTRODUCTION

An early and effective communication with constituencies is a vital part of any major infrastructure planning application. Not only is it a legal requirement in most jurisdictions, it is also helpful in gauging the sentiments of the general populace towards the scheme and their critical input could mean a minor adjustment resulting in a wider acceptability and embracement of the scheme. The technological advances enabling social media platforms to be accessible and usable by everyone everywhere means most people could have an input for and against a development (Freshwater, 2017). This will be helpful in stopping any wasteful expenditure which could occur if the stakeholders are not properly engaged with. Timing is also crucial in implementing this process as a delayed consultation process could be interpreted as a tick box exercise with no real substance (ibid). The problem is so critical that the European Union has established peer review mechanism for member states for the voluntary ex ante assessment mechanism for large infrastructure projects. The intention is to set up reference classes of similar projects, where member states' authorities can learn from each other (European Commission, 2017). The different aspects of projects that are targeted are:

- The type of procurement procedure
- The costs of similar projects
- The stage in developing the project
- The problems in implementing the project

This development above shows that public consultation even in the developed countries is still work in progress. But these countries are starting from a much higher base since most of them have been democracies for a long time. South Africa on the other hand was characterised by high levels of authoritarianism and state-societal conflict from the colonial, then apartheid, through to the beginning of a fully representative democracy in 1994. The transition is not smooth either, as there is still widespread suspicion of state agencies even though currently such agencies are headed by democratically elected officials (South African Legislative Sector, 2013). The nature and focus of public participation has dramatically changed with the promulgation of the democratic constitution in 1996, which at its core stipulates that South Africa is a representative and participatory democracy. However lack of communication and clear channels to communicate are a clear indication

according to Allan and Heese (2017) that there is a lack of information dissemination which sometimes leads to rumours of corruption and mismanagement which are often untrue. The study sought to establish if there is any legal stipulation on what processes to follow before implementing an infrastructure project and run comparison with a mostly the UK (and other established democracies), a country which has provided so much inspiration for much of the South African legal structure.

2. LITERATURE REVIEW

Public consultation refers to a two way exchange of information which eventually results in the exchange of information and ideas between concerned parties who share a common goal, which is to ensure that a specific project is executed efficiently. For public consultation to be effective it requires interest from the general populace whose opinion will guide the final decisions (Klievink, 2011). Participation is defined as the act of actively participating in an ongoing process or activity. Participation also refers to a joint method of taking decisions which affect multiple stakeholders at a given time. Public consultation which must be reciprocated by a popular participation (response) is widely used as a tool to improve the delivery of public infrastructure projects. Public infrastructure is defined as the building blocks of a Country in that it is said to be the basic physical system of a Country. Public infrastructure projects are in a general sense referred to as all projects that are made for public use as well as for public betterment as a whole. Public infrastructure is said to include Transport, Aviation, Road and Waste infrastructure projects (Papaioannou, 2012). From the definition it is clear that public infrastructure projects are built to improve the lives of the general populace, therefore it is only fitting that the public consultation which is aimed at addressing the needs and concerns of the general populace is used (Rowe & Frewer, 2000). Consultation is not really written about in the developing countries as governments implement grandiose schemes whose benefits are not communicated satisfactorily to the general populace.

Countries at the forefront of public consultation protocols implementation are said to be the leading Commonwealth countries namely the United Kingdom, Canada and Australia. However other democratic countries such as the Majority of the Nations in the European Union (EU) and The United States of America have also developed effective public consultation protocols over last few decades (Sorensen & Torfing, 2009).South Africa is not far behind the countries that set the standard in efficient public consultation protocol in terms of the protocol contained in South African legislature (Catt & Murphy, 2003). However even though South Africa does possess legislation setting out the way public consultation should be carried out this has not prevented widespread public protests against the implementation of certain public infrastructure projects such as the protests

seen in Gauteng against the Gauteng Freeway Improvement Project, which may have been as a result of a cosmetic public consultation. A cosmetic public consultation is defined as a public consultation process carried out purely with the intention of doing it as an obligation and not in the true spirit of participatory public decision making (Klievink, 2011). The South African legislation is not very prescriptive on the protocol the processes contained therein when it comes to public consultation.

2.1 Benefits of Public Consultation

Public consultation can be advantageous in that the community will not resist the implementation of government infrastructure projects implemented because they would have known about them beforehand (Klievink, 2011). A trust between the public and the government will be fostered as a result. This trust will occur as people tend to be more trusting towards organizations that include them in major decision-making processes, especially when they are directly affected by the impacts of those decisions. If this is entrenched the public will feel respected and more acceptable in the society and this sense of worth will spill over to other spheres of life in general, in terms of cooperation and seeking a less conflictual interaction with the authorities (Sorensen & Torfing, 2009). A plethora of public protestations in South Africa resisting the implementation of sometimes vital infrastructural project could be indicative of a weak consultation regimen which might not adequately incorporate contextual dynamics.

2.2 Public Consultation Internationally

In the United Kingdom (UK) the government has set out a list of principles which highlight how public consultation should be conducted, these principles are as follows (Van Damme & Brans, 2012):

- *Consultation must be clear and crisp.*
- *Consultations must have a specific purpose.*
- *Consultations must be overtly informative in its disposal of information.*
- *Consultations are only part of a process of engagement.*
- *Consultations must last for a balanced period of time*.
- *Consultations must be targeted*.
- *Consultations must take into account the groups of people being consulted*.
- *Consultations ought to be agreed by all concerned ahead of publication*.
- *Consultation must enable scrutiny*.
- *Government responses to consultation should be published in a well-timed fashion*.

- *Consultation exercises must not be launched during election periods (Burkert, 2004)*

The government in the United Kingdom have set high standards in the international arena to ensure that the UK's public consultation process is one of the best possible practices. In a published document by the government it further highlighted the importance of public consultation, according to (Hutton, 2011). Ongoing dialogue between Government and stakeholders is an important part of policymaking. This interchange of information will at certain times need to become more formal as well as public (Yolken, 2011). When developing a new policy or considering a change to existing policies, it would be desirable to carry out a formal, time-bound, public, written consultation exercise. This kind of exercise should be open to anyone to respond but should be designed to pursue views from those who would be affected by, or those who have a particular interest in, the new policy or change in policy. Formal consultation exercises can exposed to public scrutiny as well as the government's preliminary policy analysis and the policy options under consideration (Bannon & Russel, 2011).

2.3 Public Consultation in South Africa

Public consultation is a relatively new concept in South Africa owing to the fact that the country was not a democracy due to its implementation of the Apartheid policy which ended in the mid 90's (Nyalunga, 2006). The previous government created race-based municipalities to facilitate and regulate the suppression of participation by African, Indian and Coloured communities. Under Apartheid, the bulk of power resided at the centre, with local government being the lowest tier within a strict hierarchical structure. After the fall of apartheid the Government has focused its energies on public participation in order to allow the population of the county to have an input in decisions that may affect them. The South African Local Government Association SALGA further says: The Constitution of the Republic of South Africa is underpinned by the principles of good governance, also highlighting the importance of public participation as an essential element of successful good governance (South African Legislative Sector, 2013).

There are regulations in South Africa making it a right for citizens to participate in the consultation process (Nyalunga, 2006). They are clear about the need to legally streamline public participation by providing for the right to:

- contribute to the decision making process of the municipality;
- be informed of decisions of the municipal council;
- Disclosure of the state of affairs of the municipality (Nyalunga, 2006).

According to SALGA (2013) the criteria for the consultation is as follows:

- The participants should be representative of the general populace it is aimed at. It may be likely that it will not be conceivable to comprise of every member of the populace but the aim is to strive to contain all the identified benefits comprising cross-border trepidations.
- The process described ought to be independent of any political entity or private investor's securities. Caution must be reserved to evade relying on politically affiliated local structures.
- There should be relatively prompt participation of the general populace. As soon as the relevant committee has identified a need for policy, it should transfer the alleged need to the general populace
- The inputs by participants should influence policy. For public participation to be consequential, the general populace must have assurance that their offering will impact judgement making. Furthermore, the public must collect comment on each conclusion of their contribution.
- The process should be transparent. The process of participation should be easily transmitted to all parties that are said to be affected (SALGA, 2013).

Even though there are laws and guidelines set to ensure the success of consultation processes, they do not always work, and according to Nyembezi and Waterhouse, (2012) the reasons for the failures are as:

- Party politicization of development and participatory framework (Malahleha, 2011).
- There also appears to be a lack of commitment from local government and municipalities to highlight the public consultation process (Adler, 2000).
- The slow pace of basic service delivery impedes not just the general populace's participation but also prevents average South Africans from partaking in a satisfactory standard of living conditions (Nyembezi & Waterhouse, 2012).
- A general lack of capacity amongst public stakeholders.
- Access to information surrounding the benefits and cost relating to the infrastructure projects being implemented is not provided in its entirety to the populace being consulted (Nyalunga, 2006).
- The subsequent Failure to identify and work diligently with community based organizations on achieving common goals (Nyembezi & Waterhouse, 2012).

The stipulations of the current legislative stipulations are broadly useful where there is a will but it appears as if they is do not compare well with

their for instance UK counterparts in elaborateness. A strong will from the officials could deal with this impediment and the following sections will enlighten on the implementation aspects of consultation and the views of the members of the public.

3. METHODOLOGY

When selecting a certain research methodology it is said that a researcher should select a research methodology whose assumptions are best met by the phenomenon being investigated (Leedy & Ormond, 2010). The setting for the research was a case of the Gauteng Freeway Improvement Project in Gauteng with has been met with a stiff resistance from the masses. The nature of the problem requires a mix of both the qualitative approach and quantitative assessment of the opinion of the general populace. The two primary methods of data collection that were used in this research study are interviews and questionnaires. Qualitative research consists of a systematic inquiry into the nature of certain behaviours by using interpretivist methods (Simon, 2011). Semi-structured Interviews were conducted with officials in implementing agencies and regulatory bodies to assess the role that the government is currently playing with regard to the implementation of public consultation protocol in South Africa. Professionals from all the companies involved were interviewed as well. Interviews are useful when one seeks to get the story behind the experience of a participant. Interviews offer additional in-depth information relating to participant's experiences of a certain topic or area of knowledge (Briggs, 2000). Typically it is said that unstructured interviews can be time consuming and problematic in terms of the analysing of the data accumulated (Zhang & Wildemuth, 2006). The questionnaire method was used to solicit the sentiments of the motorists in Gauteng as it has an advantage over the interview method of data collection as questionnaires can be aimed at a wider audience when compared to an interview process (Foddy, 1993). Questionnaires provided this study with a relatively quick and efficient way of gaining large amounts of data from a large sample of people (A general populace). Questionnaires are effective in the analysis of the behaviour, attitudes and preferences of a general populace (OECD, 1995). The surveys were conducted strategically in malls located in around Johannesburg where the team members handed out surveys to local motorists in order to gauge their opinion/s on the effectiveness of public consultation protocol carried out on public infrastructure projects in Gauteng- the GFIP in particular. 403 people cooperated with the researchers. The reason for the choice of the malls as location to gather data for surveys is that a mall is generally a social area where people come together with the purpose of mingling and therefore they are not averse to conversation to people they are not familiar with and the questionnaire were kept relatively short to not deter people from assisting.

The approach in this study is similar to the one taken by Leromanachou et al (2006) with regards to the Norway's urban tolling where reports, articles, grey literature and a series of semi-structured interviews with the members of the Norwegian Public Road Administration and local authorities were had. The mixed method approach advocated for earlier on was opted for because it was thought both methods together enhance the perspectival clarity of the research problem intensely than either type by itself (Creswell, 2008). The multiple viewpoints accorded by this approach pits the subjectiveness (which provides depth) of qualitative data against the objectiveness (which provides girth) of quantitative approach. This is complementarily beneficial in assisting researchers in properly appreciating the nature and extent of the phenomenon under scrutiny. Interviews elicited common themes from the respondents and the thematic analysis was used to code these themes, after which they were grouped in order to glean any commonalities that might be meaningful. There are two stages to treating themes, the semantic and the latent level. The semantic looks at the surface meaning of what the data says and does not go beyond what the respondent has actually uttered (Patton, 1990). The overall research design is Convergent Parallel Design where quantitative and qualitative data collection and analysis is done separately but the results of both the questionnaires and interviews are compared and related to offer a substantive interpretation. Not only does this approach offer corroboration from different methods but it proffers a more complete understanding from the two databases.

The limitations to this study are chiefly emanating from the utilisation of a single case study which will make the generalisability of the observations contestable. The motorists who responded to the questionnaires distributed might not necessarily be from Johannesburg at all, there was no practical way of confirming this. The study is not complete as there was no objective self-criticism from the government side and therefore the conclusions might not be as rounded as the researcher had hoped.

4. RESULTS AND FINDINGS

Five officials' responses from the companies that took part in the interviews are shown below. The government officials for their part were adamant that everything that could be done to inform people about the Gautrain project was done so their input did not have much utility at the end of the day. Five respondents were involved in interview lasting about 45 minutes each. Only the major highlights are shown below.

Table 4.1 List of interview respondents

Profession	Participant
QS	P1
QS	P2
CM(Working for a contractor)	P3
Civil Engineer	P4
Architect	P5

P1: Believes that public consultation is secondary as the need for development is paramount and should be guiding how decisions are made. However P1 did concede that the decision to implement the GFIP was imposed on the people.
P2: the decision to advertise the project (GFIP) was put on newspaper sections that people would not ordinarily look into, meaning there was an intention for malicious compliance.
P3: there is a gaping disparity between what the legislation is stipulating and what is being practiced when consulting the general populace.
P4: the members of the public are consumers of the project and they have to be informed first and at every stage along the way.
P5: the government does not abide by its own recommendation when it comes to infrastructure implementation and public consultation.

The following figures show the salient data that was garnered from questionnaires distributed to motorists in Johannesburg Malls.

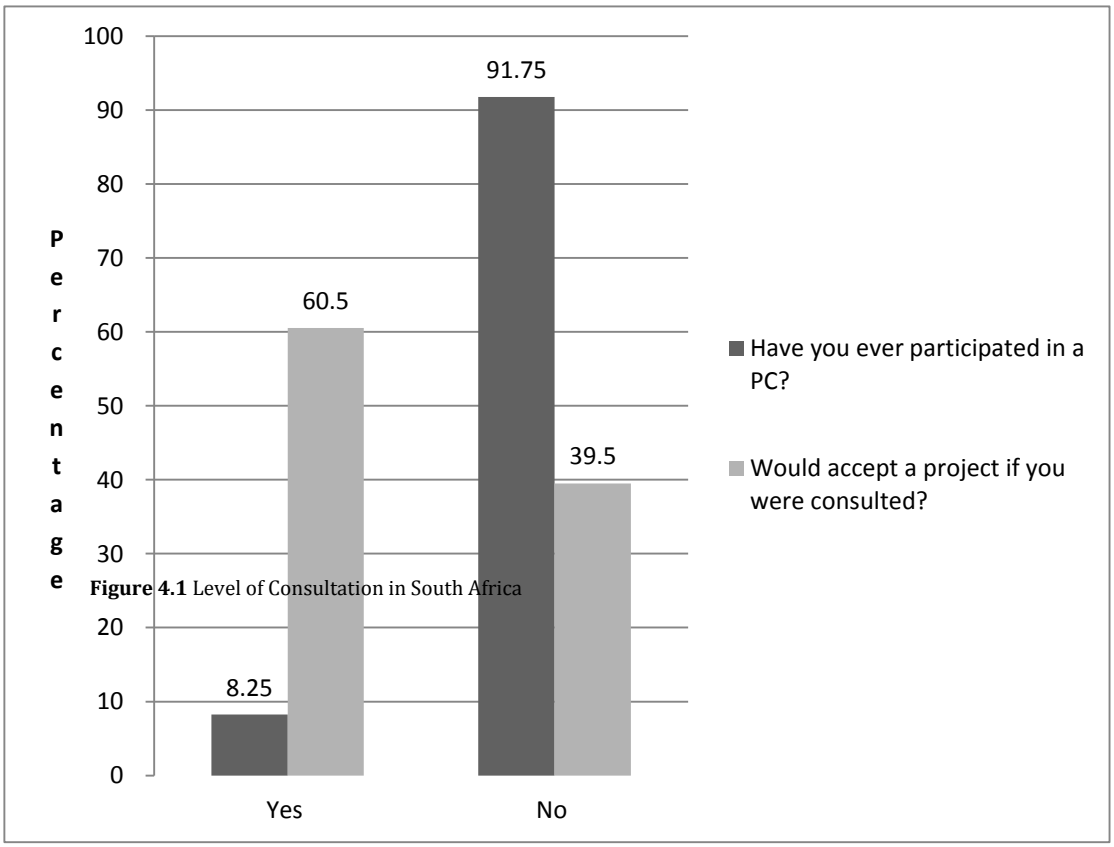

Figure 4.1 Level of Consultation in South Africa

As can be seen in figure 4.1 above a simple implementation of the consultation process with a bit more diligence could lead to a wider acceptability of the projects. As was the case with GFIP project the rejection stems from the fact that members of the public did not feel that they owned the project.

The consensus from the questionnaire respondents and interviewees in the figure 4.2 below is that South Africa has got comparable consultation protocols which if they were followed they could lead to a wider acceptability of the projects. The professionals, who assist the government in projects especially in the GFIP Project that was widely resisted, show that the government does not abide by its own consultation stipulations. It can also been seen from the responses above that the main reason for project resistance is the suspicion that there is a widespread corruption in the government. A proper dialogue would go a long way in mitigating the suspicion or assisting the very government in tackling it, if it is the real problem. There appears to be a disconnect between the communication platforms currently used by the government compared to what the public currently have access to. The government is not doing enough to keep up with the times.

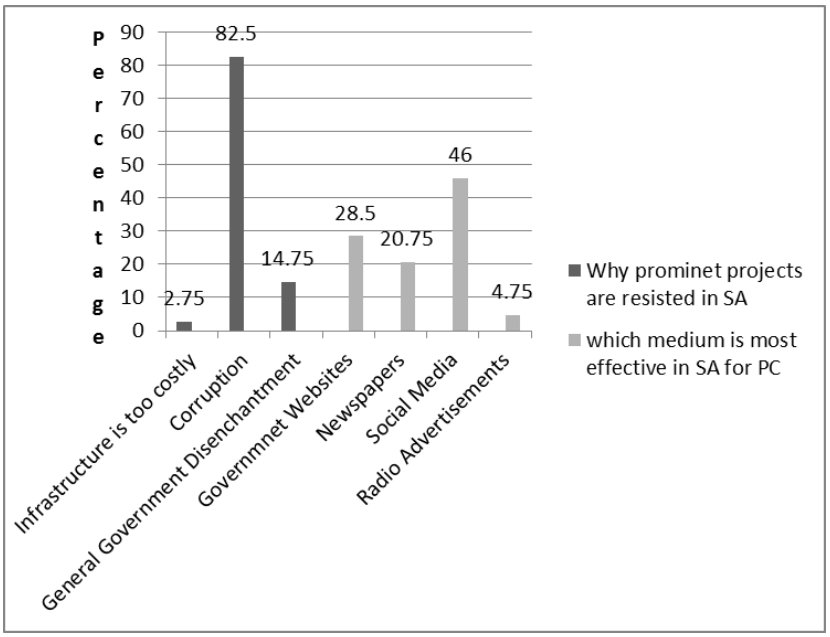

Figure 4.2 Consultation Approach and Projects Resistance in S.A.

5. CONCLUSIONS

Although South Africa is a constitutional democracy with well-articulated precepts on attaining a very consultative and inclusive governance, it appears that a lot of work still has to be done to ensure enforcement and monitoring of the government agencies. The disconnect between the well-structured and magnificently worded writs and implementation is indicative of a very indifferent civil service when it comes to diligently soliciting the sentiments of the consumers of the government infrastructure. This leads to virulent public protestations as the harboured misgivings of the fiscus mismanagement are voiced late in the projects' implementation leading to costly delays. The government should:

- Ensure robust monitoring mechanisms are put in place to ensure consultation is done as prescribed by law.
- The communication methods should be overhauled to reflect the advances in information technology
- Only the methods with a wider appeal and reach should be invested in.

The culture of thinking and providing for the public should be changed as its paternalistic undertones are resulting in a lot of resistance.

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Public Procurement reforms in Ghana: Impact on the growth of the local Construction Industry

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ABSTRACT

Purpose:
The study investigates how the various procurement reforms instituted by the government of Ghana have impacted on the growth of the Ghanaian construction industry.

Methodology
The research instrument used is the interview guide made up of tick box and open-ended questions to interview 37 construction firms operating from Accra, Ghana were interviewed. The Head of Public Relation Officer of the Ghana Procurement Authority was also interviewed. Other sources of data included archival records such as contracts awarded, the current public procurement regulations, and manuals.

Findings
The findings show that, even though public procurement reforms have brought about improved procurement practices and increased the participation of the local contractors in the procurement processes, the reforms have failed to have a significant impact on the growth of the local construction industry.

Research Limitations
Out of 69 construction and consultancy firms targeted for interview, 37 were reached for interview and all the firms interviewed are operating in Accra.

Practical implications
The findings of this study provide an opportunity to government to improve her procurement policies to help grow the local construction industry.

Value of the paper
The research has produced a procurement model with improved protective mechanisms that will help grow the local construction industry. The study provides recommendations to all stakeholders in the Ghanaian construction industry and proposes that the procurement model produced by this study be used in the public procurement system to help grow the indigenous construction industry.

Key Words: Public procurement reforms, Ghana, Act 663, Local construction industry, Growth

1. INTRODUCTION

All over the globe and over the years, nations and international bodies have been concerned with how to modernise, simplify and improve public procurement practices using public policy and legal reforms (Schooner, Gordon & Clark, 2008). The target for reforming public procurement systems has been to reap the associated reward of improved competition with the attendant efficiency and lowered contract costs (Bovis, 2010). Since the 1990's there has been a wave of reforms initiated in developing and developed nations alike in response to the plodding of international bodies such as the World Trade Organisation-Agreement on Government Procurement (WTO/GPA) of 1994, the World Bank and the Organisation for Economic Co-operation and Development (OECD) (Evenett & Hoekman, 2005). Having linked the fight against corruption in public procurement to economic development, many organisations have been encouraging reforms in public procurement systems, particularly in developing nations (Evenett & Hoekman, 2005).

Making procurement systems more effective, efficient and transparent has therefore become an unending issue of governments and the international community. It is of no surprise that many countries have geared toward strengthening the effective use of public funds, as well as other funds provided by their development partners through effective public procurement system that meets international standards (Osei-Tutu *et al.,* 2011). Due to the indispensable role of public procurement in socio-

economic development of countries, the World Bank specifies three thematic areas of public procurement for its funded projects. These are, ensuring that there is fair competition among bidders, promoting transparency in awarding and execution of its contracts and finally, encouraging the development of indigenous contractors and suppliers (Thai, 2001).

In Ghana, public procurement amount to 50%-70% of the national budget (after personal emoluments), 14% of GDP and 24% of imports and hence public procurement has both social and economic effects on the country (World Bank, 2003). The impact of the public procurement system on construction industry is therefore important as the industry has effects on the country's Gross Domestic Product (GDP) and social needs, such as housing, in Ghana.

The growth of the local construction industry is a priority of many governments including that of Ghana. The use of public procurement reforms to achieve social outcomes is widespread as many governments, over the years, have attempted to use public procurement reforms to achieve desired social policy outcomes (McCrudden, 2004). Since government procurement in developing countries accounts for over 50% of the national budget (McCrudden, 2004), reforms in public procurement laws have major impact on the local construction industry. A study of the available literature has revealed that no effort has been made in the area of research that seeks to identify the impact of public procurement reforms on the local construction industry in Ghana, hence the need for this research.

In their assessment of the Impact of the Public Procurement Act, 2003 (Act 663), Frempong *et al,* (2013), acknowledge the benefits derived from using the Public Procurement Act, 2003 (Act 663). These they suggest include "the assurance of quality goods, timely delivery of goods, right delivery of right quantities, transparency, reduced corruption, value for money, uniformity in performing procurement activities, economic and efficient use of state resources and harmonization of public procurement processes in the District Assemblies and also greater efficiency". But they agree with Afoakwa (2013) that there are difficulties in applying and implementing the Public Procurement Act, 2003 (Act 663). They mentioned some of these implementing difficulties as lack of usage flexibility, lack of authority to dispose public assets, the lack of an independent procurement auditing function, lack of a central body with technical expertise and inadequate thresholds for entities such as District Assemblies in case of emergency situations. They therefore concluded that even though the Public Procurement Act has been largely effective, it needs to be amended to include provisions for electronic procurement to improve transparency, accountability, and compliance within public procurement systems. They however, did not talk about the impact of the Act 663 on the local construction industry.

It is no surprise that Ameyaw *et al,* (2010) found that the tender evaluation stage of the procurement process is the most susceptible to

corrupt practices and thus the evaluation panel as provided by the law should therefore be closely monitored to foil any attempt by unscrupulous bidders to bribe officials at this stage. They suggest that a lot of things happen during this stage and that the evaluation panel is sometimes pressurized to disqualify the most competitive tender and rather recommend favourites of politicians or those in authority and in other instances corrupt bidders pay their way through the evaluation team to use all foul means to disqualify other bidders to their advantage. This clearly shows that the various procurement reforms including the current procurement law (Act 663) do have implications on the local construction firms as local contractors may not have enough funds to pay their way through at the tender evaluation stage.

Even though the PPA (Act 663) of Ghana is reputed to be an integrity promoter and corruption resistant (Osei-Tutu *et al.,* 2011), the implication of the Acts on the local construction industry is largely unknown. This research therefore seeks to identify the impact of the public procurement reforms instituted by Ghana on the local construction industry.

1. Research Objectives

The main research objectives are as follows;

1. To find out the effectiveness of these public procurement reforms
2. To find out how public procurement reforms have affected contractor/consultant selection for public works.
3. To find out the impact of public procurement reforms on the growth of the local construction industry.

2. LITERATURE REVIEW

2.1 Why public procurement reforms

Various methods and strategies have been employed to ensure public procurement reform conforms to the international standard. The purpose of public procurement reform differs from country to country; however, reforms are generally aimed at a common goal. Watermeyer (2000), indicates that procurement has been used by various governments to achieve several goals such as to: stimulate economic activity, protect national industries against foreign competition, improve the competitiveness of certain industrial sectors and remedy regional disparities. Procurement has also been used to foster the creation of jobs; promote fair labour conditions; promote the use of local labour as a means to prevent discrimination against minority groups; protect the environment; encourage equality of opportunity between men and women; and promote

the increased utilisation of the disabled in employment in order to achieve social policies set out by the government.

In most developed countries, public procurement reforms take place as result of international obligations, such as the World Trade Organisation's Agreement on Government Procurement or regionally agreed Procurement Directives as the European Union or the North America Free Trade Agreement (Watermeyer, 2000). The requirements by the World Bank and other donor organizations in recent years have however augmented the need for reform as the provision of development aid are now based on how efficient the country's procurement systems are; and as most developing countries depend on income such as foreign aids and assistants from international institutions such as World Bank to support their budget, they have no alternative than to reform their public procurement and financial management systems (Watermeyer, 2000).

2.2 Public procurement reforms in Ghana

The World Bank (2003) estimated the annual value of public procurement for goods, works, and consultancy services, at six hundred million dollars (US $600 million). This value is about 10% of the country's GDP and the bulk of the public procurement expenditure was spent on Municipal and District Assemblies (MDAs) and District Assemblies (DAs). The MDAs and DAs spent much on capital investment procurement (Westring, 1997).

According to the World Bank (1995), the procurement of construction works and services in Ghana have been mainly regulated through circulars from the Ministry of Finance complemented by other procedures evolved by convention in connection with the control of procurement exercised by the ministry. The Central, Regional and District Tender Boards also processed and awarded contracts in accordance with thresholds defined by the World Bank Procurement Guidelines and the World Bank Consultant Guidelines (World Bank, 1996).

The shortlists used on World Bank-administered projects for the selection of consultants were identified to be repetitive, with many instances where the same firms were selected for civil engineering and building works supervision (World Bank, 1995). Also, identified in most cases were situations where a single contractor was buying and pricing all the bidding documents and several contracts awarded to the same contractor/supplier, under different contracting names (Westring, 1997).

The World Bank (1995), suggest that conflict of interest, bribery, embezzlement, kickbacks, tender manipulation and fraud are observed corrupt practices in the Ghanaian infrastructure projects delivery and procurement system. The severity of corruption practices therefore increased the intensity of searching for value for money in delivering infrastructure projects. To arrest corruption practices in procurement

processes, it would require the constitution of an efficient procurement system and pro-social equity policies that would foster good governance, corporate social responsibility, transparency, accountability, prudent public expenditure and national progress. The introduction of new public procurement regulation (Public Procurement Act, 2003) was therefore long overdue.

2.3 The PPA, 2003 (Act 663 of 2003)

The Public Procurement Law (PPL), 2003 is a comprehensive legislation designed to eliminate the shortcomings and organizational weaknesses which were prevailing in public procurement systems in Ghana. To address perception of corrupt practices and inefficiencies, the government of Ghana, in consultation with its development partners identified the public procurement system as an area that required urgent review to build trust in the procurement system. A study by the World Bank, (2003a) reported that about 50-70% of the national budget (after personal emoluments) is procurement related in Ghana hence an efficient public procurement system could ensure value for money in government expenditure, which is essential to a country facing vast developmental challenges.

To ensure sanity and value for money in the public procurement environs, the government of Ghana in 1996 launched the Public Financial Management Reform Programme (PUFMARP). The purpose of the programme was to improve financial management in Ghana because of weaknesses identified in the procurement system over the years. These findings by PUFMARP led to the establishment of the Public Procurement Oversight Group in 1999. The task of this oversight group was to design of a comprehensive public procurement reform programme which led to the drafting of a public procurement bill in September 2002. In 2003, the Parliament of Ghana enacted the Public Procurement Act to help procurement activities in the country and to enhance the procurement reforms. As Kotoka (2012) suggests, the Act 663 has contributed some level of sanity into the construction sector.

2.4 Overview of the construction industry in Ghana

The construction industry is defined as “a group of firms with closely related activities involved in the construction of real estate, buildings, private and public infrastructure” (Lange, and Mills, 1979). The industry also deals with renovation, repair or extension of fixed assets in the form of buildings, land improvements of an engineering nature and other construction works such as roads, bridges and dams. The construction industry is important in Ghana because infrastructure facilities required for improved living

conditions are relatively scarce (Eyiah, 2004). In Ghana, the industry has a big potential to help accelerate economic growth.

Gold, timber and cocoa production are major sources of foreign exchange in Ghana and the domestic economy continues to revolve around subsistence agriculture, which accounts for about 40% of GDP and employs 60% of the workforce in Ghana (Government of Ghana 2006a). The construction industry currently takes the fourth position in government expenditure in Ghana, outstripping goods and services (The Budget Statement, 2016) (see table 1). The construction industry is expected to grow by 30.60% by the end of 2016; outperforming all other areas such as petroleum, manufacturing, mining and quarrying according to the The Budget Statement, (2016) (see table 2). This trend shows how important the construction industry is to economic development.

Table 2.1: Government expected expenditure for the year 2016

Expenditure items	Budget expenditure in (million cedis)	Rank
Compensation of Employees	GH₵14,023.99	1
Goods and Services	GH₵2,536.78	5
Interest Payments	GH₵10,490.60	2
Subsidies	GH₵50.00	7
Grants to Other Government Units	GH₵9,651.42	3
Social Benefits	GH₵75.43	6
Capital Expenditure	GH₵6,676.88	4

(**Source:** The citizen's version Ghana Budget Statement 2015, p.5)

The construction industry in Ghana is characterised by a multiplicity of small firms (Ayarkwa, 2010). Eyiah and Cook, (2003) noted that the large construction firms consist mainly of foreign firms whilst the small firms are mostly Ghanaian indigenous businesses. According to Ayarkwa, (2010) out of a total of 7095 construction firms registered in Ghana in 2002, 90% were small contractors who belong to classes D3 and D4 and undertake less complex construction jobs with tender sums up to one million US dollars.

Table 2.2: Industry Growth Performance (%)

Activity	2013	2014	2015	
			Target	Outturn
Industry	6.6%	0.8%	0.8%	9.1%
Mining and Quarrying	11.6%	3.2%	3.3%	-3.8%
Petroleum	18.0%	4.5%	3.0%	2.0%
Manufacturing	-0.5%	-0.8%	-1.8%	-2.0%
Electricity	16.3%	0.3%	0.5%	3.2%

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Water and Sewerage	-1.6%	-1.1%	-0.7%	15.6%
Construction	8.6%	0.0%	1.7%	30.6%

(Source: The Budget Statement, 2015. p14)

Ayarkwa (2010) claims that the total value of work carried out by these small contractors' ranges between 10% and 20% of the total construction output and that these small construction firms is estimated to be over 50%, in terms of cost, when it comes to building materials production. Not only that, but they also contribute to about 80% of all short-term employment, especially when it comes to unskilled workers in many underdeveloped communities in Ghana (Amoah, *et al.,* 2011).

It is therefore surprising that policy makers have not promoted this industry considering its enormous contribution economically. The government policy strategy documents released recently buttresses the lack of attention given to the construction industry in Ghana (Government of Ghana, 2005). Indeed, no data was captured on the construction industry in the industrial census report released in June 2006 by the Ghana Statistical Service, while comprehensive data were provided for many firms in the utilities, manufacturing and mining industries. The importance of the construction industry need to be made known frequently to major policy makers, economic planners and the public to hasten economic growth in Ghana.

3. RESEARCH METHOD/APPROACH

The research method is a planned strategy through which the study is done to acquire answers to research problems. According to Kerlinger and Lee (2000) the research approach constitutes the overall structure of the research. There are two broad research approaches currently being employed in the social sciences, namely quantitative and qualitative research. However, Creswell (2003) has also proposed a third approach, called mixed method approach. This research chose the philosophically rationalist approach, which is ontologically and epistemologically subjectivist. It uses the phenomenological (interpretivist) paradigm to collect qualitative data using intensive interview to seek people's perception of object reality. Participants in the construction industry (contractors and consultants) and a staff at public procurement head office were interviewed to verify and explore impact of procurement reforms on the local construction industry. Since the researcher aimed to gain maximum information from the participants, personal interviews (face-to-face interview) were used (Blumberg *et al*, 2008) with the aid of interview guide. Purposive sampling was adopted since the subject under investigation is of specialized nature. From the targeted population of 69, 37 reached for interview. The characteristics of the respondents interviewed are as follows:

3.1 Profile of the interviewees

The people contacted for the interviews are in the know of the past and current public procurement practices in the Ghanaian construction industry. They were authorized by their organizations to grant the interview as they are involved in both public and private tender processes for their respective organizations. Their views on the research topic are therefore very reliable and valuable. The figure 1 shows the profile of the respondents.

Table 3.1: Profile of interviewees

Positions	Frequency	Percentage
Managing Director	11	29%
Project Manager	9	24%
Project Architect	1	3%
Quantity Surveyor	8	21%
Project Engineer	6	16%
Operation Manager	2	5%
Head of Public Affairs (Ghana Public Procurement Authority)	1	3%
Total	**38**	**100%**

3.2 Interviewee's construction industry profile

The analysis of the interviewee's industry profile is indicated in figure 2. The figure shows that 69% of them are in the building construction industry, 19% are consultants in the construction industry and 12% are in the road construction sector.

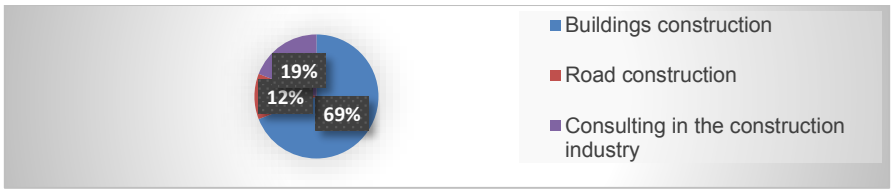

Figure 3.2: Interviewee's construction industry profile

3.3Interviewees work experience

From figure 4, 21 interviewees (representing 57%) have worked between 6 to 10 years, 8 of them (representing 22%) have worked for 11 to 15 years, 5 interviewees (representing 14%) have worked in the construction industry for 1 to 5 years, 2 of them (representing 5%) have worked for 16 to 20 years and 1 interviewee (representing 3%) has worked for 21 to 25 years. Thus, a substantial number of the interviewees have experience of working

in the construction industry before and after the introduction of the current public procurement systems and hence are well placed to know the effect of the new public procurement systems.

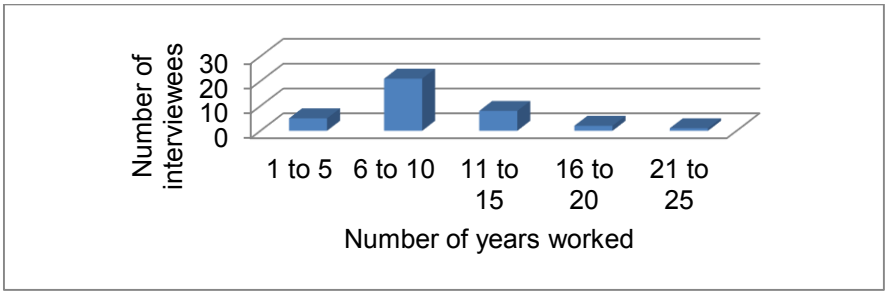

Figure 3.4: Profile of interviewee's work experience

3.4 Interviewee's educational background

An analysis of the interviewee's educational achievement indicates Bachelor's Degrees as a common qualification. Fifty one percent (51%) of the interviewees have Bachelor's Degrees. This is followed by Masters Degrees and Higher National Diploma with 22% of the interviewees respectively and 5% of the interviewees however, have Diploma Certificates. This analysis is shown on figure 5.

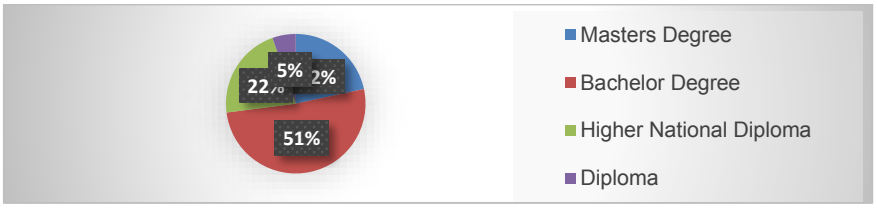

Figure 3.5: Profile of interviewee's educational qualification

4. FINDINGS AND DISCUSION

4.1 Effectiveness of the public procurement reforms

Generally, the results show that, public procurement reforms in Ghana have been effective in terms of correcting anomalies in the past procurement systems and this was supported by 54% of the respondents. Currently, future projects to be put on tender are advertised on the website of the public procurement authority ahead of time and tenderers can challenge the outcome of the bidding process. However, the

implementation of the law to achieve the desired result has not been effective as implementation challenges of the past regulations persist.

4.2 Effect of public procurement reforms on contractor/consultant selection for public works

It was identified that the public procurement reforms in Ghana have increased opportunities for local contractors and consultants to participate in the tendering processes for public projects as stated by 54% of the respondents. It has however not had any positive effect on the contractors and consultant's selection for major government projects as foreign contractors still dominate in the execution of major government projects as stated by 57% of the respondents. This result was not surprising as majority of the respondents accused public procurement agencies of not implementing the local content policies in the law. However, the public procurement authority stated that the various reforms have assisted in awarding contracts to the local construction industry. They also agree that there is still room for improvement.

4.2 Impact of Public procurement reforms on the growth of the local construction industry

The findings indicate that public procurement reforms in Ghana have hardly had any positive impact on the growth (ability to execute all government projects) of the local construction industry as the industry is still dominated by foreign contractors and consultants. Most of the respondents (57%) stated that the works done by the local contractors are mainly through subcontracting arrangements with the foreign contractors and/or for minor works such as school building and road resurfacing or upgrading.

4.3 Proposed public procurement model that will have positive impact on the growth of the indigenous construction sector

The proposed procurement model shown in figure 6 is divided into two phases, namely the pre-contract stage and post contract stage. At the pre-contract stage, a policy objective must be put in place by government and the policy must be made as part of tender requirements. Government procurement should be divided into three categories, namely international, national and local competitive tendering. Government should then implement the policy objectives in the tender evaluation process. Points should be awarded for each preferential policy based on the requirement stated in the tender documents and these points should be paramount in awarding the contract.

At the post contract stage, government should then institute and implement support systems in the form of soft loans or provision of

construction equipment to the local contractors to help them execute their part of the project successfully. The implementation of this model would help local contractors have access to public works as it would eliminate unfair competition from the foreign contractors whilst boosting employment opportunities in the communities.

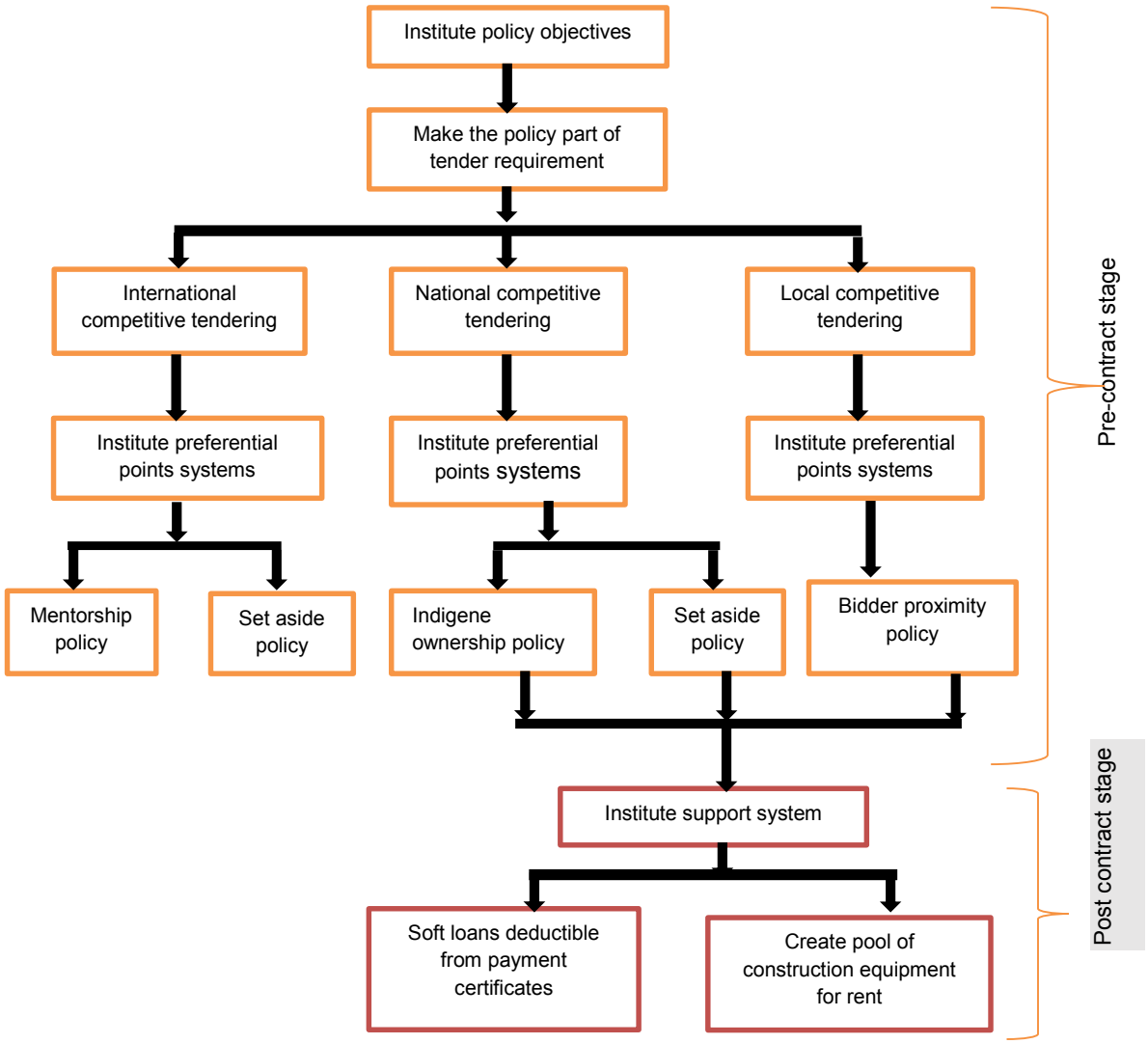

Figure 6.1: Proposed public procurement model

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The study concludes that public procurement reforms in Ghana have been effective in the attempt to resolve the anomalies and deficiencies in the past procurement practices. There are however, still, implementation challenges that need to the tackled. There are situations where procurement officials have refused to give feedback with respect to tender outcome to the participants upon request. The public procurement reforms have also increased the participation of the local contractors and consultants in the tendering processes for government projects. In most cases however, local contractors are only appointed for contracts with low values, devoid of complexities. It was also revealed from the study that public procurement reforms have not had any significant impact on the growth of local construction industry in Ghana. The procurement reforms have therefore failed to generate growth and increase capacity of the local construction industry in Ghana. The over reliance on foreign aid, donors and loans, by government is also seen as a major contributory factor to the influx of foreign firms in Ghana. Most of the donor and aid countries stipulate terms and conditions regarding who to execute the projects they are funding. This hampers the government actions in terms of engaging the local contractors and consultants on those donor/aid funded projects.

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Improving construction project performance in the South African public sector

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ABSTRACT AND KEYWORDS

Purpose of this paper
The purpose of this study is to improve construction delivery of projects executed by the public sector by investigating current procedures, practices and approaches which can provide value for money to meet project cost, quality and time imperatives.

Design/methodology/approach
This study used literature review, case study and survey as primary research methodology. This study used purposive sampling approach. This study purposively selected a total of 25 registered consultants from the total number of registered consultants from the CIDB database. Survey questionnaires and semi structured interviews were used in this study to collect data, and data was analysed quantitatively through Microsoft 2013 Excel program

Findings
The key results include that; public sector projects often result in cost overruns, delays and poor quality; most of the respondents agreed that late payments result in delays and inconsistent and cumbersome contract administration results in poor quality and cost overruns. Further results indicate that; while the causes of cost overruns, delays and poor quality are varied, cost overruns were linked to political influences, project teams' incompetence while delays are related to non-payment of contractors, poor planning and scheduling by the contractor together with late payments and poor quality is related to the selection of the lowest bidders and lack of compliance to specifications

Research limitations/implications (if applicable)
This empirical study was limited to a single province and therefore further research is recommended to include other departments and other provinces and a larger sample.

Practical implications (if applicable)
This study concludes that there are performance challenges in the public-sector construction procurement in relation to time, cost and quality. There is a need to improve performance and mitigate risks in public sector construction project delivery

Keywords: Construction project, Cost overruns, Project delivery and Public sector.

1. INTRODUCTION

The construction industry plays a significant role in the development of any country. Construction industry projects delivers, creates infrastructure, affects Gross Domestic Product (GDP) and creates employment among others (CIMP, 2005 cited in Eaton et al, 2014:1). During 2014 construction industry impact contributed to R133.1 billion and averaged 3.9% of total added value into South African economy (South Africa, 2015). The success implementation of construction projects positively enhances socio-economic growth and improves standard of living (Jacob, 2013).

The success completion of a construction project depends on good performance against time, cost, budget and satisfaction of project stakeholders (Ismail et al, 2014). However, construction projects are not usually completed within the client's intents due to cost overruns, delays and poor quality (Ismail et al, 2014). Literature indicates that substantial number of public sector projects in South Africa are not executed within the predetermined parameters of cost, time and quality and experienced delayed payments (Baloyi & Bekker, 2011). An example of such projects includes the construction of 104 housing units in Saulsville in Tswane (City of Tswane Municipality) with a cost of R85 million and delivered with defective or poor quality (Mogomotsi, 2013). This paper investigates the main causes that affect project performance leading to poor quality, cost overruns and delays in public sector projects. This paper improves evaluation remedies that can improve project performance with regards to time, costs and quality and responds to the sub theme of public procurement.

2. LITERATURE REVIEW

2.1. An overview of Procurement in the Construction Industry

Procurement in the construction industry refers to a process that creates, manages and accomplishes contracts related to sourcing of suppliers, services and construction works which involves the acquisition of any rights and obligations (Watermeyer et al*,* 2004:1). Procurement methods used to award tenders in the public sector are primarily based on principle of selecting the lowest bidder (Topcu, 2004). Van Rign (2005) argues that the lowest bidder may lack capacity to undertake the contract and may unintentionally underestimate construction cost due to competitive pressure. Lai et al. (2005) append that contractors selected on lowest bid basis are most likely to experience cost overruns than those awarded on reasonable bids.

Lai et al. (2005) claim that project administrators can reject unreasonable tenders however, practice shows that few unreasonable bids are rejected and lowest bidder selection is due to savings in public sector public finance. Cruywagen (2012) claims that alternative of selection of lowest bidders is not beneficial to public officials because the contractor will make up for lowest price by instigating claims against the client. Topcu (2004) expresses that tenders which are unreasonable lower in France are excluded while in Italy, Portugal, Peru and Korea the highest and lowest bidder are excluded, in Denmark the two lowest and the two highest are equally excluded. National Treasury (2003) reports that South African practice with section of contractors for public sector projects comprise four steps. Contractor selection steps are outlined by the National Treasury and comprise of approaches that identify, invite bids, receive responses and evaluate responses.

2.2. Cost Overruns, Project Delays and Quality Issues In Public Sector Construction Projects

2.2.1. Defining delays, cost overruns and poor quality

Delays mean different things to project stakeholders. However, delays are commonly defined as differences between the actual completion dates and the planned dates, whereby completion project planned date reflects from project approved date as set expected completion date (Singh, 2009:4). Construction projects comprise critical and non-critical project delays and critical delays affect the critical path of the project, while non-critical delays do not have an impact on the critical path (Mukuka, 2014). Irani et al. (2012:3) claim that construction cost overruns are often linked to “cost escalation”, “cost increase” and “budget increase”. Carey et al (n.d.) contend that cost escalation and cost overrun are not the same thing,

because cost escalation is the cost growth that is anticipated due to factors such as inflation.

2.2.2. Main causes of cost overruns, delays and poor quality

Construction cost overruns issues have been investigated by various scholars since 1980's (Ashish et al, 2014). Eray et al. (2014) claim that construction overruns causes are design problems, high inflation rate, mistakes in cost estimates, bribes, delays in payments, change orders and rework. Jokkaw et al. (2015) claim that lack of skilled labourers, lack of competent consultants, unclear definition of client's requirements, lack of quality inspections and improper use of construction methods, equipment and material increases poor quality. Mahamaid (2013) asserts that selection of the lowest bidder, poor communication and coordination, poor site management and poor planning, late payments of contractors, poor labour productivity and construction rework are the main causes for delays.

2.3. Measures of Construction Project Success

The construction industry involves numerous multidisciplinary teams of stakeholders such as project managers, quantity surveyors, engineers, architects and contractors (Bansal, 2009). Eden et al. (2002) claim that "project stakeholder" define organizations or individuals who are active in the project or who are affected by the project. Project stakeholders may hold different definitions of project success, and the definition of project success criteria is important (Akoa, 2011). In addition, Akoa (2011) claims that cost overruns and delays can affect the entire project lifecycle if the project success measures are not extensively defined. Ramabodu (2014) opines that good performance of cost in construction project is a major criteria of project success for project stakeholders. Atkinson (1999) claims that core traditional project success measurements as reflected through the "Iron triangle" consist of cost, time and quality. In addition to these three project success criteria, the following are found in the literature:

2.3.1. Health and safety

Health and safety is defined in the construction industry as the degree in which the general conditions ensure that the project is executed without any accidents or injuries (Alai et al, 2009:29).

2.3.2. User satisfaction

Clients undertake projects for various objectives, therefore it is imperative for clients to be fully satisfied with the actual product. Alai et al. (2009:3) explains that satisfaction often consists of conflicting scenarios and is a comparison between expected outcomes and perceived outcomes of the

project. Literature suggests that lesser fulfilment is displeasure that is caused by project cost overruns, delays and poor quality in construction projects. In addition, satisfaction is often measured in relation to performance and assessment of quality, time and cost.

2.3.3. Commercial profitability

Commercial profitability is one of the most important criteria for project success especially for developers who aim to achieve certain returns from projects (Eriksson et al, [n.d]).

2.3.4. The performance of cost

Construction projects are subject to fluctuations; therefore, construction costs are not only confined to contract amount but includes costs associated with variances and modifications during project life cycle (Alai et al, 2009). Chan, (2001) states that costs are evaluated as per the initial estimate, all changes to costs variations and modifications are also added to the final project cost. To measure the degree of cost variance into construction project, the planned costs are minimized from the actual construction costs (Alai et al, 2009). Ariff et al. (2014) express that the mathematical cost variance is (CV=BCWP-ACWP), and BCWP is budget cost while ACWP is the actual construction cost. Upon calculation of cost variance, the following conclusions can be made that when:

- Cost variance is equal to zero, then the project is on budget;
- Cost variance is greater than zero the project is under budget; and
- Cost variance is less than zero, the project is over budget.

2.3.5. The performance of time

Time in construction industry is defined as the speed for completing the project, which is calculated in days/weeks from the construction starting date to completion date (Chan, 2001:10). (Alai et al, 2009) define time in construction industry as time from site delivery to completion of construction works and handing over the project to the client. Time is usually specified before the actual construction starts. To measure the performance of time in construction project, time variance is used and planned time is compared to actual completion time (Alai et al, 2009).

2.3.6. The performance of quality

Quality is an abstract term and is difficult to define because various project stakeholders hold different views of what is deemed quality (Rezaian, 2011: 219). Quality can be defined in accordance to functions and features of products or services that should satisfy the client (Arrif et al, 2014:3). For projects to be completed within the desired client quality, it is imperative

that all project stakeholders understand clearly the prerequisite requirements into quality.

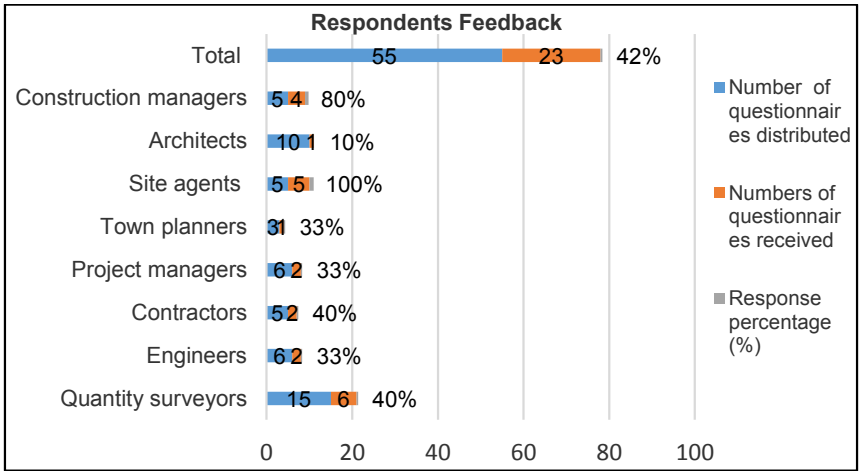
2.3.7. Functionality

Functionality is often measured during post construction phase when the project is delivered to the client (Ariff et al, 2014:4). Functionality correlates satisfaction and it can be measured by the extent of conformity to technical specifications (Alai et al, 2009:29).

3. RESEARCH METHODOLOGY

This study used literature review, case study and questionnaire as the research methodology. The study used a sampling approach that was justified by the need to identify respondents who are involved in public sector construction projects. Thus the study sample comprised of CIDB registered consultants who were randomly selected from the CIDB database and a list of total 25 consultants was sampled as appropriate for this preliminary study. Questionnaires and semi structured interviews were used in this study to collect data, and data was analysed quantitatively through Microsoft 2013 Excel program

Figure 1 *Respondents feedback*

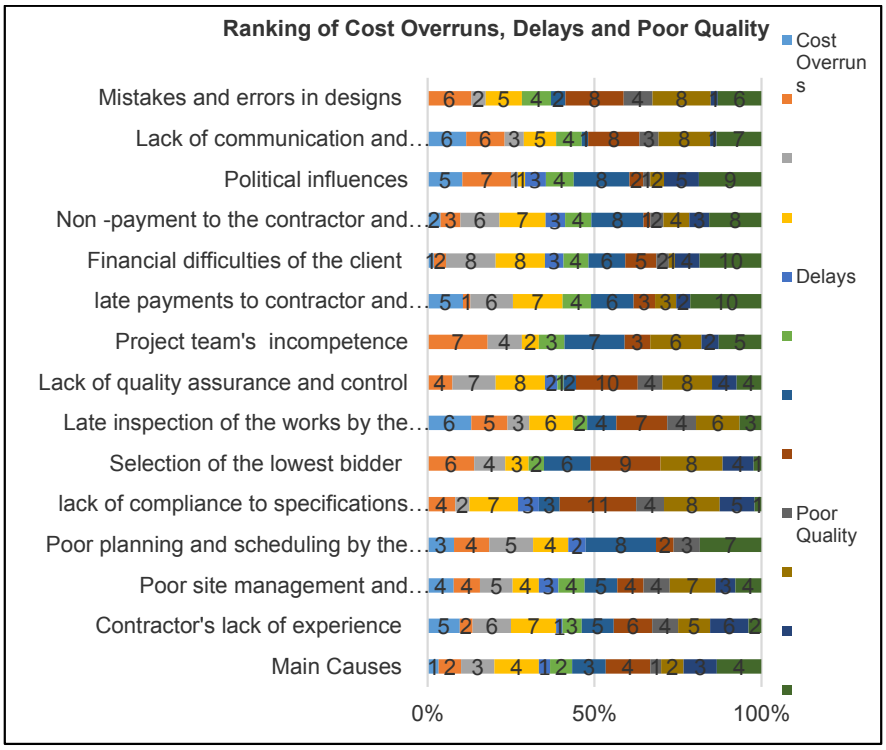


4. RESULTS PRESENTATION AND ANALYSIS

4.1. Main causes of delays, cost overruns and poor quality in the delivery of public sector construction projects

As depicted in figure 2, the responses provided by respondents were ranked from 1 to 4. The ranking depicted in figure 2 represented (1= neutral, 2= small extent, 3= moderate extent and 4= severe moderate). Figure 2 depicts that the three main causes for cost overruns are severe moderate and encompass political influences, project team's incompetence, and selection of lowest bidders. Figure 2 depicts further that the main causes for delays are severe moderate and encompass non-payment of consultants and contractors, poor scheduling and planning and late payment of contractors and consultants together with project team's incompetence's. Figure 2 depicts that the main causes for poor quality are severe moderate and encompass selection of lowest bidders, late inspection of work by consultants and contractors lack of experience.

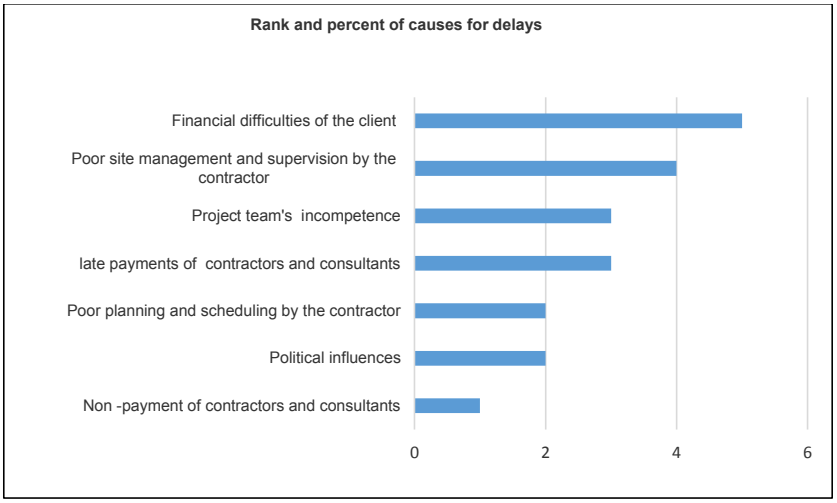
Figure 2. *Ranking of cost overruns, delays and poor quality*



4.2 Causes for delays in construction projects

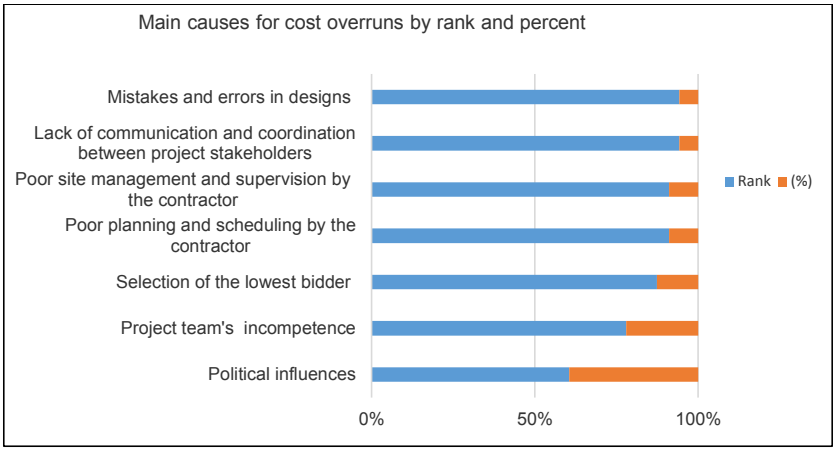
As depicted in figure 3, the non-payments of contractors and consultants is ranked as the highest cause for delays in projects. Figure 3 depicts that poor planning and scheduling by contractors and political influence is ranked as the second cause for delays or projects. Figure 3 illustrates that project team incompetence's and late payments of consultants and contractors are ranked as third causes for delays of projects. As depicted in figure 3, poor site management by the contractor is ranked as fourth causes for project delays. Figure 3 depicts the last cause for project delays as financial difficulties of the client and is ranked fifth.

Figure 3 Causes for delays



4.3 Causes for cost overruns in construction projects

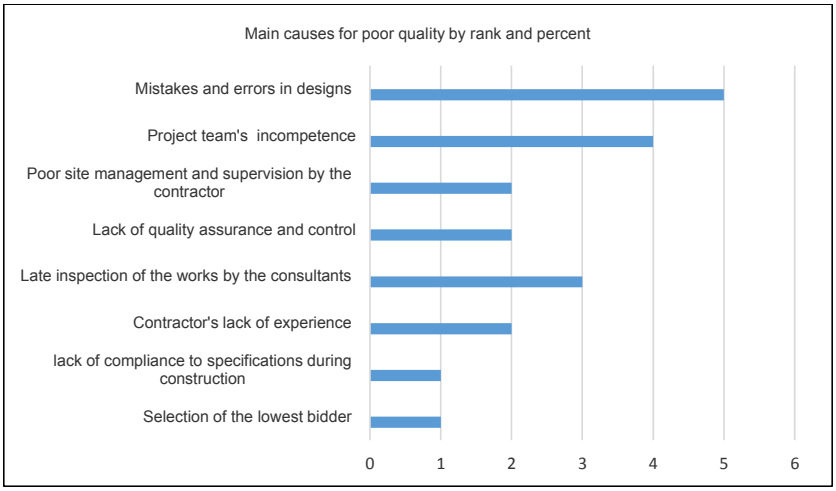
Figure 4 Causes for cost overruns



As depicted in figure 4, political influence into projects is ranked as the highest cause that causes cost overruns. Figure 4 depicts project team incompetence's as the second ranked cause for cost overruns. As depicted in figure 4 selection of the lowest bidders into projects increases cost overruns and is ranked as a third cause. Figure 4 illustrates that poor planning and scheduling by the contractor and poor site management are causes that escalates cost overruns and are ranked as fourth causes. As depicted in figure 4, lack of communication and coordination between stakeholders and mistakes and errors in designs are causes that cause cost overruns and are ranked as fifth causes.

4.4 Causes for poor quality in construction projects

Figure 5 Causes for poor quality



As depicted in figure 5, selection of the lowest bidder and lack of compliance to specifications during construction of infrastructure projects are factors that cause poor quality and are ranked as highest causes to poor quality. Figure 5 depicts that contractor's lack of experience, lack of quality assurance and control and poor site management are factors that are ranked as second causes to poor quality of infrastructure projects. As illustrated in figure 5, late inspection of works by the contractor is ranked as the third factor that causes poor quality. Figure 5 illustrates that project team incompetence's is the fourth factor that cause poor quality into projects. As depicted in figure 5, mistakes and errors in design is ranked as the fifth factors that causes poor quality.

Findings revealed that compelling causes for project delays severely impact timely delivery of projects and consist of non-payment to contractors and consultants with 78, 26%, political factors together with poor planning and scheduling with 73, 91%, project team's incompetence together with late payment to contractors and consultants with 65,22%, poor site management and supervision by contractors with 56,52% and financial difficulties of the client with (52,71%). Findings revealed that 4,35% of responses outlined that public sector is characterised by delays that ranged from 80-90%. Findings revealed that 8,70% of responses highlighted that 60-70% of projects experienced project delays. Findings revealed that public sector and private sector construction delays comparison are that public-sector projects are delayed twice than private sectors. Findings revealed that financial difficulties of the client with 42,48%, non-payment of contractors and consultants with 26,09%, lack of compliance to specifications during construction with 17,39%, poor site

management by the contractor with 13,04%, contractor's lack of experience and political factors with 8,70%, late inspection of works by consultants with 4,35% and lack of communication and coordination between project stakeholders were main factors that caused project delays and is consistent with (Balag and Bekker, 2011).

Findings revealed that the main factors that cause construction cost overruns in the public sector as derived from the study are outlined as political factors with 65,22%, project team's incompetence with 56,22%, selection of the lowest bidder with 43,48%, poor site management and supervision by the contractor and poor planning and scheduling by the contractor with 39,13%, Findings revealed that lack of communication and coordination, mistakes and errors in design averaged 30,43%. These factors revealed a highest level of correlation with causes for delayed construction projects and is consistent with (Erayl et al, 2014 and Mahamaid, 2013). Findings revealed that causes for poor quality severely impact on quality of construction projects due to lack of compliance to specifications by contractors because of lowest selected bidders and averaged 78.26%.

Findings revealed that contractor's lack of experience averaged 73,91%, while late inspection of construction works by consultants averaged 69,57%. Findings revealed that lack of quality assurance and control, poor site management and supervision averaged 65,22% while project team's incompetence factors averaged 56,22%. Findings revealed that factors such as selection of the lowest bidder with 21,74%, late inspections of works by the consultants with 21,74%, lack of quality assurance and control with 26,09% and contractor's lack of experience with 13,04% were the several causes that impact the quality construction projects with poor quality and is consistent with (Ismail et al, 2014 and Mogamotsi, 2013).

5. **CONCLUSIONS AND RECOMMENDATIONS**

The results suggest that built environment role players need to improve construction project delivery and reduce delivery bottlenecks that delays the delivery of projects. These results also suggest that built management professional need to improve the delivery of construction projects with time, costs and quality to improve project delivery. These results also infer that built management professions need to deliver construction projects with full compliance into infrastructure quality and specifications and improve infrastructure functionality. This study concludes that factors that delays construction projects, increases costs overruns and affect construction projects quality affect the functionality of construction projects, and this paper has identified the factors that affect construction projects, although this was the case, there is an opportunity to improve construction project delivery by improving timely delivery of construction project, deliver projects

according to time, cost and quality to improve the quality of construction projects.

The following recommendations are made;

This study suggests the following ways to improve construction project delivery

1. Further studies be undertaken to establish the extent of delays of construction projects into public finance.
2. To establish the extent of financial burden of delayed projects to the client.
3. To examine the socioeconomic impact of delayed construction projects to project beneficiaries.

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Integrated Project Delivery System Implementation in the public sector in South Africa: A Pilot Study

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ABSTRACT

PURPOSE: This study aims to examine the most commonly used procurement approaches utilised within the public sector of South Africa and to explore the potential impact of using the Integrated Project Delivery System on these types of projects. This paper reports on the preliminary exploratory findings of a larger study dealing with delays, disruptions and acceleration.

RESEARCH DESIGN
The research was conducted via a questionnaire survey of a sample ten project stakeholders who had been involved on public sector projects, confined to the KwaZulu-Natal region.

RESEARCH LIMITATIONS
The study has been conducted on a small sample of public sector projects in KwaZulu-Natal during the past 3 years. Given the exploratory nature of this part of the study the findings may not be generalizable across the entire sector or industry.

RESEARCH FINDINGS
The study found that specific procurement routes were followed on public sector projects in KwaZulu-Natal and there was little resistance or objection to using a different approach. The Integrated Project Delivery route is known and is an innovation which is being reviewed.

RESPONSE TO CONFERENCE THEME & OUTCOMES
This study will contribute to improvement in delivery of projects with increased efficiency and waste reduction by optimising resource allocation.

The study will potentially highlight barriers that inhibit the effective implementation of this form of procurement in South Africa and provide insight on how to overcome these barriers in an effort to enhance the development of the construction industry.

PRACTICAL IMPLICATIONS
This study contributes to the body of knowledge of public sector procurement routes and proposes an Integrated Project Delivery approach given its benefits to all parties involved in the project delivery process.

VALUE OF PAPER
This study aims to examine the most commonly used procurement approaches and routes in the public sector of South Africa and to explore the potential impact of using the Integrated Project Delivery System on public sector projects in KZN. The findings of this study may provide opportunities for increased efficiency and waste reduction by optimising resource allocation. The findings will potentially also highlight barriers that inhibit the effective implementation of this form of procurement system within South Africa.

KEYWORDS: Procurement, public sector, Integrated Project Delivery System

1. INTRODUCTION

The construction industry's use of the Traditional Procurement Methods has become notorious for failing to integrate construction with design (Trigunarsyah, 2004). Arguably, the consequences of this weakness are schedule delays and increased construction costs as a direct result of designers not considering buildability/ constructability within their designs with many amendments having to be made to the working drawings once the construction team has given their input. Many of these changes are driven by issues of buildability or constructability (Arditi, *et al*., 2002).

Designers' drawings usually convey the quality they intend for the building once completed, often with little concern of how this objective is to be achieved. Typically, the assembly of the building and its associated components reside within the jurisdiction of the contractor. When these designs are of a complex or unusual nature the contractor draws the attention of the design team to the implications of the construction process. Often this action results in variations to the working drawings. Arguably, the lack of consideration for the manner in which a builder or contractor and his team will apply the design to the construction process often results in project delays in the form of cost increases and schedule delays (Ibid).

Traditionally there is a separation between the design and construction phases of a project due to the traditional procurement approach which is

widely used in the construction industry in KwaZulu-Natal. This separation deprives the contractor of the opportunity to provide input into the design informed by his experience, often resulting in designs that lack buildability or structural integrity. By neglecting the concept of constructability projects are not being carried out in the most efficient manner (Motsa, *et al*., 2008).

In order to optimize the construction process, it is essential for constructability to be incorporated into the design process. The seemingly most effective way in which to achieve this objective is to include the construction knowledge and experience of the contractor/ constructor/ builder during the early stages of design. The procurement system of choice is therefore paramount to the success of the project and not just the contractual obligations.

2. LITERATURE

2.1 Procurement Methods

According to Lupton, *et al*., (2007) 'Procurement' often describes the flow of relationships (interactive and contractual) between the client and the construction teams and consultants within a construction project. In most instances in the traditional procurement approach the Architect is appointed as the lead consultant known as the principal agent. However this is not always the case. Companies may stipulate who the principal agent or lead consultant may be and sometimes the client may have pre-selected the principal agent (Ibid).

The assumed role of planners undertaken by the design team translated in these teams being primarily concerned with the end result. They often failed to consider the necessary construction activities required to complete the building works. These details were rather transferred to the constructing team. Through delegating the additional responsibility to the builder, the design team was requiring the builder to be liable for much more than was actually required of him. The builder/constructor often experienced construction problems leading to possible delays, inefficient utilization of resources and work that was not sequential, all of which posed a threat to the budget, schedule and health and safety, when constructability was not considered during the design process.

The need for a more comprehensive procurement method becomes increasingly apparent as numerous projects continue failing to meet delivery requirements. "Maximising value and minimising waste at the project level is difficult when the contractual structure inhibits coordination, stifles cooperation and innovation, and rewards individual contractors for both reserving good ideas, and optimising their performance at the expense of others" (Matthews and Howell, 2005: 47).

2.2 Project Delivery in the Public Sector

Procurement in the public sector in South Africa is governed by the Construction Procurement Reform Policy which outlines its main objectives as

- Cost certainty at the tender award stage;
- Better value for money; and
- More efficiency in the delivery of public works projects.

According to Ambe and Weiss (2012), the reform was initiated to encourage the principles of good governance and a preference system was introduced by the National Treasury to additional address the socio-economic aims. The reform was a process devised to address the inconsistency in policy application, fragmentation of the procurement process and want for accountability within the process. A new Preferential Policy Framework has just been released effective immediately on public sector projects. It is too early to establish the impact by the authors are of the view that the current practices with the same consequences will be the result despite the desire for improvement accompanied by transformation of the economy.

2.3 Integrated Project Delivery System

According to Matthews and Howell (2005) there are four systemic issues which arise when utilising the existing traditional procurement methods, namely:

- Innovative ideas being held back due to competitive bidding processes; in order to gain a competitive edge, contractors often keep their innovations to themselves. Once the contract has been awarded, time and opportunity is often lost as the design team has to amend working drawings to incorporate the ideas.
- Difficulty experienced in innovating across trade boundaries due to contract stipulations; subcontract agreements containing requirements of the party, penalty and remedy details provided difficulty for contractors to innovate across other trades despite their work often being interdependent.
- Absence of formal efforts being made to link planning systems of the subcontractors involved in the process; despite ‘partnering’ sessions being held in some instances, there are no formal records of mutual commitment.
- Subcontractors constantly struggling to optimize individual performance; the subcontract agreement often persuades the contract to experience an attitudinal change with regards to taking

care of his own interests. The contractor protects his own interest often at the expense of the client and even other subcontractors.

The Integrated Procurement Delivery (IPD) System seeks to align the objectives of various parties while providing a system which is more comprehensive. Since a single contract binds the IPD team to the client the risk of claims is mitigated.

"Team members are united together under the prime contract. The team has one price, and that is the price to the Client. The Team has one scope, and that is the project scope as defined in the prime contract. There is no accounting among PTMs (Primary Team Members) for who is over or who is under budget. Holding everyone solely accountable for their own scope and price would drive the project back down the road to local optimisation and inhibit innovation. IPD was formed to avoid these problems" (Matthews and Howell, 2005:49).

Matthews and Howell (2005) identify two key principles that define the IPDS team relationships. These key principles are:

- Primary Team Members are held responsible for all provisions of the prime contract with the client. The prime contract is signed by the team as a single entity.
- Primary Team Members divide the risk and profit for overall project performance.

Each PTM legally bind themselves to each other to fulfil the requirements of the contract. An agreement to share the costs and profits based on a formula according to the participation on the project is entered into. Possible consequences of the approach have been highlighted, the main concern being that should a PTM err, the other PTM's are held jointly liable however this may also be regarded as a strength of the system due to the risk of errors and cost overruns being minimised as the consequences are shared rather than a single party accepting liability. The approach of joint risk encourages the team to heighten the group dynamic and aim for a common goal. (Matthews and Howell, 2005)

Bongiorni (2011) identifies challenges and issues experienced with implementing IPDS such as:

- The need for a capable team with regards to the ability to making sound and competent decisions by the client as well as the staff.
- Technological advancements must be made available and team members are required to have detailed knowledge on this in order to aid implementation of IPDS.
- Teams may be structured to allow parties who have experience with each other, therefore diminishing opportunity for new ventures.
- The contractor is involved early in the cost forecasting process, which differs to the commonly used Traditional approach.

- Team members are compensated according to their contribution as stated in the prime contract. This creates an incentive approach which can be highly advantageous.

3. RESEARCH APPROACH

A qualitative methodology was applied in the form of a structured survey consisting of open ended questions. The pilot survey was conducted on a sample of ten key stakeholders involved in the procurement process on construction projects within the public sector. Due to the research being conducted within the public sector, a relatively small sampling population was utilised as there are individuals whom are specifically allocated the responsibility of procurement decisions within the relevant departments. The structure of the approach was based on a literature review on the subject matter.

4. FINDINGS AND DISCUSSION

A majority of participants (75%) acknowledged that there existed shortcomings to the current construction and associated procurement processes such as fragmentation and lack of a common goal among the parties to a project. . All participants considered the relationship between project delivery and procurement method to be a strong one. However the opinions of the details of the relationship varied. Research has indicated that these shortcomings can be overcome with the implementation of a more comprehensive approach which would seek to align the goals of the parties involved. IPDS has proven to contain characteristics which assist in aligning the objectives of the various parties to a project. Most participants reported that unsuccessful project delivery was due to the inexperience of the construction team. Bongiorni (2011) has highlighted the issue of IPDS requiring competent teams. The term competence in this regard translates to a team which has the necessary knowledge and experience, is reliable, trustworthy and morally transparent.

It was evident from the data that all participants were aware of characteristics of an approach such as the Integrated Project Delivery System (IPDS). The Traditional Procurement System (TPS) had been the preferred method of procurement on public sector projects. The majority of participants concurred that the criteria for the selection of procurement method stemmed from existing policies and frameworks such as the Preferential Procurement Framework and National Treasury guidelines on procurement (CIDB, 2005).

All participants have noted that while successful project delivery has been common, it is often at the sacrifice of secondary objectives. The use of a principal agent has proven to be advantageous within the construction

process with 100% in agreement however the issue of fragmentation of participants due to the Traditional approach has emerged. IPDS contains similarities with regard to the benefits of a main communication link using 'Primary Team Members', which would provide the same benefits as a principal agent. These PTM's share the risk among themselves under the prime contract, while still providing a single line of communication with the client however the risk of fragmentation is eliminated due to the nature of the Integrated Project Delivery System (Matthews and Howell, 2005).

While 75% of participants agreed that IPDS implementation would have a positive impact on the construction process, it is apparent from the 75% who considered IPDS implementation project specific that knowledge on the particulars of IPDS was deficient This reinforces findings by Bongiorni (2011) that identify lack of a capable IPD team as a challenge experienced. Numerous barriers to implementation exist, although the most prevalent being legislative barriers (75%). The implementation of the existing policies and framework in South Africa appeared to be one of the main barriers, while the possibility of collusion tied in closely.

5. CONCLUSION

Jeff Radebe in 1997 when he was the Minister of Public Works stated "The appropriate orientation of public sector procurement would enable the State to use its purchasing power to attain specified socioeconomic objectives. Within the South African context, public sector procurement can make a critical contribution to the transformation and democratisation of South African society. In striving for the above, Government must also ensure that such a procurement policy subscribes to international best practice and reinforces the principles of good governance." A comprehensive system which has the potential to contribute significantly to the development of the construction industry must be explored.

It has been claimed that a standard procurement method and process cannot be developed in seclusion from the objectives and goals which are outlined. The study has illustrated that Integrated Project Delivery Systems should be considered as a potential procurement route within the South African construction public sector despite the primary barriers. These barriers can be overcome with greater knowledge of the details of implementing the Integrated Project Delivery System. The benefits of IPDS address numerous inadequacies of the current procurement systems in use and therefore it may be concluded that with further research into the details of the IPD system, it can potentially contribute to the development of the processes carried out within the public sector in South Africa.

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Managing demand risk in South African transport public private partnership projects

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ABSTRACT AND KEYWORDS

Purpose of this paper
South Africa is relatively new compared to its international counterparts in administering user-pay transport Public Private Partnerships. The biggest challenge with these arrangements is managing the demand risks adequately to ensure viability. The contextual nuances like a politically restive clientele such as the one in South Africa could adversely affect the patronage of a facility if the consensus is not solicited utilizing acceptable channels.

Design/methodology/approach
A very qualitative approach which dealt which involved interviews and document analysis for two cases was adopted. This research investigated the management of the demand risk in two transport PPPs by investigating the Gautrain metro rail project and the N3 highway from Durban to Johannesburg.

Findings
Although the concessions have been utilized in highway tolls, this was the first time they were utilized in passenger railway project. The conservative estimates deployed proofed to be helpful in a period of explosive growth occasioned by changing political climate. However it was observed that the borrowed models have to be adapted to provide a proper fit with climatic dynamics.

What is original/value of paper. It is hoped that the lessons garnered here will be instructive to other future projects even in other jurisdictions.

Keywords: viability, PPPs, climatic dynamics, contextual nuances

1. INTRODUCTION

The increasing demand for infrastructure around the world has put a lot of pressure on the fiscus, compelling most governments to look for alternative and innovative ways of financing infrastructure. Public Private Partnerships (PPPs) have been seen as viable in most cases and have been deployed in many jurisdictions, and in South Africa they have been used over the past two decades. South African law defines a PPP as a contract between a public sector institution/municipality and a private party, in which the private party assumes substantial financial, technical and operational risk in the design, financing, building and operation of a project (National Treasury, 2016). PPPs have generally become popular worldwide. Risk Management is one of the critical determinants of a Public Private Partnerships (PPP) project success. Demand risk, being one of the major risks affecting PPP concessions, need particular attention and effective management to avoid project failure (Alasad et al, 2011). Demand risk can be defined as “change in demand normally occasioned by such issues as: the economic cycle, new market trends, a change in final users’ preferences and technological obsolescence (EIB, 2016). The notion of charging the public for using infrastructure facilities (e.g. toll roads) is not new (Hensher & Puckett, 2005). However, recently these kinds of projects have become popular in many countries and are diverse. The relationship between demand risk and user-pay stability is directly proportional. Demand is believed to be slowed down or increased for the duration of the concession period in a way that can extremely affect the project‘s revenues. This study was exploring how this critical risk has been managed in South African PPPs in order to assess if there are lessons that can be garnered for future projects in this jurisdiction and beyond.

2. MAIN DISCUSSION

The are many different arrangement for financing PPPs. Sponsors generally organize a special purpose vehicle (SPV) or a concessionaire company to deal with contractors, lender, investors, insurance providers, and other parties especially government authority (Kurniawan & etal, 2015). The sponsors should have a developed fairly sophisticated and accurate models that portray the economic and financial feasibility of a project under a variety of scenarios and assumptions. In this study the focus is on User-pay projects in the developing country such as South Africa where the income levels are not comparable to developed countries. It is important for the success of any self-financing infrastructure project to take into consideration whether the public can afford the user fee or not

(Alasad, 2011). This consideration is important as several user-fee-based PPP projects have failed (i.e. cross city tunnel in Sydney, Adelaide-Darwin Rail), and this could have either been a problem with the model itself or purely poor judgement and human error.

In terms of user-pay and user-fees, the actual price of the fee may play a vital role. In today's economy in which many people are struggling, the actual user-pay fee may determine whether people may use that service or facility. A higher quality may simply reflect higher contractual demands that are in turn reflected in higher vendor payments under PPPs than would be the case for conventional arrangements (Kelman, 2016). Vendors managing highways would have relatively little control over the level of road traffic, raising questions about putting vendors at risk for traffic growth assumptions through having a road PPP financed through user-fees. Through this statement a deduction may be formed around the importance of experience and knowledge needed for user-pay PPPs. Additionally, the required risk management should be abided with when planning and designing PPP projects. There are several different policies highlighted in terms of what governments should implement. In South Africa it is stated that government should consider alternatives to the build-own-operate-transfer model for PPPs, where revenues to the vendor are generated all or mostly by user charges (e.g. Highway tolls) in situations where much of the usage risk is outside the vendors control (ibid.). However South Africa has had a long history of concession highway projects even before the popular PPP concept came into being. However this is the first time it embarked on a rail PPP project in the form of Gautrain metro rail network. But the issue of demand risk management has not been dealt with in the research community in South Africa.

Demand Risk

Risk is part of every human endeavour. Everyone is exposed to risk of different degrees. Risk can result in possibility of damage and injury. In addition, it is defined as a probability or threat of damages, injury liability, loss or any other negative occurrence that is caused by external or internal vulnerability, and may be avoided through pre-emptive action (Businessdictionary, 2016). Project risk is defined as an uncertain event or condition that, if it occurs, has an effect on at least one project objective (Dittmer, 2013). Project plans can be seen as 'living documents' and therefore will result in change. The requirement for changes is to prevent or rectify unsuccessful situations. Kerzner, Saladis, & Frank (2009) state that risk refers to those dangerous activities or factors that, if they occur, will increase the probability that the project's goals of time, cost, and performance will not be met. Many risks can be anticipated and controlled. Therefore, risk management is very essential throughout the complete life

cycle of the project. Risk management focuses on identifying and assessing the risks to the project and managing those risks to minimize the impact on the project (Dittmer, 2013).

Some common risks in a project include:

- Poorly defined requirements
- Lack of qualified resources
- Lack of management support
- Poor estimating
- Inexperienced project manager (Kerzner, Saladis, & Frank, 2009)

Due to increase in risk in a project, “many companies now allocate great amounts of money and time in increasing risk management strategies to help manage risks related with their business and investment dealings”. However, not all risks are negative as some are positive impact risks, positive risks are opportunities and therefore preferred by project a manager and a stakeholder. It is the project manager’s duty to ensure that risks are kept to a minimum. As this study focuses on PPPs, it is important to recognise risk in PPPs. According to Loosemore and Cheng (2015), construction is a complex and dynamic industry and all construction projects involve significant risks. PPP projects last for many years and are complex, they involve many parties in dynamic relationships with a multitude of interdependencies. According to Koubatis and Schonberger (2005) one of the defining characteristics of such complex organisations is that risks can propagate through numerous pathways, spreading quickly and rapidly in unpredictable and contagious ways. Helbing (2013) argues that if left undetected and unmanaged, such risks can ensure that a relatively minor and localised problem can lead to multiple cascading failures with potentially disastrous and unbounded effects. A key characteristic of PPPs is the transfer of risk from the public sector to the private sector. Risks are allocated to the party ablest to carry them. This means mitigating their impact and/or being able to absorb the consequences. There are various project risks which can be identified and filtered into different categories. Political, economic, social, and financial and demand risk are all factors which may be considered under risk management. For the purpose of this study the focus will be on demand risk and how it may affect the success of a project.

Demand risk is defined as the possibility of unforeseen variation in the demand for services generated by a project (Quiggin, 2004). Many researchers have identified demand risk as very crucial and that it is a major risk to both the public and private sectors. According to researchers, employing PPP procurement as a way to deliver infrastructure projects has placed demand risk at the top of the risks list (Alasad, 2011). User-pay also known as user chargers and user fees, are an arrangement where the fares paid by the end users are the main sources of revenue. As

infrastructure projects typically, cover their expenses from two revenue sources: the private partner will either receive payments from the government or from user-payment charged directly on the end users, or an arrangement of both (Dochia & Parker, 2009). End users being the members of the public who are consumers of the service. The relationship between demand risk and user-pay is directly proportional. Demand could either diminish or increase over the duration of the concession period in a way that can significantly affect the project's revenues. In addition, uncertainty over the user willingness to pay a toll, especially when these tolls are higher than average, is one of the major drivers of demand risk (Bain, 2009). Evidence shows that a very expensive tariff is off-putting to possible users. It can be argued that the public will choose the cheapest alternative where possible and this has lead to user-pay projects having high demand risk which needs to be evaluated throughout the project life.

As the contracting arrangement and the operation of user-pay PPP projects are becoming complex, some of the literatures have shown that they are many factors which can explain why demand volume typically departs from that projected figures (Alasad, 2011). Authors have identified main factors which affects demand in user-pay PPP projects, some of which includes:

- Public acceptance for the project,
- Uncertainty over the user willingness to pay toll
- Economic growth of the facility, amount of user fee
- Bailing and toll collection method
- Population growth in the facility area (Alasad, 2011).

User-pay

User-pay can be defined as the principle that a user of a service or resource pays directly for the amount they use, rather than the cost being shared by all the users or a community equally (Engineering Dictionary, 2016). User-pay includes commuters who are consuming services paying for those services where those services might have previously been absent before. The main reason for user-pay is that the benefit of the service is for an individual, not the general public, for example basic education. It has been used as a cost recovery and means of funding throughout the world on Public-Private Partnership projects and other public facilities. Countries such as Australia, Canada, New Zealand and the United States have also been using user-pay projects. These stated countries deliver the most comparable examples to the South African social and undoubtedly economic perspective and many countries around the world charge recreational parks entry fees. Therefore, South Africa commuters are charged for services they choose to consume like toll roads, Gautrain, National parks facilities etc (Fackler & Niemeier, 2014).

User-pay projects' services are consumed by the public on a daily basis based on demand of commuters. Sometimes commuters can or cannot choose to consume the user-pay services based on various factors and interests. The government needs to consider factors that trigger the implementation of the user-pay. Some user-pay projects generate little revenue at the start leading to serious price hikes in order to recoup the development costs thus excluding the poor from the service. To achieve success of the user-pay projects the government should announced the economic benefit to the commuters so that commuters can be aware (National Treasury, 2016). With the introduction of the Gautrain project, an important objective of the project was very clear as it was to alleviate the traffic congestion on existing roads between Johannesburg and Tshwane and promoting public transport, tourism and public-private partnerships, and in changing the culture of public transport usage in South Africa (Gautrain, 2016).

Factors Affecting Demand in User-pay PPP Projects

Demand risk in PPP projects relates to the variability of demand (higher or lower than expected when the PPP contract was signed), irrespective of the performance of the PPP Company. Such a change in demand should be the consequence of factors such as the economic cycle, new market trends, a change in final users' preferences or technological obsolescence (EIB, 2016). Public acceptance for the project is also an important factor taking into consideration. Bain (2009) states that the public acceptance of a new toll road is significantly affected by tolling culture. To increase public approval, it is important that people are given the opportunity to participate in influencing the project by evaluating and assessing the scheme's proposal. In addition, public opinion regarding setting an appropriate tariff should be evaluated by referring to the community representative and setting up public debates. For instance, the ignorance of the community's opinion is likely to get them outraged when considering tariff levels and this can cause pressure on the government which could ultimately lead to cancellation of the project (Alasad, 2011).

Bain (2009) argues that uncertainty over the user willingness to pay tolls, especially when those tolls are higher than average, is one of the major drivers of demand risk. It is important to reflect on the issue of public acceptance and willingness to pay at the early stages of feasibility of the project. If ignored then the consequences could mean reduced revenue stream or termination of the entire contract. Alasad (2011) identifies economic growth as one factor, which can cause both optimistic and pessimistic forecasts. Hence growth in the economy could excite the forecasters to overestimate demand. Conversely, it can lead to decision makers to underestimate the demand with dim forecasts that could actual

result in under designs. Accordingly, the inspection of economic growth in the facility's area needs to be accurate to evade any opposing consequences during the operational stage. Based on this, a consistent evaluation of the performance of the economy in the future is an important requirement for obtaining a more precise demand forecast. It is important to note that the public will distinctively choose the most inexpensive option where one is available. According to (National Treasury, 2016), user fees are susceptible to demand and collection risk and generally lead to keen consideration by private party bidders and in some cases to an underwriting of demand risk or user subsidisation by government. According to Alasad (2014), to guarantee a constant demand for a project the tariff should be set at a reasonable level. The expensive construction cost and the private sector's desire to speed up repayment of the debt and gain high profits are the main reasons behind imposing high tariff. Bailing and toll collection method is also a factor identified that affects the demand in PPP projects. According to Alasad (2011), the way in which the concessionaire intends to collect the tariff can also have an impact on project demand. Attention should be paid to selecting the most suitable method for toll collection early in the project's lifecycle. For example, manual tollbooths have been used for decades in toll road facilities. However, due to the fast technological development and inadequate processing ability of human beings, the propensity of most toll collection points nowadays is headed for automated systems. Hence, electronic toll collection technology has been hosted in many countries.Population growth in the facility area is one of the key factors distressing the future demand for the project concerned. OECD (2012) states that infrastructure demand has long been rising due to population growth. As the demand for the facility decreases the companies are obliged to close some of their facilities, this can be due to financial problems due to decrease in facilities demand. In brief, the downsized demand performance can be due to the overestimation of population growth in the project area.

EMME (Equilibre Multimodal, Multimodal Equilibrium)

An EMME model is a global tool that's used to build demand, it's a simulated model and it's the first point of call after you have identified the demand requirement, but the tool is generic and its not automatically capable of dealing with local nuances. According to INRO Consultants, (2016), Emme is a complete travel demand modelling system for urban, regional and national transportation forecasting. Emme is used in over half the world's most populous cities and runs some of the world's most complex transportation forecasting models. EMME model is used for:

- Demand forecasting
- Transit planning
- Traffic planning
- Economic, emissions and environmental analyses
- Transportation data science

According to Maunsell (2004), It is the most used public transport assignment model in UK. The London rail plan model is based on EMME model. It is stated that operating the model requires experience of using EMME/Cube software and a good understanding of Rail plan's methodology, public transport networks, model assumptions, data preparation and interpretation of results (Transport for London, 2016). Gautrain was built based on EMME model that was based on London underground train. According to Brocklebank, Burnett, Ras and Van de Walt (2001). A rail network-based transportation model was developed using EMME/2 modelling software. This model contained a coded rail network, defined as a set of links, nodes and routes, with information on rail service patterns, journey times, fares, frequencies and rolling stock capacities.

Forecast of the possible alteration of air passengers had been completed using stated partiality results and attained from the EMME/2 model challenging highway times. "Forecasts of rail mode share, patronage and revenue were undertaken in a spreadsheet with an adjustment made to EMME/2 forecast diversion from road to avoid double counting of airport rail demand (Brocklebank, Burnett, Ras, and Van de Walt 2001). It can be concluded that, from the results of the EMME/2 demand model established for the Gautrain Rapid Rail Link, in the base year, the proposed service would appeal to approximately 12 400 passengers, travelling 442 000 km in total, during the morning peak hour. This equates to 64 000 daily passenger trips and 2 265 000 daily passenger kilometres (ibid). The estimated annual rail revenue is R304 million in the base year. Further observation can be made that the demand model has been developed to sufficient precision to be able to carry out comparisons between several alignments and service options and to regulate the feasibility of the project.

3. METHODOLOGY

In this research, case studies were examined and analysed. According to (Nisar, 2007) although case study research is not generalizable, it allows the researchers to evaluate key findings. Case studies are used as they excel at bringing us to an understanding of a complex issue or object and can extend experience or add strength to what is already known through previous research (Yin, 1994). According to Nisar (2007) although case study research is not generalizable, it allows the researchers to evaluate

key findings. An important strength of case studies is the ability to undertake an investigation into a phenomenon in its context. Thus case studies are a valuable way of looking at the world around us (Rowley, 2002). Case studies will be used in this research to understand the context of demand risk in user-pay PPP projects as this will help compare to what is already known through previous research. This research will look at two case studies. Gautrain case study will be used, as rail projects tend to fail more than other economic infrastructure PPP projects. Both these case studies are public transport user-pay Public Private Partnerships. The link between the two is critical in terms of relevance and comparisons. Burke and Demirag (2015) outlines that the use of multiple case studies facilitates comparisons and can improve reliability and validity. The rationale for using multiple cases is this research is to focus upon the need to establish whether the findings of the demand risk of first case occur in other cases and, as a consequence, the need to generalise from these finding. Semi-structured interviews with the 12 officers involved in the projects were conducted for this research. Professionals such as specialist and experts in the field were interviewed for objective information. Semi-structured interviews are referred to as 'qualitative research interviews' (Saunders, Lewis, & Thornhill, 2009). Semi-structured interviews consisted of a list of themes and questions that were asked. This allowed researchers to omit some questions when in specific interviews as the nature of involvement as expertise differed. The last methodological strategy deployed was archival strategy; it focusses at historical documents in addition to recent ones in order to observe the changes that have occurred over time. Archival strategy, also referred to as literature review since it looks at secondary data and this study will adopted this strategy since documents from the authorities had to be studied (ibid.).

4. DISCUSSIONS AND FINDINGS

N3 Toll Concession (N3TC)

This project was started in November 1999 where the South African National Roads Agency (SANRAL) entered into a 30-year Toll concession ending in 2029 with N3 Toll Concession (RF) Propriety Limited. The mandate was to design, construct, finance, operate and maintain the N3 highway between the Cedara interchange, near Hilton, in Kwazulu-Natal and the Heidelberg South interchange in Gauteng. The intention is to provide a world-class road, with engineering, education and enforcement forming the pillars of the design philosophy. This route is considered to be one of the most strategic road links in Southern Africa as it conveys large volumes of freight, both imports and exports, vital to the region's economy. Apart from being a major transport facility linking South Africa's inland

provinces to the Durban Harbour in Kwazulu Natal, the road is popular with travellers wishing to access the many holiday destinations from the route.

Gautrain Metro Rail Project

Gautrain is the only metro project in Africa coming with a price tag of R25.2 billion (US $1.94 billion). Since its inception in 1999 when a need to link Johannesburg, Pretoria, Sandton and OR Tambo International Airport was hatched the project was completed in 2011 when it was commissioned, the growth and popularity of this mode of transport has been growing steadily. It involves 80 km of railway and 10 stations all geared towards mobility to the airport and urban commuter service. The intention of the project was to promote economic growth and job creation in Gauteng, in relieving traffic congestion, in promoting public transport, tourism and public-private partnerships. It is hoped that in time the culture of public transport will be changed through this project in South Africa.

Findings

The opinion with regards to Gautrain and its success is uncertain. Within Gautrain there was an initial model used which identified the projected demand in relation to train times and various other factors. The use of consultants from the London Underground Railway network assisted in implementing the Gautrain. Professionals within the Gautrain industry indicate that the current demand is not as predicted during the development stages. The reason given behind such inadequacy may lie not within the failure to comply with demand risk management, but rather using the wrong model. The demand model was based on the London underground railway network. Such a network is vastly different from South Africa as the destinations are closer and more condensed. Other professionals within the industry have indicated the effect of political influence in the development of Gautrain which led to the demand risk modelling being ignored in the development stages. However the numbers have improved over the last few years and it shows that the issue of culture change and a slow uptake was not factored in properly. But the growth when it came was sudden leading to concerns about capacity. When the numbers of 2012/2013 are compared there was an upshoot of 60%. In the month of March 2013 18,000 people used the trains but in 2013 in the same month 48,000 people used the trains. This growth in demand is already approaching the levels predicted in year ten of the concession period but then project was only in its third year of operation. There is also the issue of asymmetrical ridership pattern that was not predicted; the Tshwane to Johannesburg route is very busy in the peak hours while the reverse direction is much less so. This pattern is reversed in the afternoons, and during the day demand is much lower than expected. The extra trains have been introduced during peak times to accommodate

the demand, this has resulted in the increase in the numbers of feeder buses as well. The growth has been positive although it is not related original predictions. The demand is such that a financial viability of an expansion of extra 200km is seriously under consideration.

South African National Roads Agency (SANRAL) the body which is managing national roads claimed to be fairly conservative within their demand forecasting. One of the interviewee said, “All the toll road projects within the country are successful.” The N3 Toll Concessions interviewee conceded on the fact that they underestimated the growth of heavy and light vehicles on the road. They have seen a significant increase in vehicles passing through the toll roads. It may not be termed as inadequate management, but such a disparity has resulted in increased costs in terms of maintenance of roads. If the vehicles continue to increase, the concession requires them to increase the amount of lanes etc. The main reason for these is the dramatic growth of the middle class occasioned by changing political climate which allowed the upward economic mobility of the black people who were not allowed to have any meaningful participation in the economic activities in the country. The use of the cargo rail is on the decline in South Africa and this has moved the long haulage of cargo to the roads leading to the increase of heavy vehicles on the road.

5. SUMMARY

South Africa’s economic growth has led to a situation where PPPs are the viable option for the government to provide world class infrastructure for long distance travel and commuter mobility in big centres. Although on the surface there appears to be a demand for these developments the issue of demand risk has to be properly managed and proper models used to adequately deal with contextual eventualities. Although South African has a long history of toll roads, the inexperience with PPP toll roads in particular has highlighted the issue of under-estimation in the traffic forecasts and this has to be accommodated as a possible scenario in planning. Although it leads to increased revenue it also leads to high maintenance costs and yet the user-pay tariffs are strictly controlled by the government and the numbers might in some cases not add up to meet the shortfalls. The contract should then be designed to be flexible to accommodate positive developments which could benefit both parties.

The Gautrain PPP project as the flagship urban metro project has been very insightful in many ways as it was the first time such a development was taken and even using a relatively new contractual arrangement of PPP. The following lessons were considered to be very important:

- The international models have to be adapted to local conditions in order to have maximum utility.

- The issue of culture change must be accommodated in models where the project is introduced for the very first time.
- The pricing of the user-pay tariffs should strike a balance between avoiding exorbitant rates which could be elitist and not serve the general populace and at the same time allowing enough time to recoup the money invested.
- Sudden rises in demand should be anticipated and contingency plans should be included in the designs to avoid overburdening the infrastructure.

Although the two projects were beneficial to the government because they both exhibit some measure of underestimation in the traffic forecasts, it is possible that the opposite could have happened with dire consequences. This means that going forward it is imperative to revisit the models and their contextual applicability given the climatic nuances where such projects are envisaged.

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Occupants' satisfaction with indoor environmental quality of social mass housing projects in South Africa

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ABSTRACT AND KEYWORDS

Purpose of this paper
The aim of this study is to investigate the level of satisfaction of occupants with the indoor environmental quality of social mass housing projects in South Africa.

Design/methodology/approach
The study was conducted in Ekurhuleni Metropolitan Municipality (EMM) where low-salary housing projects are concentrated in South Africa. The descriptive survey research design was used for the study. The target of the study is the low-salary income earners that stay in the social mass housing units provided in South Africa. The convenience sampling technique was used for the study. The primary methods of data analysis for the study are percentages and mean scores.

Findings
The results of the study indicate that the highest factors with which occupants claim to be satisfied with are amount of light in building unit, level of privacy, air quality, sound privacy between units and general cleanliness of the building. The result also shows that occupants are satisfied with all the indoor environmental quality elements in the different spaces of the buildings except for acoustic conditions that fall short of average.

Research limitations/implications
The implication of this research s that designers will knows the indoor environmental quality elements that need to be improved upon during the design of housing projects.

Practical implications
The study recommends that, acoustic design needs to be improved upon during design of housing schemes in order to further improve the level of satisfaction of occupants with social mass housing projects. The recommendation is based on the conclusion that acoustic quality of social housing projects is not satisfactory to occupants.

What is original/value of paper
What is new in the paper is that researches on occupants' satisfaction with indoor environmental quality of housing projects are scarce, yet necessary because of its impact on health and well-being of occupants.

Keywords

Housing projects, Indoor Environmental Quality, Occupants satisfaction, South Africa.

1. INTRODUCTION

There is a paradigm shift in the conceptualization of building designs and construction around the world today. This conceptualization is hinged on sustainable building designs and construction. Sustainable building design is currently encapsulated in the growing and widely accepted Green Building syndrome. The aim of green building is to significantly reduce or eliminate negative impacts on the environment and the occupants of a building (Abbaszadeh, Zagreus, Lehrer & Huizenga, 2006). Hart (2014) informed that green building does not only mean indoor air quality, health and comfort; it also includes location of the buildings; choice of building materials used and energy efficiency among others.

The United States in 2000, through the United States Green Building Council (USGBC) established the Leadership in Energy and Environmental Design (LEED) to rate and certify green buildings (Altomonte & Schiavon, 2013). In 2009, the Green Building Index was established in Malaysia to perform the same function as LEED (Qahtan, Keumala & Rao, 2010). Other countries that have embraced the green building design are the United Kingdom (BREEAM), Japan (CASBEE), Hong Kong (BEAM), Singapore (Green Mark Scheme), South Africa

(Green Star SA) and UAE (Pearl Rating System) among others (Kiprotich, 2016).

While the rating and scoring systems for green buildings are different from one country to the other depending on the scoring establishments mentioned earlier; their composition are basically the similar. One of the key constituents of the green building is the indoor environmental quality (IEQ). Indoor environmental quality is a conglomerate of thermal, acoustic, visual and air quality (Al horr, Arif, Katafygiotou, Mazroei, Kaushik & Elsarrag, 2016; Qahtan, Keumala & Rao, 2010). Indoor environmental quality was singled out among the green building criteria as the most important and directly related to the health, comfort and productivity of building occupants (Bluyssen, Janssen, Brink &Kluizenaar, 2011).

Many of the countries that embraced the green building concept have had many buildings constructed in conformance to the rating of green building (Radwan, 2014). However, this is not the case for South African buildings in spite of the existence of Green star SA for about 10 years (Kiprotich, 2016). Hart (2014) noted that South Africa is involved in green building challenge of advancing building environmental performance assessment methodologies, recognizing and looking out for sustainability issues related to green buildings and creating knowledge among the parties involved in green building developments.

In view of this, limited researches have been conducted in South Africa on green buildings (Musa, 2013). To this extent, it is difficult to ascertain the level of satisfaction of occupants on the indoor environmental quality of the buildings they live in. The focus of this study is on investigating the level of satisfaction of low-salary income earners with the indoor environmental quality of social mass housing units in South Africa.

2. LITERATURE REVIEW

It is a widely accepted consensus that majority of the people in developed countries spend their time indoor (Frontczak, et al, 2012), therefore it is essential that the indoor environmental quality of such buildings are satisfactory to the occupants because it impacts on their health and general well-being (Sakellaris, et al, 2016). Researches have been conducted on the indoor environmental quality of occupants in Hotels (Perera & Sumanarathna, 2016), teaching rooms (Lee, et al, 2012), LEED certified buildings (Lee, 2012), office buildings (Brits, 2011), hospitals (Nimlyat & Kandar, 2015) and school buildings (Theodosiou & Ordoumpozanis, 2008) among others. However, researches on the indoor environmental quality of residential buildings, especially the unrated ones where people expectedly spend about 50% of their time are scarce.

Also, researches have been conducted on the benchmarking of the rating of HK-BEAM, BREEAM and LEED (Lee & Burnett, 2008),

comparison of LEED and non-LEED certified buildings in United States (Altomonte & Schiavon, 2013) and examining the performance of green and conventional buildings (Perera & Sumaranathna, 2016) among others. Studies on indoor environmental qualities have also taken the dimensions of literature reviews (Raid, Kasim & Hussin, 2015), factors affecting the indoor environmental quality of buildings (Frontczak & Wargocki, 2011) and occupants' level of satisfaction with indoor environmental quality of buildings (Ranasinghe, Perera & Halwatura, 2012). Many of these researches were conducted on green and non-green buildings outside South Africa. Hence, it is difficult to ascertain the level of occupants satisfaction with the indoor environmental quality of buildings in South Africa.

Kiprotich (2016) recommended in his study that occupants' satisfaction surveys should be conducted more often not only on green buildings but also on conventional buildings to enable facility managers to come up with effective ways of improving the environmental performance as well as productivity of their occupants. It is on this basis that the study is investigating the occupants level of satisfaction with the indoor environmental quality of social mass housing projects in South Africa.

3. RESEARCH METHODOLOGY

The descriptive survey research method was used for this study. The study was conducted in Ekurhuleni Metropolitan Municipality (EMM) where low-salary buildings are concentrated in South Africa. The respondents were the occupants that dwell within the social housing projects that are managed by the Ekurhuleni Development Company (EDC), an institution that was established to advance and administer rental accommodations for low and direct pay families in South Africa.

There are many of low-salary housing projects in South Africa that are being managed by EDC, hence the population of qualifies respondents are large. However, the research chose the non-probabilistic convenience method to obtain data from respondents. Therefore, the criteria for participating in the study are that occupants must live in one of those houses and must be willing to participate in the survey. Fifty of the distributed structured questionnaire was returned and used for the study. The methods of data analysis include percentages, mean scores, and correlation analysis.

DATA ANALYSIS

Table 1 shows the general information of respondents and their houses. 66% of the respondents were females while 34% were males. This shows that there are more female respondents in this study than males. Also, 2% of respondents were 20-25 years, 20% were 26-30 years, 32% were 31-35 years, 22% were 36-40 years, 16% were 41-45 years and 8% were above 45 years. This indicates that majority of the respondents fall within 26 and 45 years. In the same vein, 74% of the respondents are Africans by ethnicity while 22% were coloured.

Those that have spent less than 1year in their apartment were 16%, 1-5 years were 44%, 6-10 years were 40%. Also, 50% live on the first floor, 22% live on the second floor, 18% live on the third floor and 10% live on the fourth floor. Moreover, 20% had their windows facing the North, 26% had their windows facing the east, 8% had their windows facing west, 18% had their window facing core and 28% did not know where their windows faced. Lastly, 74% of the respondents live in 2 bedroom units while 26% lived in 1 bedroom unit.

Table 1: General information about respondents and their houses

Information	Percentage (%)
Gender	
Male	34
Female	66
Age	
20-25	2
26-30	20
31-35	32
36-40	22
41-45	16
Above 45	8
Ethnicity	
African	74
Coloured	26
Number of years in building unit	
Less than 1 year	16
1-5	44
6-10	40
Floor level of	

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respondent	
First	50
Second	22
Third	18
Fourth	10
Direction of occupants buildings	
North	20
East	26
West	8
Core	18
Do not know	28
Type of unit occupied	
2-bedroom unit	74
1 bedroom unit	26

Table 1 Cont'd

Table 2 shows the time spent by occupants in various locations of their apartments and on some household activities. The rating was done differently and result shows that occupants spend most of their time in the lounge (4.38), followed by bedroom (3.90), Kitchen (3.82), bathroom (3.12) and then common areas of the building (2.12). On the activities conducted in the house, result shows that occupants spend more time on sedentary activities (3.82), followed by sleeping (3.46), low-intensity activities (3.16) and then high-intensity activities (2.46).

Table 2: Time spent in different locations of the unit and to conduct various activities

Unit location	Mean	Rank
Lounge	4.38	1
Bedroom	3.90	2
Kitchen	3.82	3
Bathroom	3.12	4
Common areas of the building	2.12	5
Activity Conducted		
Sedentary activities (reading, eating, watching TV, etc.)	3.82	1
Sleeping	3.46	2
Low intensity activities (cooking, etc)	3.16	3
High-intensity activities (exercising)	2.46	4

Table 3 shows the level of satisfaction of occupants with the indoor environmental quality of their apartment and building as a whole based on gender.

Table 3: Level of occupants' satisfaction with indoor environment of unit and building based on gender

	Female		Male		Both	
Indoor Environmental Quality factors	**Mean**	**Rank**	**Mean**	**Rank**	**Mean**	**Rank**
Amount of light in the unit	3.55	2	3.18	1	3.42	1
Level of privacy	3.46	3	3.18	1	3.36	2
Air quality in the unit (stuffy/stale air, cleanliness, odours)	3.64	1	2.77	3	3.34	3
Sound privacy between the units(ability to have conversations without neighbours overhearing)	3.24	6	3.12	10	3.20	4
General cleanliness of the building	3.39	4	2.41	6	3.06	5
Comfort of furnishings	3.33	5	2.00	9	2.88	6
Temperature in the unit	3.18	8	2.29	7	2.88	6
Visual comfort of the lighting(e.g glare, reflections, contrast)	3.21	7	2.24	11	2.88	6
Ability to adjust or move furniture to meet personal needs	3.06	9	2.47	4	2.86	9
Colours and textures of flooring, furniture and surface finishes	3.03	10	2.06	12	2.72	10
Amount of space available for individual daily activities (storage, recreation, etc.)	2.94	11	2.29	7	2.72	10
General maintenance of the building	2.49	12	2.47	4	2.48	12

For the females, air quality (3.64), amount of light (3.55), level of privacy (3.46), cleanliness of the building (3.39) and comfort of furnishings (3.33) are their highest priority. For the males, amount of light (3.18), level of privacy (3.18), air quality (2.77), ability to adjust or move furniture (2.47) and maintenance of the buildings (2.47) are their highest priority. Combined choice of males and females shows that amount of light (3.42), level of privacy (3.36), air quality (3.34), general cleanliness (3.06) and comfort of furnishings (2.88) are their priorities. Comparison by gender shows that there is no much difference in the top choices of males and females on their satisfaction with the indoor environmental quality of their units and building generally because they both had almost the same choice as their top five factors.

Table 4 describes the level of satisfaction of occupants with indoor environmental quality based on the type of unit they occupy.

Table 4: Occupants' satisfaction with indoor environment based on type of unit occupied

Indoor Environmental Factors	1 Bedroom Mean	Rank	2 Bedroom Mean	Rank	Both Mean	Rank
Amount of light in the unit	3.83	1	2.33	8	3.42	1
Level of privacy	3.51	2	3.00	5	3.36	2
Air quality in the unit(stuffy/stale air, cleanliness, odours)	3.34	3	3.42	1	3.34	3
Sound privacy between the units (ability to have conversations without neighbours overhearing)	3.23	4	3.17	2	3.20	4
General cleanliness of the building	3.06	7	3.08	3	3.06	5
Comfort of furnishings	3.11	6	2.17	10	2.88	6
Temperature in the unit	2.80	11	3.08	3	2.88	6
Visual comfort of the lighting (e.g glare, reflections, contrast)	3.14	5	2.08	11	2.88	6
Ability to adjust or move furniture to meet personal needs	2.97	8	2.50	7	2.86	9
Colours and textures of flooring, furniture and surface finishes	2.83	10	2.25	9	2.72	10
Amount of space available for individual daily activities (storage, recreation, etc.)	2.91	9	2.08	11	2.72	10
General maintenance of the building	2.40	12	2.58	6	2.48	12

For those living in 1 bedroom units, amount of light (3.83), level of privacy (3.51), air quality (3.34), sound privacy between units (3.23) and visual comfort (3.14) are the top factors of their satisfaction. For those occupying 2 bedroom units, the top factors of satisfaction are air quality (3.42), sound privacy (3.20), cleanliness of the building (3.08), temperature in the unit (3.08) and level of privacy (3.00). The combined rating based on type of type of unit is in the order of amount of light (3.42), level of privacy (3.36), air quality (3.34), sound privacy (3.20) and general cleanliness of the building (3.06) among others. The result in this table shows that according to type of unit, the preferences of occupants on the factors of indoor environmental quality are slightly different from one another.

Table 5 shows the level of occupants' satisfaction with the components of indoor environmental quality in different locations of their building units.

Table 5: Occupant's satisfaction with IEQ elements in their building units

IEQ elements	Bedroom Mean	Rank	Bathroom Mean	Rank	Lounge and Kitchen Mean	Rank
Lighting	3.50	2	3.64	1	3.50	2
Furniture & Furnishings (floors, paint, windows, shades, etc.)	3.64	1	3.46	2	3.74	1
Temperature	3.12	4	3.26	3	3.42	3
Air quality	3.42	3	3.20	4	3.30	4
Acoustic conditions	2.72	5	3.04	5	3.14	5

In the bedroom, the order of satisfaction with IEQ elements is furniture and furnishings (3.64), lighting (3.50), air quality (3.42), temperature (3.12) and acoustic conditions (2.72). In the bathroom, the order is lighting, furniture and furnishings, temperature, air quality and acoustic conditions. In the lounge and kitchen, the order of satisfaction with IEQ element is furniture and furnishings, lighting, temperature, air quality and acoustic conditions. The difference in the orders described in this table indicate that apart from considering individual characteristics like gender and type of building for green building design, the preferences for the spaces in the units should also be put onto consideration. It can also be seen that all the indoor environmental quality have mean scores above average to show that occupants are satisfied with all the elements of indoor environmental quality in their units. However, acoustic condition in the bedroom is rated lower than others to show that it needs improvement.

CONCLUSION

Based on the findings of this study, it was concluded that majority of occupants spend more time in the lounge than other parts of the building, followed by bedroom, kitchen and bathroom. As a result of the time spent in the units, it was concluded that the activities they do in their building units are in the order of sedentary activities, sleeping, low-intensity activities and high-intensity activities respectively. The study further concludes that occupants' order of satisfaction with indoor environmental quality factors is, amount of light available in building units, level of privacy in the units, quality of air, sound privacy within the units and general cleanliness of the building. The factors with the least level of satisfaction are colour and texture of flooring, amount of space available in the unit and maintenance of the building.

The study further concludes that occupants are satisfied with all the indoor environmental quality elements except the acoustic conditions. Therefore, it was recommended that, acoustic conditions of mass housing projects should be improved during design to better improve the satisfaction of occupants with the housing units. Further recommendation is that, though colour and texture of flooring, amount of space in building units and maintenance of buildings may not directly impact the health and well-being of occupants, it should be given more consideration for future projects because it has impact on satisfaction and comfort of occupants with their buildings.

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Risk Assessment For The Importation Of Bitumen For Road Construction Into South Africa

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ABSTRACT

Background and Purpose of the Paper
Bitumen has established itself as a product essential to the constructability and sustainability of roads and other associated structures. However, bitumen is not always readily available due to irregular maintenance shut downs of refineries, causing shortages.

Primary Objectives
This article will only focus on the identification and assessment of the risks involved with the importation process.

Design/ methodology/approach
The risks identified were classified as primary data. The assessment of the associated risks was then done by means of a Fuzzy Logic risk assessment.

Findings
The identified risks and their associated ratings were defined and classified in full. These can be referenced by future importers of bitumen, providing information on the procedures, where resources should be allocated and how the associated risks can be managed.

Research limitations/implications
Areas of the risk environment which require additional quantitative research are indicated.

Practical Implications / Original value of the paper.
The paper provides the first attempt at an overview and analysis of the risks involved in the importation of bitumen for use in the South African construction industry.

Response to the conference theme
The paper provides information to ensure that the supply and delivery of a basic raw material for the construction industry i.e. bitumen is not unnecessarily interrupted with negative impacts on role players in the industry.

Keywords
Bitumen importation, risk assessment, fuzzy logic, import risk, South Africa

Sub Theme:
Public Sector Procurement and Contracting / Infrastructure Delivery Challenges

Acronyms Used:

PRAM	Project risk analysis and management
MCDM	Multi-Criteria Decision Making
MODM	Multi-Objective Decision Making
MADM	Multi-Attribute Decision Making
OL	Occurrence likelihood
DI	Degree of impact

1 INTRODUCTION

Bitumen has firmly established itself as a product which is not just essential to constructability and sustainability of roads but also plays a key role as an economic driver of a country (Dobson, Lemphers & Guilbeault, 2013). However, the product is not always readily available as it is derived from a non-renewable resource. As known oil sands resources are depleted and new deposits are discovered, resulting in the fluctuation of bitumen production. This in conjunction with irregular maintenance shut downs of refineries can cause bitumen shortages, resulting in construction companies having to endure economic losses (Ndihokubwayo & Haupt, 2009).

Bitumen is naturally extracted through the fractional distillation of crude oil and is mainly used as a binder in road construction. The majority (91%) of crude oil consumed in South Africa is imported, with the rest being locally sourced (Department of Energy, 2012).

In the years 2012 and 2013, South Africa was faced with a bitumen shortage estimated at 20% of the country's total production volume. This

was due to an untimely and unplanned shutdown of a refinery, causing disruption of the complete road construction industry of South Africa (Cokayne, 2013). Since 2014 the industry has recovered to producing bitumen on a reliable basis. However, the likelihood of this recurring in the future remains a reality.

Due to the unplanned shutdowns in 2012, COLAS (a South African bitumen supplier) imported 3849 metric tons (MT) of bitumen into Cape Town. The successful importation of bitumen into South Africa resulted in the creation of an importation guidance document, aimed at assisting prospective new importers. The document discussed the international sourcing of bitumen, quality assurance of bitumen during the import process, bitumen import logistics and the various health, safety and environmental management procedures. The document did, however, not discuss the risks involved when importing bitumen. With risk management becoming the focal point of many activities and technologies (Fischhoff, Watson & Hope, 1984:123), combined with limited available literature on the international procurement of bitumen, the research problem was developed.

2 RESEARCH APPROACH AND METHODOLOGY

The main focus of the research study is the identification of risks when importing bitumen into South Africa. Some of the risks identified will be specific to South Africa, whereas other risks will be applicable to international procurement in general. Risk identification will be performed for all facets of the import process, and thus will not be specific to just one area of the process.

The risk identification process will be conducted using two methods. The first being a literature study based approach on international procurement of general commodities, general construction project risk management and logistics management. The second will be a review and analysis of information gained from industry professionals who have been involved in the importing of bitumen. All risks identified using literature on international procurement, will be presented to the professionals who have imported bitumen, for consideration. Furthermore, the professionals in question will be from South Africa as well as from Australia. This is done to get a more comprehensive risk identification range, incorporating all risks associated with the process.

The fuzzy logic risk assessment which will be performed is based on the risk assessment methodology as implemented by Lu, Yu and Chang (2014). The quantification of the risks for the risk assessment will be performed by two participants, being the researcher himself and one industry professional. The quantification by the analyst will be performed by means of expert judgement, based on referenced academic literature and semi-structured interviews. Each individual risk will be analysed and researched individually, whereupon the risk will be quantified. The semi-

structured interviews were not specifically directed at the quantification of risks, as intellectual property surrounding the risks exist (M. Schafer, 2015). As such, data collected during interviews, with reference to certain risks, will be taken into account during the quantification process. All additional risks, not mentioned during interviews, will be researched. The research of the individual risks gives an indication of the approach to be taken by an inexperienced organisation for the import of bitumen. The participant will be selected based on his experience with the complete bitumen import system, and not just individual components thereof. The participant will not be from South Africa, and also not subject to intellectual property regulations. This will provide better insight as to different risk quantification perspectives perceived by different countries.

3 RISK MANAGEMENT

International procurement strategies require an integrated approach to risk management (Carter and Ferrin, 2015). By doing so, managers can develop effective and efficient processes to reduce risks to an acceptable level. Purchasing organisations, or importing firms, face risks which are not easily identifiable. Global competition for sources of supply, technological advancements, international currency and interest rate movement are all part of the risk filled environment. Adding political, social, environmental and other factors, creates an unstable risk environment, known as the global economy (Carter and Ferrin, 2015).

The term global supply management captures the comprehensive focus of the problem. This is done by analysing the entire spectrum of significant, and insignificant, risks which have the possibility to disrupt a purchasing organisations success. In addition, each purchasing organisation will have a set of risks, some generic international trade risks, and some unique to their international procurement strategy (Carter and Ferrin, 2015). A global supply management perspective is thus needed for this study.

4 DEFINING RISK

For risk management to be successful, an explicit and widely accepted definition of the term risk is essential. However, the term “risk” is of controversial nature, as the choice of the term’s definition can affect the outcome of debates surrounding certain policy matters (Fischhoff, Watson & Hope, 1984:123). The process of practically applying risk management, in terms of stating risk limits, determining performance-based compensation or penalties, the optimisation of system processes, and capital calculations all depend on the measurement of risks (Holton, 2004:19). As such, it is only justified that in the construction industry, an

industry plagued with risk and the consequences thereof, risks are defined in correlation with the nature of the industry.

According to literature, a construction risk is defined in various ways. According to Akintoye et al. (1997), a risk can be defined as a variable in a construction project, which has the potential to fluctuate, and if so introduces uncertainty which can have an influence on the quality, schedule and cost of a project (Akintoye & Macleod, 1997:31). According to Ehsan, Alam, Mirza and Ishaque (2010), risks are present in all construction projects, being classified more as fate than a choice, as the inherent uncertainty of construction project makes risk inevitable, creating uncertainty as to the quality-, schedule- and cost outcome of a project (Ehsan, Alam, Mirza & Ishaque, 2010). Other definitions supported by Perry and Hayes (1985), state that risk is directly connected to economic loss or gain when involved in the process of construction (Perry & Hayes, 1985:499). When analysing the definitions as presented, it can be concluded that a risk is a variable in a construction project, which if not managed responsibly, could have a negative or positive influence on the desired outcome of the project.

5 RISK IDENTIFICATION

The aim of risk identification is to identify, to the best of the organisations ability, all relevant risk sources. As the risks are identified, it is the responsibility of the identifier to give a detailed description of the risks which has been identified. Should risks be articulated correctly, it will have a large influence on the assignment of risk ownership, estimating risks, developing effective risk response strategies, identifying the risk causes, and the explaining of the implications of risks. It is recommended that risks should be described using a three-part method, stating the context and sources of uncertainty and impact (RMCapability, 2011).

The project risk analysis and management (PRAM) process is made up of various stages, being risk identification, risk assessment, risk management, risk monitoring and review. From these stages it is acknowledged that the risk identification and assessment stages are deemed the most important, having the largest impact on the accuracy of the risk assessment. The risk identification is mainly based on subjective expert judgements, whether being in the form of literature or through communication (Chapman, 1998:333). It is stated by Tchankova (2002) that the initial risk identification process is essential to risk management effectiveness, with non-identified risks becoming un-manageable problems further on in the project. The views of Tchankova (2002) is supported by Perry (1986), Garrido *et al.* (2011) and Chapman (2001). Perry stated that risks should be identified early in the project lifecycle, as the risks themselves acts as constraints on the project. Following this, Perry stated that the identification of risks are of great importance, even if the next stage of the risk assessment procedure is not implemented (Perry, 1986). Garrido

et al. (2011) stated that many consider the risk identification phase as being the most challenging and relevant phase in the risk assessment process (Garrido, Ruotolo, Ribeiro & Naked, 2011:242). Chapman (2001) stated that risk identification is considered by many to be the most important element of the complete risk assessment process (Chapman, 2001:147).

The process of risk identification can be divided into two phases being initial risk identification, and on-going risk identification (Dinu, 2012). Risk identification techniques can be further classified into three categories or techniques. These categories are (1) identification done solely by the risk analyst, (2) identification by the analyst when interviewing a member of the project team, and (3) the analyst leading the working group (Chapman, 1998:333). The study required the implementation of a combination of two categories, being the Identification by Risk Analyst and One-to-one Interview.

6 APPLYING MULTI-CRITERIA DECISION MODEL (MCDM) TO RISK ANALYSIS

The use of Multi-Criteria Decision Making (MCDM) models have increased over the past decades as the models have been implemented for different decision making scenarios, in different fields of work, with older models being upgraded and improved. The MCDM models can be used directly for real world problems.(Velasquez & Hester, 2013:56).

6.1 Types of Multi-Criteria Decision Models

Multi-Attribute Decision Making is one the most widely used branches of general decision making. The branch is part of a general class of Operational Research models which deal with decision problems within the borders of certain prescribed decision criteria. The complete class of models, of all sorts, are defined under the name of Multi-Criteria Decision Models (MCDM). According to Triantaphyllou et al (1998), the class known as MCDM models are further divided into Multi-Objective Decision Making (MODM) and Multi-Attribute Decision Making (MADM). MODM models are used for decision problems where the decision space is continuous, thus it does not use a pre-determined set of alternatives. As such, MADM models use a pre-determined decision space, using known boundary conditions as well as pre-defined and determined alternatives (Triantaphyllou, Shu, Nieto Sanchez & Ray, 1998:175) (Zanakis, Solomon, Wishart & Dublish, 1998:507).

Many different MCDM models have been developed over the years, each pertaining to a unique set of advantages and disadvantages, and is

classified by their individual data input. That is, we have deterministic, stochastic and fuzzy MCDM methods.

6.2 Selecting the Appropriate Type of Multi-Criteria Decision Model

For the research study at hand, the alternatives will be pre-determined, being the identification of the risks, thus a MADM method will be best suited for analysis purposes. The data input sets to be used will be discrete of nature. According to Zanakis *et al. (*1998), many researchers have proposed different methods for decision making problems, describing how decision models could help analyst in choosing between alternatives (Zanakis, Solomon, Wishart & Dublish, 1998:507). Schinas (2007) stated that this inherent attribute of MCDM models, however impeding the extensive use in daily business, can be surpassed should the right model be selected for a specific problem. The model should be selected based on previous implementations, literature and by means of extensive boundary condition definition (Schinas, 2007).

In the case of a risk analysis, the data can be classified as fuzzy. The term fuzzy, according to Velasquez *et al.*, 2013, is used for a set of data which is imprecise and uncertain. When analysing bitumen import risks for South Africa, participants are asked to rate risks based on research, professional knowledge and experience. As such, different professionals will rank certain risks differently based on their subjective knowledge. The complete set cannot be defined by a single number but rather a range. Such a single number is referred to as a crisp number. Information gathered for this study will not be deemed as crisp, but rather as vague and imprecise (Velasquez & Hester, 2013:56).

According to Chou, Chou and Tzeng (2006) choosing a decision model for a specific problem, addressing all the project variables is a difficult, if not impossible process (Chou, Chou & Tzeng, 2006:1026) (Kahraman, Cebeci & Ulukan, 2003:382). However, when analysing risk factors associated with the importation process of bitumen, only factors relating to impact and probability will be taken into account. This, combined with the rankings being based on expert estimations instead of personal experience, creates a domain best managed by a fuzzy based approach. According to Chou *et al.,* 2006, the requirements for a decision model to be a success are [1] incorporate the opinions of experts of all levels of a corporate structure, with different levels of experience, [2] incorporating different criteria into one model, [3] the appropriate model flexibility to change weights given to certain criteria, [4] the model should combine quantitative and qualitative decision making, and [5] be easy to use and save time (Chou, Chou & Tzeng, 2006:1026).

7 FUZZY LOGIC BASED RISK ASSESSMENT FOR BITUMEN IMPORTATION INTO SOUTH AFRICA

Ten sources were reviewed for the identification of the risk criteria, the sources are (Miller, 1992:311), (Tah & Carr, 2001:835), (Zou, Zhang & Wang, 2009), (Ghosh & Jintanapakanont, 2004:633), (Baloi & Price, 2003:261), (Howell, 1994), (Wabiri & Amusa, 2011), (Martin, 2013), (Chapman, 2001:147) and (Luu, Kim, Tuan & Ogunlana, 2009:39). After reviewing the ten academic sources, the risk structure was divided into two sub-sections, being internal- and external risks. The internal risk criteria was further sub-divided into local and global risks.

7.1 Identified Risks for International Trade in Bitumen

The risks will be identified in accordance with the relative risk criterion. The risk identification techniques were previously defined. The sources are Baloi *et al.* (2003), Chapman (2001), Ghosh *et al.* (2004), K.F. Kroner and W.D. Lastrapes (1993), K. Louw (2015), Luu *et al.* (2009), Maritime Safety (2004), H.G. Meissner (1990), F. Niepman and T. Schmidt-Eisenlohr (2014), P. Rajib (2015), P. Secru (2013), B. Seyoum (2008), Southern African Bitumen Association (SABITA) (2013), SunCorp Bank Australia (2015), Tah *et al.* (2001), United Overseas Bank (2015), Zou *et al.* (2009). The risks identified from the sources are stated in the following sub-section, as well as the level of significance associated with each of the individual risks. 75 risks in total were identified.

8 RISK ANALYSIS RESULTS

The risks were listed in accordance with the relative risk criteria, whereupon the occurrence likelihood (OL) and degree of impact (DI) ratings were determined. The fuzzy logic risk analysis was performed using the methodology as presented in the study done by Lu *et al.* (2014).

The following section shows the risk rankings, as well as stating and discussing the top 10 most significant risks. As previously stated, the fuzzy logic risk assessment methodology is implemented as was done in the study of Lu *et al.* (2014). Table 8.1 shows the risks as well as the associated risk rankings.

Table 8.1: Risks and Associated Risk Rankings

External Risks		Rank
Economic Risks	Inflation	36
	Changes in relative price/ Price Fluctuation	43
	Foreign exchange rates	33
	Interest rates	57
	Terms of trade	60
	Taxation on imported product	68

Political and Social Risks	War in exporting country	30
	Coup d'état	66
	Democratic changes in government	59
	Other political turmoil	46
	Price controls	62
	Trade Restrictions	72
	Nationalization	71
	Government regulations	46
	Monetary reforms	50
	Changing social concerns	75
	Riots	35
	Terrorist movements	14
	Government relations	66
Technological Change Risks	Product innovations	68
	Process innovations	74
	Innovation by competitors	55
Force Majeure Risks	Hurricanes	62
	Earthquakes	62
	Other natural disasters	37
	Bad weather on open sea	6
Internal Local Risks		**Rank**
Sub-Contractor Risks	Unavailability of skilled sub-contractors	25
	Low management competency of sub-contractors	18
	Lack of coordination between project participants	28
	Sub-contractor lack of adequate equipment or staff	28
Safety Risks	Employee safety risk	18
	Labour unrest	37
Management Risks	Unavailability of sufficient professionals and managers	6
	Project size and complexity	18
	Inadequate project management controls	6
	Incorrect balance of resources and expertise	37
	Knowledge inadequacy	2
Internal Global Risks		**Rank**
Industry Market Risks	Changes in the quantity used by others	30
	Shifts in market supply	30
	Availability of product from other sources	5
	Scarcity in complimentary products	42
	Rivalry among existing competitors	33
	New entrants in importing industry	53
Client Risks	Design variations by client	54
	Occurrence of disputes	18
	General client generated risk	70
	Client does not allow for adequate time for process	57
	Responsibilities of the client team ill defined	73
Contractual Risks	Product liability uncertainty	65
	Emissions and pollutants liability uncertainty	56
	Delay in solving contractual issues	6
	General legal risks	24
Environmental Risks	Ecological constraints	51
	Pollution in harbour during unloading	4
Financial	Inaccurate cost estimation	46

Risks	Corrupt practices	12
	Fraudulent practices	26
	Inadequate project funding	45
	Timing of availability of funds	41
	No budget for contingency measures	60
	Design errors	51
	Quantity variations	44
	Loss of Cargo	13
	Storage Facilities	14
Pre-Contract Risks	Unproven design solutions adopted	23
	Tendered price	27
Product Quality Risks	Product does not conform to specifications	1
	Viscosity changes of bitumen during transport	2
Time Related Risks	Unloading delay	6
	Unsuitable program planning	46
	Excessive approval procedure in administrative government departments	14
	Attainment of correct documentation and permits	14
	Delay due to labour or equipment productivity	6
	Availability of bitumen specific ports in South Africa	22
Trade Compliance Risks	Incomplete approval	37

9 SUMMARY OF RISKS IDENTIFIED

Table 9.1 states the top 10 risks, with the associated risk descriptions. The risks are ranked from most- to least significant.

Table 9.1: Top 10 highest Ranking Risks and Descriptions

Rank	Description
1	**Product does not conform to specifications** Organisations and experienced professionals in the field of bitumen importation stated that the conformation of the product was the largest concern when importing bitumen from a new supplier.
2	**Viscosity changes of bitumen during transport** Organisations and experienced professionals in the field of bitumen importation stated that the conformation of the product was the largest concern when importing bitumen from a new supplier.
3	**Process and managerial knowledge inadequacy** When interviewing Mr Schafer, emphasis was placed on the managerial component of importing bitumen. It was stated by an industry professional that inadequate experience and knowledge regarding the importation process of bitumen can cause time and monetary difficulties early in the process. A large portion of the intellectual property regarding the risks associated with bitumen importation is centred on managerial procedures.
4	**Pollution in harbour during unloading** The SABITA import guide placed emphasis on the harbour rules and regulations. All

	three professionals stated that large fines can occur should product be spilled.
5	**Availability of product from other sources** Some of the variables are the product quality, the location of the refinery (being in the same region as the previous refinery) and the exporting capacity of the refinery.
6	**Unloading delay due to machine failure** The risk was emphasised by COLAS after importing bitumen in 2013. The unloading of bitumen at a port, which is not bitumen specific, requires additional logistic planning and management.
7	**Unavailability of sufficient professionals and managers** A lack in professionals and managers experienced in bitumen importation will lead to delays and financial implications.
8	**Inadequate project management controls** The management component for the bitumen import process is regarded as the most complex and risk filled.
9	**Delay in solving contractual issues** Most contracts place emphasis on the fair distribution of risks, however this is not always possible, which could result in contractual issues.
10	**Bad weather on open sea** This risk was identified by industry professionals as being highly probable, and having a large financial impact in terms of schedule delays.

10 CONCLUSION

It can be concluded that the risk ratings provided by the analyst, in conjunction with the ratings obtained from the international analyst, provide a sufficient indication of the risk structure for organisations attempting to import bitumen. The identified risks and their associated ratings can be used as a guideline for future importers, providing information as to where resources should be allocated. It also gives an indication as to areas of the risk environment which require additional research, and more comprehensive quantification study. The complexity associated with importing bitumen stems from the extensive logistical management, which if not done correctly could have large financial consequences.

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Critical success metrics for measuring construction project success in small and medium enterprises: an exploratory factor analysis study

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ABSTRACT

Purpose of this paper

Achieving project success is the primary goal for every construction project. Nevertheless, the concept of success in construction has remained unclearly defined and the criteria for measuring project success still remain unclear, despite numerous studies conducted. Most of these studies review theoretically what the criteria for assessing success should be at the project level. This paper presents the findings of an exploratory factor analysis (EFA) study of project success measures at project level of construction SMEs in South Africa.

Research methodology

A questionnaire was used as a data collection instrument from 187 construction small and medium enterprises who were conveniently sampled in Gauteng (South Africa). The data was analysed using the Statistical Package for the Social Sciences (SPSS) version 23.

Findings
The study evinced that project success could be reasonably measured by three measures namely time, cost and quality. The results support current literature which advocates the use of time, cost and quality as success metrics to assess the success of construction projects. The study provides truthful information which could be beneficial in evaluating project performance.

Research limitations
The respondents were construction small and medium enterprises and were all based in Gauteng province, hence a limitation in the study.

Practical implications
The measures established in the current study using Exploratory Factor Analysis (EFA) will enhance measures used in assessing success at project level of construction SMEs.

Value of paper
The tool used in the current study and the results obtained could be of value to researchers and industry practitioners on the theme where no agreement has been attained relating to key metrics for assessing success in construction SMEs projects in South Africa.

Keywords: Exploratory factor analysis (EFA), key metrics, measuring, project success

1. INTRODUCTION

The construction industry (CI) is a key sector for the development of a country through its contribution to economic growth, employment as well as the physical development of infrastructures (Ye *et al.* 2009). Consequently, the success of a construction project is of upmost importance to construction enterprises and to most governments. However, these projects not only are faced with significant challenges in successfully delivering projects but also defining project success itself, which is a complex issue (Lam *et al.* 2008; Toor and Ogunlana, 2010). Chou and Yang (2012) indicated that the notion of project success is used to help deliver projects with the most recommendable outcomes. Nevertheless, the notion of success remains vaguely defined regardless of numerous studies on the subject (Ahadzie *et al.* 2008).

Traditionally, project success has been assessed based on three dimensions namely; completion within time, budget, and quality (Iron triangle). However, Toor and Ogunlana (2010) indicated that the three dimensions can no longer be the sole dimensions to measure project success owing to several reasons namely; other dimensions such as client's satisfaction and issues of health and safety need to be considered

in assessing success at project level (Banki *et al.* 2009; Ng *et al.* 2009). The above thoughts suggest that the use of traditional measures to measure project success is integrally flawed.

Furthermore, most studies theoretically assess what should measure project success in construction. Few empirical studies have been conducted to determine the factor structure of project success measures. Hence, this paper aims to determine the factor structure of the project success measures used in the study. In order to achieve the objective of the study, an in-depth review of the literature on project success measures in construction was first conducted. Thereafter, in order to introduce the approach used in the study and to encourage a meaningful return as suggested by Berssaneti and Carvalho (2015), the measures of project success adopted in the study were included in the questionnaire. This was to assist respondents in judging the most success measures that could be used to measure success at project level of SMEs. This was followed by the presentation of data analysis and discussion of the findings. The final section of the paper concludes the study objectives and key findings.

2. REVIEW OF LITERATURE

2.1 Criteria of project success

Silvius *et al.* (2013) define a project as the accomplishment of a stated objective, which encompasses a sequence of activities and responsibilities that require resources. The Oxford Dictionary considers criterion as a standard or principle by which something is judged, or with the support of which a decision is reached. The Oxford Dictionary further explains success as an advantageous outcome or the acquisition of fame or prosperity. When merging these two notions, criteria of project success can be regarded as the set of principles by which advantageous outcomes can be accomplished within a set specification. Wang and Huang (2006) posited that project success means different thing to different people. Carvalho and Rabechini (2015) regard success as an imperceptible sensitive sentiment, which changes with dissimilar management outlooks, and with the stages of the project. Contractors, sub-contractors, designers, consultants and owners have specific criteria for assessing success. For instance, architects usually value aesthetics rather than building cost as the leading criterion for success. However, the client may consider other measures more. Additionally, even the same person's perception of success can vary from project to project.

2.2 Project success measures

Over the years, numerous studies have been conducted on project success, and most of them have suggested various dimensions for measuring project success. Wang and Huang (2006) opined that project success is contrastingly viewed among researchers and practitioners. The

conventional measures of time, cost, and quality known as the Iron triangle have been the leading success metrics in construction (Toor and Ogunlana, 2010). The Iron triangle is cited in nearly every study (Banki *et al.* 2009; Ng *et al.* 2009; Hinze *et al.* 2013; Chou and Pham, 2013) on project success. Contrariwise, Collins and Baccarini (2004) posited that project success should not be limited to just the Iron triangle and the project management community need to be informed about this. Toor and Ogunlana (2010) indicated that while other definitions of project success have emerged, the iron triangle is constantly cited in the unconventional definitions.

In addition to the conventional measures, Ojiako *et al.* (2008) supported that dimensions for project success should also encompass project psychosocial outcomes which involve the contentment of interpersonal relations with the project team. Individual dimensions such as participants' satisfaction level are referred to as soft dimensions. The incorporation of satisfaction as a success metric is recommended by Weninger *et al.* (2013). Berssaneti and Carvalho (2015) further suggested incorporating the absence of legal claims as a measure of project success. This indicates the importance of including safety as a success measure since it is logical to anticipate that if accidents materialise, both clients and contractors may be subject to financial loss, contract delay as well as legal claims. Ahadzie *et al.* (2008) assessed project success extensively based on five criteria namely; maintenance cost, construction cost, time, safety and flexibility to users. Lam *et al.* (2008) stated that it is problematic to evaluate whether the performance of a project is a success or a failure owing to the fact that the notion of success remains unclear amongst project participants. According to Roelen and Klompstra (2012), the project is a complete success if it attains the technical performance specifications to be executed, and if there is satisfaction regarding the project outcome among key users and project team members. In evaluating project success, Chou and Pham (2013) included a range of criteria which included project meeting planned cost, time, quality of work, affability of the environment, transfer of technology, client and project manager's satisfaction, and health and safety. Chou and Yang (2012) defined project success based on four measures namely; achieving design goals, the value to the end user, the value to the organisation, the value of the technological infrastructure of the country and of organisations implicated in the development process. All these measures combined together provide the inclusive evaluation of project success.

Regardless of the controversy in defining project success, this study follows the definition of project success as per Dingsdag *et al.* (2008); Ahadzie *et al.* (2008); and Chou and Pham (2013). This implies that the measures used in the study reflect project performance (Banki *et al.* 2009; Ng *et al.* 2009). Chou and Pham (2013) posited that the utilisation of a set of project success measures gives a considerable evidence of project performance than focusing on a single measure or a minor number of unplanned measures.

3. RESEARCH METHODOLOGY

3.1 Population and data collection

A population refers to the entire group of individuals in which the researcher has an interest (Neuman, 2006). For the purpose of this study, the population of SMEs in the Building Construction Industry in Gauteng was selected from the CIDB register of contractors. The reason for sampling from the CIDB population was that it contains potential respondents. An internet search was therefore conducted on the CIDB website to identify the potential respondents. In identifying potential respondents, the researcher ensured that all respondents were graded 1 to 6 and that they had a valid registration with CIDB in order to participate in the study. The respondents included owners, owner-managers, managers, project managers and other personnel with strong knowledge about the organisation and risk management practices.

After generating a list of potential respondents, the questionnaire was collected via personal hand delivery method. However, in a study of construction SMEs in South Africa, Agumba (2013) used both the drop and collect and emails method to collect the data. However, the researcher used only the drop and collect (i.e. personal hand delivery method). This method was chosen because it ensures very high response rate and that the researcher makes a physical contact with the target respondents.

3.2 Sample and sampling procedures

225 questionnaires were administered, 187 were returned of which six were excluded from the study due to various ambiguities (questionnaire incorrectly answered, respondents' information missing and inadequate information provided). Consequently, the remaining 181questionnaires were deemed usable representing approximately 80% response rate.

Non-probability sampling was employed to get the sample for the study. Vosloo (2014) indicated that non-probability sampling is one in which decisions regarding the individuals to be included in the sample are taken by the researcher, based upon a diversity of criteria which may include knowledge of the researcher issue, or aptitude and preparedness to partake in the study. Non-probability sampling is one which convenience forms the basis for selection (Neuman, 2006). Convenience sampling was deemed to be the most appropriate method owing to the small sample size to represent the entire population. Furthermore, Zikmund (2003) indicated that convenience sampling is the process of acquiring sampling units or people who are most conveniently available and is used when researchers want, swift and a cost-effective approach to obtaining a large number of completed questionnaire. Potential respondents were identified by sampling on the CIDB contractor register website in South Africa.

3.3 DATA ANALYSIS

SPSS version 23 was employed to perform descriptive statistical analysis of the demographic data and to establish the factor analysability of the project success measures, which were interpreted using Oblimin with Kaiser Normalisation rotation method.

Equally, EFA was used to assess the internal consistency reliability of the measures. Reliability was assessed using Cronbach's *alpha* with a recommended value of no less than 0.60 (Hair *et al.* 2006). However, prior to performing EFA, important assumptions for the factorability of data were taken into consideration. The sample size for the current study was of 181, which were larger than the lowest size of 150 (Pallant, 2013). This result indicated factorability of the sample size.

Furthermore, both Bartlett's Test of Sphericity and Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy were conducted to assess factorability. Outliers were identified and removed before analysis. Items with eigenvalues above 1 were retained using the Kaiser's criterion. The decision to retain factors was further supported by the scree test, where all factors above the elbow on the plot were retained (Pallant, 2013).

3.4 VALIDITY AND RELIABILITY

Chou *et al.* (2013) indicated that when measuring the outcome of project purposes, it is essential to ensure the outcome measure being used is appropriate. Therefore, for a project of this nature employing a questionnaire as an instrument to collect data, it was indispensable to ensure validity and reliability of the questionnaire which is compulsory to assess the construct validity and reliability of the project outcome variables. Validity was ensured as a result of conducting an extensive literature review by consulting previous related studies, this was requisite to specify the variables. The questionnaire was reviewed and revised by experts (academics, researcher's promoter, and a professional statistician) before conducting the pilot study with the intended respondents.

Cronbach's Alpha was used to assess the reliability of the questionnaire. A generally agreed upon minimum limit for Cronbach alpha is 0.70 (Hair *et al.* 2006). However, a cut-off value of 0.60 is common for exploratory research and values closer to 1 suggest good reliability (Zaiontz, 2014). For this study, a cut-off value of 0.60 was adopted (Sekaran, 1992). The overall Cronbach's alpha of the factor was 0.786 and the one of each item ranged from 0.659 to 0.852 (Table 1). These were all greater than the suggested value of 0.60, indicating good reliability (Zaiontz, 2014).

Table 1. Cronbach's Alpha of project outcome measures

	Project outcome	Cronbach's Alpha (0.786)
PO1	Meeting time objectives for key milestones	0.756
PO2	Meeting cost objectives for the project	0.852
PO3	Meeting quality objectives for the project	0.786
PO4	Meeting required health and safety levels for the project	0.753
PO5	Meeting expected client's satisfaction levels for the project	0.659

4. SURVEY RESULTS AND DISCUSSION

4.1 Respondents' information

Table 2 presents the information on respondents. It is obvious that most (87.56%) of the respondents were either owners or managers of their enterprise, male (81.80%), African/Black (56.40%), had either Matriculation (22.70%) or a Certificate (20.40%); 43.10% of respondents had 10 years' or less experience in construction.

Table 2. Respondents' information

	Frequency	Percentage
Position		
Owner	56	30.90%
Owner/Manager	40	22.10%
Manager	28	15.50%
Project Manager	31	17.10%
Other	26	14.40%
Total	181	100.00
Gender		
Male	148	81.80%
Female	33	18.20%
Total	181	100.00
Population group		
Asian/Indian	18	9.90%
Coloured	14	7.70%
African/Black	102	56.40%
White	47	26.00%
Total	181	100.00
Qualification		
Doctorate degree	3	1.70%
Master's degree	11	6.10%

Honours/BTech/BSc	27	14.90%
HND/Diploma	29	16.00%
Certificate	37	20.40%
Matric	41	22.70%
Basic schooling	26	14.40%
No qualification	5	2.80%
Missing	2	1.10%
Total	181	100.00
Experience in construction (years)		
1-5	30	16.60%
6-10	48	26.50%
11-15	29	16.00%
16-20	22	12.20%
21-25	7	3.90%
26-30	14	7.70%
31-35	7	3.90%
Over 36	9	5.00%
Missing	15	8.30%
Total	181	100.00

4.2 SMEs profile

Table 3 indicates that most (37.60%) SMEs were subcontractors or general contractors (31.50%), working mostly in Johannesburg (41.40%) and Tshwane (30.90%) Metropolitan Municipality. Nevertheless, the subcontractors either operated for the main contractor or were sole trade contractors.

Table 3. SMEs profile

	Frequency	**Percentage**
Type of contractor		
General Contractor	57	31.50%
Sub-contractor	68	37.60%
Civil contractor	12	6.60%
Specialist contractor	32	17.70%
Home building contractor	9	5.00%
Missing	3	1.70%
Total	181	100.00
Municipality		
City of Johannesburg Metropolitan Municipality	75	41.40%
City of Tshwane Metropolitan Municipality	56	30.90%
Ekurhuleni Metropolitan Municipality	19	10.50%

West Rand District Municipality	30	16.60%
Missing	1	0.60%
	181	100.00
Total		

4.3 Factor analysis

In order to ensure suitability of data set, the five project outcomes measures namely time, cost, quality, health and safety and client's satisfaction were subjected to EFA. Results of correlation matrix coefficient evinced the presence of many coefficients above the cut-off value of 0.30 (Table 4). The coefficients of these items correlated with at least one other item. These results indicated that the five items were good measures of project outcome.

Table 4. Correlated matrix for project outcome measures

		PO1	PO2	PO3	PO4	PO5
Correlation	**PO1**	1.000				
	PO2	0.503	1.000			
	PO3	0.326	0.589	1.000		
	PO4	0.097	0.655	0.167	1.000	
	PO5	0.324	0.557	-0.150	0.300	1.000

Legend: PO1: Meeting time objectives for key milestones; **PO2:** Meeting cost objectives for the project; **PO3:** Meeting quality objectives for the project; **PO4:** Meeting required health and safety levels for the project; **PO5:** Meeting expected client's satisfaction levels for the project.

The KMO measure of Sampling Adequacy was 0.815 (Table 5). This result was greater than the suggested value of 0.60. The Bartlett's Test of Sphericity was statistically significant at p=0.000 (<0.05), indicating the factorability of the correlation matrix (Pallant, 2013). The anti-image correlation matrix coefficients (Table 7) were all above 0.50. This result further supported the factorability of the data set (Pallant, 2013).

Table 5. Test of data factorability

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		**0.815**
Bartlett's Test of Sphericity	Approx. Chi-Square	168.135
	df	10
	Sig.	**0.000**

Results of EFA further evinced that three of the five items had eigenvalues (shown in bold, Table 6) above 1 (1.954; 1.217; and 1.003). These results explained 39.08%; 24.35%; and 20.06% of the variance and accounting for 83.49% of the total variance. The decision to retain the three components was further supported by inspecting the scree plot (Figure 1) which evinced a change in the second component.

Table 6. Percentage variance explained-Project outcome

Component/Item	Eigenvalue	% of explained Variance	Cumulative %
1- PO1	**1.954**	**39.079**	**39.079**
2- PO2	**1.217**	**24.350**	**63.429**
3- PO3	**1.003**	**20.064**	**83.493**
4- PO4	0.501	10.020	93.513
5- PO5	0.324	6.487	100.000

The three components were further interpreted using Oblimin with Kaiser Normalisation rotation method. Results evinced the loadings of each measure on the three components (Table 8). Many variables loaded on component 1 while only one variable loaded on components 2 and two loaded on component 3. These variables were still retained because they strongly loaded on these components as recommended by Hair et al., (2006).

Table 7. Anti-image matrices for measures of project outcome

		PO1	PO2	PO3	PO4	PO5
Anti-image Correlation	**PO1**	**0.525**[a]	-0.487	-0.298	-0.017	0.047
	PO2	-0.487	**0.530**[a]	0.134	0.089	-0.503
	PO3	-0.298	0.134	**0.682**[a]	-0.209	0.162
	PO4	-0.017	0.089	-0.209	**0.661**[a]	-0.328
	PO5	0.047	-0.503	0.162	-0.328	**0.649**[a]

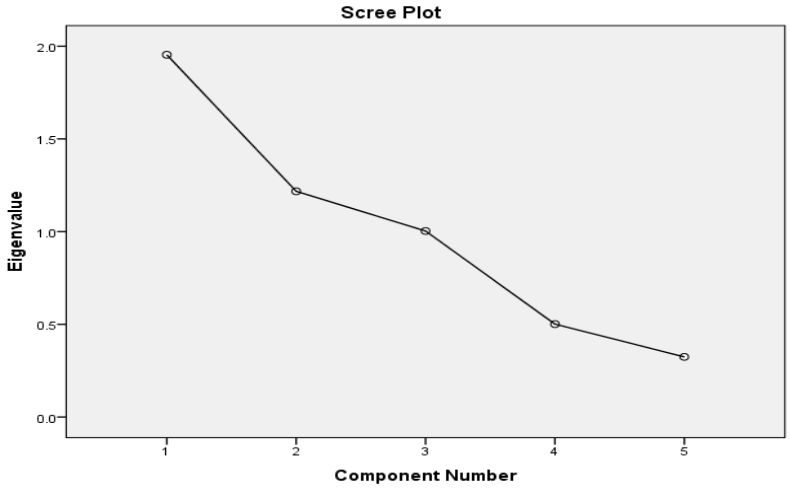

Figure 1. Output from scree plot for project outcome measures

Table 8. Component matrix for project outcome measures

	Component		
	1	2	3
PO2	**0.890**	-0.154	0.095
PO1	**0.790**	0.430	-0.077
PO5	**0.612**	-0.368	**0.520**
PO3	-0.011	**0.913**	0.128
PO4	0.018	0.170	**0.936**

The results indicated that construction SMEs in South Africa only consider time, cost and quality measures in assessing project success and that other measures such as client's satisfaction and health and safety seem not to be attracting considerable attention. The possible reason may be the intervention of the CIDB, amongst industry players to implement quality measures in their projects (CIDB, 2008). Partially, some project clients in South Africa necessitate a quality assurance system as a requirement for tender in any construction project.

Furthermore, the results provided information that prompt actions to reach desired outcomes and/or avoid undesirable outcomes as indicated by Toor and Ogunlana (2010). The findings provided support to existing literature which advocates the conventional metrics of the triple time, cost, and quality to measure project success in the construction industry (Toor and Ogunlana, 2010). However, these results are not in line with the empirical studies of Dingsday *et al.* (2008) that established project success as having results much better than anticipated or often observed in terms of cost, schedule, quality, health and safety, client's and participants'

satisfaction. In addition, Banki *et al.* (2009) indicated that a result is a tool that truthfully mirrors the project manager's knowledge base and includes the range of appropriate success measures related to construction projects that are not limited to the classical objective success measures (cost, schedule, performance, and safety).

Traditional measures of project success, the measures that evaluate project after cost overruns, accidents and injuries materialise, have a restraint in the sense that it forms measurement on the failure of the system (Ng *et al.* 2009). Anticipatory measures need to be considered before unwanted results happen. Project success measures can assist to forecast success levels to produce the essential pre-emptive actions prior to the occurrence of undesirable results. Thus, measures determined in this study should ideally be included in assessing the performance of construction projects. Although Dingsdag *et al.* (2008) indicated that performance indicators may not directly reflect actual success in preventing the materialisation of undesirable results (project cost overrun, the occurrence of accidents and/or injuries), they are progressively becoming accepted as posited by Hinze *et al.* (2013). Therefore, equal consideration should be given to other project success measures not determined in the study.

5. CONCLUSION

The study sought to establish the factor structure of project success measures at project level of construction SMEs. Project success was found to be measured by three success metrics namely; time, cost and quality. The three metrics are the elementary and most critical success measures in construction. Other measures, such as health and safety and client' satisfaction are enticing increasing attention. The current findings support literature which advocates the measures established in this study as performance indicators used to assess the success of construction projects. Furthermore, factual evidence is provided, which could be beneficial in evaluating project success. These findings provide a benchmark for measuring the performance of construction projects and could possibly boost prevailing knowledge on the theme of project success.

Regardless of the achievement of the study objectives, there are boundaries to the conclusions. The study was conducted in South Africa; however, it was delimited to the province of Gauteng. The surveyed respondents were small and medium enterprises in the CI; hence, the findings of this study may not be representative of the entire country. Furthermore, data were collected quantitatively. Other methods such as interviews could have been used to gather in-depth information from respondents.

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Strategic Alliances amongst the SMME Contractors: A Driver towards Strategic Capabilities and competencies

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ABSTRACT AND KEYWORDS

Purpose:
This study aimed to evaluate the forms and motives of strategic alliances amongst SMME contractors towards gaining capabilities, competencies and competitiveness in the construction industry.

Design/methodology/approach:
This study adopted qualitative research approach based on an in-depth face-to-face interviewing. A total sample of 74 SMME contractors within the cidb grade 4-6 contractors, out of which 34 (46%) were interviewed.

Findings:
The study findings revealed that most of the SMME contractors who have consciously adopted strategic alliance as part of their organisational strategy gained competitiveness in the market. The competitiveness in terms of: assess to strategic capabilities and competencies; opportunities to share project risk and knowledge; seamless collaborative and partnership with suppliers, other contractors, investors and project sponsors. The SMME contractors acknowledged the significance of strategic alliances towards their economic survival in the market. However, strategic alliances are underutilised as some of SMME contractors does not apply this strategy consciously.

Research limitations/implications:

Findings are based on a small sample frame in the context of the South African construction market, and thus, cannot be universally generalised.

Practical implications:
The findings provided strategic insights for SMME contractors on how strategic capabilities and competencies could be consciously acquired and utilised in the construction industry.

Value of paper:
This study promotes the SMME contractors' development, capabilities procurement, and contracting competitiveness.

Keywords:
Capabilities, Competencies, Construction, SMME contractors, Strategic alliances.

Sub Theme: SMME Contractor Development.

1. INTRODUCTION

The South African construction industry has grown substantially throughout the previous decade, which has resulted in a shortage of skilled or trained workers within the sector at all levels (Crampton, 2016). According to the, Queensland Department of Public Works (2008) resources and competences constraints are typically unique to each project design and procurement, this may include: time constraints; budget constraints; physical asset constraints; availability of labour resources; skills, capability and capacity of the project participants, most especially for the SMME contractors. Jenkins, Akhalkatsi, Robert, and Gardiner (2007) add that these constraints has cause pressure and driving many contractors to change their supply chain management strategies on how to reduce cost, time and maximize strategic resources usage. Eyiah (2001) posits that Small, Medium and Micro Enterprises (SMMEs)/ contractors are generally characterized by limited capital resources, plant and equipment, and managerial support systems which hamper their ability to acquire skilled labour and employ professionals its project procurement and delivery.

1.1 Constraints Encounter by SMME Contractors in Delivering Project Services

Snyman *et al.* (2014) denote that the crucial challenges facing the oragnisations such as SMME contractors is inadequate business strategy to access strategic resources and competencies, which has been a practical constraint on their business growth. Snyman *et al.,* (2014) further

assert that about 75% of new SMMEs in South Africa do not become established organisation nor will survive beyond 42 months than in any other Global Entrepreneurship Monitor (GEM) sampled country such as Brazil. Ntuli and Allopi (2014) state that the most conspicuous cause of insolvency for organisations such as SMME contractors results from inadequate cash and access to strategic capabilities, resources and competencies. That escalation of material prices, plants and equipment, and cost overhead, coupled with high interest rates have forced the management of construction firms to focus on the control of cash flow as being critical to its survival (Ntuli and Allopi, 2014); and perhaps, utilisation of strategic alliance in acquisition of plants and equipment, and skilled labour could assist to alleviate these enormous challenges related to constraints on access to strategic resources and competencies.

Thus, Heck (2014) argues that for organisations, managers and business owners such as SMME contractors to survive and be successful in the market, they need to think about adoption of strategic alliances. This approach serves as an innovative way towards acquiring, designing, procuring and delivering of project products and services. In addition, Snyman *et al.* (2014) advise that there is need to retain the socio-economic benefits of SMMEs, as such competitive strategy should be adopted for these businesses in order to survive and grow into sustainable organisations. Isoraite (2009) acknowledges that strategic alliances are becoming an important form of business activity and strategy for competitiveness in many industries. However, Isoraite (2009) further states that through strategic alliances, companies such as SMME contractors can improve their competitive positioning, gain entry to new markets, supplement critical skills, resources, and competencies, and share the risk and cost of their project design, procurement and delivery.

1.2 Research Problem Identification

The inadequacy of strategic capabilities, resources and competencies has been the major cause of SMME contractors' premature exits in the South African construction market.

1.3 Objective of the Study

The study aimed to evaluate the SMME contractors' strategic alliance, processes and motives towards acquisition of strategic capabilities, resources and competencies.

2. BACKGROUND OF THE STUDY

2.1 South African Construction Industry outlook

According to Ntuli and Allopi (2014) a sustainable construction industry is critical to the economy of South Africa. As such the South African public sector expenditures on the infrastructure works is the main contributor to the growth of the construction sector. Muscat (2016) states that the year 2015 was a difficult year for the South African construction industry, which registered quarter-on-quarter GDP growth of just 0.8% and 0.2% in the first and second quarters respectively. Thus, the, Report Buyer (2016) states that robust and modern infrastructure is vital towards engendering economic growth and competitiveness in South Africa, Cidb (2016) also reports that in year 2015, a sum of R355 billion has been spent in infrastructural projects which comprises investment by the General Government, Public Corporations and the Private Sector on the areas of: civil construction; non-residential buildings and residential buildings project. The, Report Buyer (2016) clearly indicates that in the same year 2015, SA national government budgeted to spend ZAR813.1 billion (US$67.3 billion) on infrastructure over the next three years, in order to drastically to build, improve and maintain the country's transport, water, housing, and energy infrastructure. More so, Report Buyer (2016) further states that the South African construction industry will continue to expand over the forecast period (2016–2020), with investments in infrastructure, residential and energy projects as a major driver of sustainable growth and development.

However, the South African construction market outlooks have a significant growth potential as well as risks for both the SMME and large contractors as; Crampton (2016) states that for organisations such as SMME contractors to become competitive within the industry, they need to appropriately and strategically manage their business risks through adoption of strategic alliances business approach. Therefore, organisations in construction industry need to remain proactive towards addressing the potential risks, in order to remain both sustainable and competitive throughout the current challenging economic period (Crampton, 2016). Crampton (2016) further states that the businesses such as SMME contractors need to focus its time and energy on risk management options through strategic alliance. As this would be deeming as critical component for organisation's effective management strategy within the South African construction industry.

2.2 Concept of Strategic Alliance

According to Mowla (2012) organisations across all types of sectors for the past decades have witnessed the widespread phenomenon of business alliances. Today's business environment has become increasingly dynamic and volatile, and subsequently very difficult for one organisation to stay abreast of all technologies, resources, competencies and information. However, to achieve competitive advantages, organisations must combine their assets and

capabilities into a cooperative and mutually beneficial alliances (Uddin and Akhter, 2011). According to Mowla (2012), effective business alliances are required to enable organisations to create sustainable value for their clients, shareholders, business partners and suppliers. Alliances are essential building blocks for companies to achieve a stronger and more effective market presence as, Ibrahim (2011) note that a business alliance is a cooperation or collaboration of organisations who strategically aim for synergy, where each partner hopes that the alliance will be more beneficial than those resulting from individual efforts. Thus, the 21 century organisations' strategic networks typically include diverse organisations within the supply chain and economic production scale and processes, such as suppliers, buyers, competitors, regulatory authorities, financial and credit institutions (Todeva and Knoke, 2005). According to Soares (2007) the ultimate idea behind a strategic alliance is to minimize risk while maximizing the utilization of financial, technical, physical assets, competencies, and management resources. Thus, through strategic alliances orgainsations such as SMME contractors would access market opportunities and tap into the resources, knowledge, technology, competence, and skills of their partners (Todeva and Knoke, 2005). Isoraite (2009) add that strategic alliances are among the various options which organisations such as SMME contractors can utilise to achieve their strategic business goals. For instance, in their acquisition of strategic resources and personnel for their project design, procurement and delivery.

According to Bain and Company (2006) organisations may form strategic alliances with customers, suppliers, competitors or project sponsors; as through strategic alliances, companies such as SMME contractor can improve competitive positioning, gain entry to new markets, supplement critical skills, resource, capabilities and share the risk or cost of major development projects. The ultimate purposes in adopting strategic alliances are to obtain competitive advantage and successful project delivery (Isoraite, 2009). Todeva and Knoke (2005), highlight the varieties of inter-organisational strategic relations such as Hierarchical relations (Through acquisition or merger), Joint ventures, Equity investments, Cooperatives, R&D Consortia, Strategic cooperative agreements, Cartels, Franchising, Industry Standards Groups (such as cidb), Subcontractor Networks, Licensing, and Market Relations. However, in the South African context, business organisations aiming to form strategic alliances and relations must adhere to the South African competition commission guidelines and Act No. 89 of 1988 (Republic of South Africa, 2009). This Act encourage and enhance the South Africa's economic system for free competition and pure market. Therefore, according to Parvatkar (2011) generic motive for seeking strategic alliances within an industry, is ultimately to create and sustain a long-term competitive advantage in a fast-changing business world. This strategy allows organisations to utilise economies of scale, reduce costs, gain knowledge, boost research, investment and development efforts, increase access to new technology, enter new markets, and improve quality. Uddin and Akhter (2011) suggest that adequate management of strategic alliances add

value creation and enhances competitive advantage amongst parties that engage in it.

2.3 Perspective on the Importance of Strategic Capabilities, Resources, and Competencies for SMME contractors

According to Anugwo (2017) strategy is a critical component of business growth and success. However, most SMME contractors are not inclined to formulate formal strategies, nor to consciously form strategic alliance with other organisations/individuals (Anugwo, 2017). Chalhoub (2007) states that the case for alliances are becoming more compelling for organisations seeking superiority in economies of scale, operational size, market share, and successful project design, procurement and delivery. As, Snyman *et al.* (2014) note that continuous investment in up-to-date strategic skills, competences and resources such as technology is increasingly important and challenging to all businesses, not only start-ups and SMMEs. Jardon and Loureiro (2013) posit that through strategic alliance the SMMEs would potentially assemble and organize their strategic competencies and capabilities. This would also enable them to create value and gain some competitive advantage in delivering their project services and products in a given market (Jardon and Loureiro, 2013). Of course, most construction organisations would experience financial constraint in the procurement of strategic resources and such may cause stunted growth and hamper sustainability of the organisation (Snyman *et al.,* 2014).

According to Jardon and Loureiro (2013) human resource management principles have acknowledged that strategic resources and competencies are the source of competitive advantage for large enterprises as well as in small, medium and micro enterprises (SMMEs). Thus, Jardon and Loureiro (2013) also highlight that the SMME contractors faces numerous challenging in their process of acquiring strategic resources and competencies on its own when compared with the large enterprises. Jardon and Loureiro (2013) further posit that this constrains affecting SMMEs can be manoeuvred by adoption and application of strategic alliance. This approach would enable them to obtain sustainable competitive advantage in order to survive and grow in the market.

3. RESEARCH METHODOLOGY

According to Leedy and Ormrod (2013) research methodology involves three processes namely: data collection, data analyses and interpretation, which are aimed at proffering a better understanding of the study phenomenon. However, Dane (2011) claims that research is a critical process of asking and attempting to answer questions in the real world. This can be done through a questionnaire, interview, experiment and other different methods. Thus, the research design empowers a researcher to choose a research method that suits the type of investigation a study requires (Schensul, 2008). However,

Leedy and Ormrod (2013) further explain that research design provides possible resolution of an identified research problem by providing the researcher with an explicit strategy. The problem identified in this research (referring to section 1.2.)- "The inadequacy of strategic capabilities, resources and competencies has been the major cause of SMME contractors' premature exits in the South African construction market."

The study involves discovering the existing, the emergent and underlying facts about the conscious utilisation of strategic alliances amongst SMME contractors as a driver for acquisition of strategic capabilities, resources and competencies in the South African context, particularly, in the Port Elizabeth construction market. Thus, this study's primary aim was to conduct an in-depth evaluation aimed at finding the levels of understanding and practice of strategic alliances amongst the SMME contractors. A qualitative-research approach, rooted in the phenomenological paradigm and utilising the in-depth interviewing method, was used for conducting the research. Out of seventy-four (74) construction organisations in Grades 4-6 of the CIDB register of contractors, Thirty-four (34) were purposively selected and interviewed.

4. RESULTS AND DISCUSSION

The collected data were analysed using the deductive approach. This approach involved analyses after the data has been sorted and coded in order to establish whether there are patterns observed from the interviewees' evidence, experiences, opinions and perceptions regarding conscious practice of strategic alliances in the acquisition of strategic resources, competencies and capabilities. This research's intention was to capture a clear and in-depth understanding of the context of strategic alliances practices amongst the SMME contractors within in the South African construction industry, particularly in Port Elizabeth Construction market.

4.1 The Interviewees' Demographic Profile

Thirty-four (34) construction organisations were contacted to elicit their participation in the research study. The candidates contacted included the business owners, the executive directors and the executive representatives (those authorised to provide the necessary information). The researcher made assurances to them that the purpose of the study was to evaluates the level of conscious practice of strategic alliances by the SMME contractors. The researcher also gave the assurance that the information provided would remain strictly confidential and would not in any way identify or be traced back to the organisations. Table 4.1 presents the comprehensive profile of the interviewees.

Table 4.1 The profile of the interviewees.

Code	CIDB Grade	Position	Years of Exp.	Code	CIDB Grade	Position	Years of Exp.
D1	4GB	General Manager (Business Owner)	26	E6	5CE	Managing Director (Business Owner)	20
D2	4GB	Managing Director (Business Owner)	+25	E7	5GB	Managing Director (Business Owner)	40
D3	4CE	Executive Manager (Firm's Rep.)	10	E8	5CE	Director (Family Business)	17
D4	4GB	Contract Manager (Firm's Rep.)	8	E9	5GB	Director (Business Owner)	39
D5	4CE	General Manager (Business Owner)	7	E10	5GB	Managing Director (Business Owner)	11
D6	4CE	Managing Director (Business Owner)	15	E11	5CE	General Manager (Family Business)	15
D7	4GB	Managing Director (Business Owner)	17	E12	5GB	Chief Exec. Officer (Business Owner)	20
D8	4GB	Director (Business Owner)	7	E13	5GB	General Manager (Business Owner)	9
D9	4GB	Director (Business Owner)	+10	F1	6GB	Managing Director (Business Owner)	40
D10	4GB	Executive Member (Partnership Business Owners)	13	F2	6CE	Executive Manager (Firm's Rep.)	13
D11	4CE	Managing Director (Partnership Business Owner)	15	F3	6CE	Managing Director (Business Owner)	42
D12	4CE	Operation Manager (Firm's Rep)	15	F4	6CE	Director (Business Owner)	32
D13	4CE	Contract Manager (Firm's Rep)	20	F5	5GB	General Manager (Business Owner)	9
E1	5GB	Managing Director (Partnership Business Owner)	30	F6	6CE	Director (Business Owner)	32
E2	5CE	General Manager (Partnership Business Owner)	32	F7	6CE	Director (Partnership Business Owner)	35
E3	5CE	Director (Family Business)	17	F8	6CE	Managing Director (Business Owner)	8
E4	5GB	Managing Director (Business Owner)	15				
E5	5GB	Managing Director (Partnership Business Owner)	24				

Source: Researcher's Own Field Survey (2017) (*GB denotes General Building, and CE denotes Civil Engineering)

4.2 The Contractors' cidb RoC Grading

Table 4.1 presents the contractors' cidb grading, which indicates that, out of 34 interviewees, 8 firms (24%) are contractors in the cidb grade '6GB and 6CE'; 13 firms (38%) were contractors in the grade '5GB and 5CE'; and another 13 firms (38%) in the cidb grade '4GB and 4CE' respectively. The various grades amongst the interviewees were significantly well represented. The data were insightful, significant and meaningful, as most interviewees had significant levels of experience in the South African construction industry.

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4.3 The Interviewees' Business Designations

In Table 4.1 shows the interviewees' business designation. Twenty (20) interviewees making 59% of the respondents were business owners serving as the managing directors of their construction organisations. Five (5) interviewees (15%) were owners in partnerships of their respective organisations and serving as managing directors. Six (6) interviewees (17%) were executive managers serving as the organisational representatives. Three (3) interviewees (9%) were family business owners acting as managing directors of their respective construction organisations. Table 4.1 indicates that the interviewees have strategic positions, knowledge and experience to make strategic decisions in their respective organisations. This provided reliability and accuracy of their responses.

4.3 The Interviewees' Working Experience in the Construction Industry

The working experience that the interviewees have in the construction industry ranges from seven (7) to thirty-five (35) years. In Table 4.1 revealed that 44% of the interviewees had a working experience of between seven (7) and fifteen (15) years; 32% had worked for 16 to 25 years; and 12% had worked for 26 to 35 and 36 to 45 years respectively.

4.4 Interview questions on: Resource Base, Competence & Capability; and Strategic Alliance

a. How would you describe the resource base of the organisation?
b. What are the major competencies and capabilities that distinguish your services from other competitors in the industry?
c. Could you please explain if your organisation engages in any form of inter-organisational exchange of resources?

Theme: The Evaluation of SMME Contractors' Resource Base and acquisition of assets

All the thirty-four (34) respondents described their organisations' resource base as adequate, above-average and stable; with highly skilled employees and qualified artisans; with adequate staff and competent foremen; skilfully organised; with specialised construction capacity; and having significant capital resources to operate effectively in the industry. Further themes that emerged with respect to their resource base are: substantial resources; impressive track-records and experience; healthy cash flow; adequate and strategically balanced resources; strong financial and asset resources; strong capital resources and investment; financial credibility; reputation to easily lease and arrange overdrafts; and strategically beneficial relationship with suppliers, banks and investors.E8 elaborated that: "*When it comes to resource base, we have competent and experienced human resources (project team) that are dedicated*

to performing their duties; financially, we are growing significantly; assets wise (machinery), we are adequately resourced and do lease some from our business partners. These have enhanced our capacity to deliver good quality services". In addition, D5 stated that: *"through strategic alliances our resource base is healthy at the moment. We have enough plant and equipment, capital, qualified personnel and adequate cash resources. We aim to acquire more plant and equipment, in order to expand our business".*

Furthermore, F1 and D8 explained that their organisations have significant working capital and financial resource bases; and they have been consistently saving and re-investing their profits in the procurement of more assets, to further enhance their growth and sustainability. Two (2) respondents (F3 and E9) claimed that their organisations have the financial requirements to strategically buy or lease or form alliances for plant and equipment, as well as to obtain loans and bank overdrafts, and have strong strategic links with suppliers, banks, investors and clients. ‘‘*We have skilled human resources, but we do subcontract parts of our project work, so as to achieve timely delivery"* –F2. Moreover, two (2) interviewees (D9 and E11) stressed that their plant and equipment were adequate, but they still hoped to improve, in order to expand and access a wider market horizon. Additionally, D12 stated that their organisation's resource base has capability to execute specialised construction and civil engineering services. D10 and D11 highlighted that their track-records on quality service delivery, project completion certification, and experience were achieved on the back of their competent human resource and these enabled them to be among the preferred construction service providers in the market. E1 asserted that: *"I think we are adequately and strategically balanced in terms of financial resources, working capital and human resources. Moreover, we can count on our level of experience, professionalism, expertise alliances and project management techniques as great assets. In terms of plant and equipment, we purchase some, strategically outsource some, and lease out some of the plant and equipment".*

A total of three (3) respondents (D4, D6 and D7) stated that: They have adequate skilled and semi-skilled workers. Moreover, we trained most of our operatives to become qualified and skilled artisans. Though, the national economic situation is affecting our financial resources, but we are stable and trying everything possible to be more competitive, in order to sustain our growth and performance. *"We have skilled human resources, but we do subcontract parts of our project work, so as to achieve timely delivery" –F2.* D3 and E8 disclosed that their resource base is adequate and stable; and on this basis, they remain sustainable in the market. They hope to grow and explore new market, as well as double their business turnover going forward.

Theme: The Impact of Strategic Alliances on Inter-Organisational Exchange of Resources amongst SMME contractors

Five (5) respondents (2Ds, 2Es and F7) strongly believed in forming strategic alliances with other organisations (such as suppliers, contractors and investors / sponsors) as it offers a competitive advantage. D13 stated that: *"We basically*

use strategic alliance as a soft-touch approach to partnering. In so doing, we acquire and share plant and expertise, partner towards solution-based, and innovative business ideas. These create an avenue to improve project/ service delivery". In addition, six (6) respondents (4Ds, E11 and F2) stated that: They formed strategic alliances with the suppliers, as it provided them with some advantages; such as discount on purchased materials and goods and speedy delivery of orders.

Theme: Advantages of Strategic alliance in construction

Four (4) respondents (3Es and F5) explained that they entered into strategic alliances through their long standing business relationships with most of their suppliers and through their negotiation skills during procurement processes. E4 stated that: "*We are in alliances with organisations that supply us with quality mixed-concrete and reinforcement steel at an affordable price. We have benefited tremendously from this business relationship over the years."* F5 explained that: "*We are in a mutual business relationship with a large company that specialises in mixed-concrete, supa–crush and quarries. Our vehicles and trucks are under their service and 'in the process', our orders are supplied promptly. We basically formed an alliance with an industry player, and it worked to our advantage".* Coincidently, two (2) respondents (E9 and F3) hinted that there is a formal business relationship amongst the well-established medium construction organisations within the market. This includes the hiring and exchanging of plant and equipment. *"We are open to business alliances, partnerships and other relationships that would offer us some advantage in the market"*–F3. Thus, D9 stated that: *"We engage in alliances with a few contractors for exchange of plant, equipment and labour, but at a minimal level. This assisted us immensely, especially when our projects were beyond our immediate capacity".* Furthermore, four (4) respondents (3Es and F3) stressed that they partially engage in the strategic alliances, through subcontracting some parts of their projects. E7 said: "*We have competent subcontractors in areas such as plumbing, glazing and lighting",* whilst respondent E8 stated that *"we exchange resources such as skilled personnel with other organisations, but not those in finance".* Respondent F1 said that they only formed strategic alliances through consultation with specialists and that these have enhanced the quality of their project / service delivery.

However, two (2) respondents (E12 and F6) explained that they are not into asset or resource hiring and would not exchange their plant, equipment or scaffolds with other contractors; as there is no surety with respect to maintenance or even assurance that it would be returned. Thus, they resolved not to hire out or exchange plant and equipment. D8 explained that*: "We are not really in an alliance with any organisation(s), but in due course, we would critically study and evaluate the pros and cons associated with strategic alliances and partnerships. Though, we would be interested in partnering with key material and plant suppliers in the future".* Surprisingly, seven (7) of the respondents (5Ds and 2Fs) simply responded that strategic alliances are not

necessary and as such, they do not want to enter into any form of alliance with any organisation.

It was clear from the analyses that most of the contractors described their organisations' resource base as: adequate; above-average and stable with highly skilled employees and qualified artisans; adequately staffed with competent foremen; a skilful organisation; one with huge human resource competences; having specialised competencies with adequate strategic resources, capital and cash to operate actively in the industry. It was also obvious from the analyses that some of the contractors formed strategic alliances with other organisations, such as, suppliers, contractors and investors or sponsors, through hiring or exchanging machines and exchange of skilled personnel amongst contractors. These alliances led to formation of strong business relationships; provision of discount on materials and goods purchased; and speedy delivery of orders. This form of business alliance has offered the contractors concerned a competitive advantage in the market. Moreover, a few contractors disclosed that they are interested to partner with key material and plant suppliers in future. However, some of the contractors disclosed that they were not really into forming alliances with any organisations and would not exchange their plant, equipment and

5. CONCLUSION

The empirical findings showed that some of the SMME contractors have significantly gained benefits and advantages through conscious practice of the strategic alliance in the construction industry. Some of the benefits and advantages were: business opportunities to share risk and resources; and partnership with suppliers, other contractors, investors and project sponsors. However, other specific benefits of forming strategic alliances by SMME were: opportunities to hire or exchange plant and equipment; skilled personnel; strong business relationships; discount on materials and goods purchased; and speedy delivery of orders. However, strategic alliances are underutilised in the construction industry as many contractors do not apply this strategy consciously. Furthermore, most contractors focus on the risks aspects of strategic alliancing despite the benefits. Moreover, some contractors appear to have no interest in strategic alliancing. The reasons given for such luck of interest include risks such as: inadequate maintenance and untimely return of resources (plant, equipment and scaffolds) by other contractors, when rented out; as well as the administrative challenges faced with respect to forming strategic alliances with other organisations. Therefore, the study recommended that SMME contractors should consciously adopt strategic alliances when and where it is necessary, as it holds strategic channels for them to acquire and utilise strategic resources, competencies and capabilities. This approach would engender SMMEs survival, growth, competitiveness and economic sustainability.

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Why do women-owned construction firms fail in KwaZulu-Natal? A preliminary study

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ABSTRACT AND KEYWORDS

Purpose: The South African government has instituted numerous programs to advance the role of women in the construction sector. While there has been an increase in the overall number of women-owned contractors suggesting a gender-positive environment in post-apartheid, there is a high failure rate of women-owned contractors. This study seeks to explore the primary contributory factors that lead to business failure.

Design/methodology/approach: A sample of women-owned contractors in Durban was surveyed using an instrument developed from published literature on women in construction in South Africa.

Research limitations: The sample of women-owned contractors was drawn from the Durban area from the Construction Industry Development Board (CIDB) Contractors Register database.

Findings: Findings suggest that lack of training provided by the industry, dominantly male networks, prejudice and stereotyping, and lack of opportunity were the primary reasons given for failure.

Response to conference theme: This study identifies the failure factors that need to be addressed to increase the participation of women-owned contractors in the construction sector.

Practical implications: The findings provide guidance for remedial interventions that will positively impact the number of women-owned contractors that will survive in the construction sector.

Keywords: Discrimination, gender bias, construction, women-owned contractors, failures

Conference sub-theme: *Construction Education*

1. Introduction

In today's world the construction industry is known to be a male dominated one (Jaafar and Othman 2013). Women have similar entrepreneurial potential as men to contribute to developing their own businesses. Unfortunately, their potential has not been fully realised and utilised because of the systemic challenges that women entrepreneurs face (Hanson and Blake 2009). This is influenced by many factors including historical, cultural background, the choice of business, confidence and under-representation in the construction industry (Dainty, Green et al. 2007, Nchimbi and Chijoriga 2009). The cultural aspect or factor is also confirmed by Smith-Hunter and Boyd (2004) in which they state that women are less successful in business based on cultural differences. Progressing from the same cultural theory of entrepreneurship, the disadvantage theory states that women become entrepreneurs because of disadvantages in the labour market (Smith-Hunter and Boyd 2004). Currently, many voices have been raised in favour of human rights and gender equality. According to Beauchamp, Bowie et al. (2004), feminist theories recognise that subordination, inequality, or oppression of women is unethical and that women deserve equal political and legal rights,

Government policies and legislation in many countries have been created in favour of women to support them in order to address the issue of inequalities encountered in the business world. Most of these initiatives have not been successfully implemented for sustainable solutions (Verwey 2008). Generally, it has been found that customers may choose to ignore women companies or businesses for their products and services due to a perceived lack of capabilities between business owner, industry characteristics and the market trends (Heilman and Chen 2003). Customers who have the option of employing a male-owned versus a female-owned construction firm may select male owned firm for the simple reason that men are generally associated with the construction industry

which they have dominated for many years. They are also believed to be more knowledgeable about the business (Ibid). If this is the case in KZN, then women will encounter many challenges in contending the negative attitudes from potential clients regarding their success.

This study focuses on women in the public sector construction industry in KZN specifically. The study will analyse the causes behind the failures, their origin and their reflection on women as business leaders.

2. Brief review of literature

Generally, it has been found that the participation of each individual in a project affects the overall outcome of the project (Schneider and Schmitt 1976) . Therefore, it is important to stress that the organisation owning the project should always monitor closely the performance of all parties involved as they all play an integral part in a successful project (Angus, Gundersen et al. 2000). This claim implies that the human dimension in any project can have an influential impact on the project outcome. This is also relevant in the case of this current study dealing with women in the construction industry.

In this regard, many studies related to discrimination against women in construction were undertaken and brought into attention in their work completed by (Dainty, Bagilhole et al. 2004, Lingard and Lin 2004, Shalley, Zhou et al. 2004, Byrne, Clarke et al. 2005). These studies have analysed not only the discrimination of women in the construction industry but also the deep roots of issues affecting the performance of women-owned businesses in construction. Apart from the discrimination many causes could be hindering the survival of women-owned businesses.

It was found that for women to sustain careers in construction they require support from their families as they have parental duties to perform at some time which will affect how they balance work/life situations (Hatipkarasulu and Roff 2011, Haupt and Fester 2012). Also, it is important to emphasise that the nature of construction fieldwork gives rise to a large number of obstacles that particularly affect women in the construction industry. These obstacles may result in negative perceptions of women capabilities and them being repeatedly asked to do minor tasks (Loosemore and Waters 2004, Dainty and Lingard 2006, Chun, Arditi et al. 2009). These obstacles involve stereotypical attitudes that society has toward women based on gender discrimination. For instance, sexual harassment and discrimination have become more common-place. These factors have led to negativity to careers of South African women in the construction industry (Madikizela and Haupt 2010). Some previous research on women in construction industry have focussed on women in contractor organizations and how to boost the participation of women in

construction workplace, the objective being to help solve the labour crisis and skills shortage of women (Senaratne, Kagioglou et al. 2005). However, there are many other issues and factors linked to the personal capacity of some women making them incapable of achieving the result of business sustainability. Women need to be able to compete on the same footing as their male counterparts instead of being discriminated against causing them to fail in their businesses. This study focuses on the main factors which are hindering the performance of woman-led businesses in the construction industry. These include the origin and roots of the problems, the identification of the most prominent challenges faced and the suggestion of some probable ways to deal with them in order to improve to success rate of women owned businesses in construction industry

3. Research approach

A convenience sample was surveyed comprising of 25 women-owned contractors registered on the CIDB Register of Contractors about their views on factors and influences needed to be successful contractors and knowledge of business concepts and practices. The data was collected via a quantitative questionnaire survey comprising of a section containing 50 factors and influences and a section containing 33 business concepts and practices. Respondents were required to give a scaled response of importance or knowledge. Descriptive statistics were derived using SPSS v23 and presented including measures of central tendency and dispersion. The internal validity of scaled responses was determined by the Cronbach's alpha co-efficient for validity.

4. Research findings

Profile of respondents

From the analysis of the generated data using SPSS V23 it was found that respondents had worked in the construction industry for a mean 5.24 years with a minimum period of one year and a maximum period of 12 years. All respondents had CIDB gradings for a mean 3.12 years, with a minimum period of 1 year and a maximum of 9 years, as follows:

- Grade 1 - 8.0%,
- Grade 2 – 36.9%,
- Grade 3- 32.0%, and
- Grade 4 – 24.0%.

Evidently, from this sample most respondents were registered in Grades 2 and 3. These together with those registered in Grade 1 generally comprise most of the contractors on the Register and experience challenges of growth and development.

Statistical Reliability

Table 1 shows the Cronbach's alpha co-efficient for the scaled responses that make up each of the sections of the survey instrument. There is an acceptable degree of internal consistency for the scales used for the success factor/influence construct, namely a Cronbach Alpha statistic which is greater than the rule-of-thumb 0.70 for acceptable internal scale consistency. There is therefore 73,6% probability that the construct measures a single underlying concept with an error of at most 5%. The scale used is therefore acceptable in measuring of the reliability of the construct. However, the knowledge construct has a Cronbach Alpha statistic <0.70, namely 0.60 suggesting that there was only a 59.9% probability that the construct measures a single underlying concept with an error of at most 5%.

Table 1. Reliability co-efficient (n=25)

Construct	Reliability co-efficient
Critical success factor/influence	0.736
Business practice knowledge	0.599

Critical success factors (CSFs)

Respondents were requested to indicate on a 5-point Likert scale where 1 = not important at all, 2=unimportant, 3=neutral, 4=important and 5 = extremely/critically important, how important various factors/influences were to being a successful woman-owned contractor. Their responses ranked by the means are shown in Table 2.

Table 2. Critical success factors/influences (CSFs) (n=25)

Factor/Influence	Mean	Std Dev	Rank
Ability to pay suppliers	4.88	0.44	1
Health and safety requirements	4.58	0.78	2
Self-efficacy, self-confidence and self-belief	4.56	0.87	3
Proper pricing of tenders	4.52	0.82	4
Training opportunities	4.44	0.65	5
Leadership	4.42	0.78	6
Adequate cash flow during construction	4.40	0.96	7
Proper tools and equipment	4.33	0.87	8
Money/financial management	4.32	0.95	9

Communication skills	4.32	1.03	10
Attitudes, behaviours and perceptions	4.29	1.08	11
Access to and employment of skilled labour	4.28	0.89	12
Proper documentation skills	4.25	0.79	13
Construction experience and knowledge	4.24	0.78	14
Market research	4.24	0.88	15
Technical skills	4.24	0.93	16
People management	4.21	0.78	17
Project management	4.20	0.76	18
Level of schooling/education	4.12	0.88	19
Support and networking opportunities	4.12	1.01	20
Need for achievement	4.08	0.93	21
Construction Industry Development Board (CIDB)	4.08	1.21	22
Effective basic managerial skills	4.00	0.91	23
Prompt payments by clients	3.96	1.08	24
South African Women in Construction (SAWIC)	3.96	1.31	25
Access to finance during pre-construction phase	3.92	0.70	26
Bridging finance	3.92	0.88	27
Mentoring opportunities	3.92	0.97	28
Labour legislation	3.88	0.90	29
Equal opportunity policies and programs	3.88	1.03	30
Basic business skills	3.88	1.13	31
Personal motivation	3.88	1.23	32
Gender equity	3.84	1.34	33
Recordkeeping	3.84	1.37	34
Secure and appropriate storage facilities	3.83	1.07	35
Stock control	3.76	1.09	36
Kuthaza	3.76	1.16	37
Program management skills	3.72	1.06	38
Ethical practices	3.68	1.04	39
Favourable and stable interest rates	3.67	1.09	40
Access to guarantees and performance bonds	3.60	1.15	41
Continuous work opportunities	3.58	0.88	42
Enabling legislation	3.57	1.16	43
Emerging Contractor Development Program (ECDP)	3.54	1.35	44
Affirmative action	3.45	1.22	45
Favourable contract conditions	3.43	1.12	46
Fair procurement practices	3.39	0.99	47
Population group	2.71	1.40	48
Age	2.56	1.42	49
Province of origin	2.00	1.22	50

The findings in Table 2 show the ranking of factors or influence according to their importance. Therefore, 'ability to pay suppliers' ranked as most important because suppliers play a critical role in the running of a construction business. They provide raw materials and finished products needed to accomplish the required work. Almost 50% (46%) of the 50 factors were ranked as important to very important CSF's. while 48% were ranked neutral to important. Factors ranked 43-50 are not ranked as important CFS's. However, government initiatives are targeted at those CFSs which might be indicative of why women-owned contractors still struggle to survive in the public sector.

Knowledge of business concepts and practices

Respondents were requested to indicate on a 5-point Likert scale where 1 = Know nothing at all, 2=little knowledge, 3=neutral, 4=some knowledge and 5 = considerable knowledge, about the extent of their knowledge of various business concepts and practices. Their responses ranked by the means are shown in Table 3.

Table 3. Knowledge of business concepts and practices (n=25)

Business concept and practice	Mean	Std Dev	Rank
Pricing	4.56	0.65	1
Tendering	4.48	0.82	2
Feasibility study	4.48	0.87	3
Finance and accounting	4.44	1.00	4
Planning	4.40	0.87	5
Health and safety	4.32	1.03	6
Balance sheet	4.28	0.94	7
Business plan	4.28	1.17	8
Income statement	4.22	0.90	9
Leadership	4.21	1.14	10
Project management	4.16	0.90	11
Negotiation	4.12	1.09	12
Budgeting and forecasting	4.12	1.09	12
Entrepreneurship	4.08	0.91	14
Organizing	4.08	1.00	15
Advertising and promotion	3.96	0.98	16
Costs and cost control	3.96	1.00	17
Equity	3.96	1.17	18
Target market	3.96	1.21	19
Business ethics	3.88	1.01	20
Managing teams	3.88	1.01	21
Market research	3.84	1.14	22

Legal structures for ventures (forms of business entities)	3.84	1.14	22
Business positioning	3.80	1.12	24
Sales and selling	3.80	1.22	25
Risk management	3.78	1.13	26
Business models	3.71	0.95	27
Venture capital	3.64	1.41	28
Business incubator	3.52	1.23	29
Economies of scale	3.44	1.00	30
Company valuation	3.44	1.26	31
Competitive analysis	3.30	1.22	32
Break-even point or analysis	3.13	1.39	33

The findings in Table 3 suggest that most respondents regarded their knowledge of 'pricing' highest. Other knowledge areas that are closely related to pricing also ranked fairly high. It might be that the procurement systems favoured by government target price as the most critical aspect of owning and running a construction business. Without knowledge of this aspect it is almost impossible for a construction business to get work or be successful. Surprisingly, the preferential procurement framework places less emphasis on price than would usually be the case. Other factors influence the scoring during adjudication of tenders. However, the perception remains that the emphasis on public sector projects is on price.

5. Conclusion

This study provided some insight regarding the causes influencing the failures encountered by women-owned construction firms. While the respondents recognize the importance of their ability to pay their suppliers as critical for the success of their businesses, they regarded pricing of tenders and financial management as critical as well. Other aspects that were critically important included self-belief, training opportunities, access to skilled labour, and leadership. Government initiatives were targeting aspects such as enabling legislation, Emerging Contractor Development Program, affirmative action, fair procurement practices, and demographics such as population group, age and province of origin. All of these were not regarded by respondents to be CSFs for their businesses. This finding suggests that government-driven initiatives were not effective despite their well-intentioned design.

The study found that respondents claimed to be very knowledgeable about at least 50% of important business concepts and practices with pricing, tendering, feasibility studies and finance and accounting being the areas they had most knowledge in. However, it is likely that they may have misunderstood that they were supposed to

indicate the extent of their knowledge of business concepts and practices and instead indicated the degree of importance of these. Arguably, had they possessed the reported levels of knowledge their performance as women-owned businesses should have been more satisfactory.

The next phase of the study will examine these issues in greater detail.

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A conceptual framework for organizational culture, organizational structure, and sustainable construction

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ABSTRACT

Purpose of this paper
It presents a conceptual framework to investigate the moderating effect of organizational control on organisational culture and organisational structure (independent variables) on achieving sustainable construction (dependent variable) among South African construction firms.

Design/methodology/approach
This is a literature review-based study. Organisational control has been construed as a potential moderator on the relationship between organizational culture and sustainable construction (objective 1) as well as organizational structure and sustainable construction (objective 2).

Findings
Findings from the existing literature showed that: (1) organizational culture has a strong contingent effect on sustainability adoption (Objective 1); and (2) Organizational culture also has a strong contingent effect on sustainability adoption (Objective 2). A conceptual framework is proposed for subsequent in-depth research with empirical study cases.

Research limitations/implications
Findings provided insights for construction managers and researchers about the impact of organizational culture, organisational structure and organizational control in achieving sustainable construction.

What is original/value of paper?
It expands the existing literature on the roles of organizational culture, organizational structure, and organizational control.

Keywords:
Conceptual framework, Organizational control, Organizational culture, Organizational structure, Sustainable construction

Sub Theme:
Green Building

1.0 INTRODUCTION

Literature on sustainability has gained a wide acceptance (Elliott, 2012; Kibert, 2016). The Brundtland Commission's report “Our Common Future” has produced the most widely used definition of sustainable development. Sustainable development was defined as “the development that meets the needs of people today without compromising the ability of people in the future to meet their needs” (Brundtland, 1985). The three key areas involved in sustainability encompasses environment, social and economic considerations (Griggs et al., 2013). Therefore, the achievement of the right balance between these factors makes true sustainability (Benn et al., 2014). Sustainable construction is the contribution of construction to all three areas of sustainable development and it has been shown that what we build today will provide the built environment of the future (Ferreira et al., 2014). Therefore, organisations need to pay more attention to the nature of sustainability drivers and how it can be made more proactive to steer their journey towards sustainability (Lozano, 2015).

Several factors have been suggested to explain how organizations and people in them behave. Previous research in construction context has established that organizational culture and organizational structure are the most important factors that influence sustainable construction (Chen and Chang, 2012; Yesil and Kaya, 2013). Moreover, there has been a long-standing concern in the literature (Cosh et al., 2012; Scott and Davis, 2015) on needs for better understanding of how organisations are structured for common goal sharing and working in harmony to attain sustainability (Lozano, 2013). Organizational culture and organizational structure are among the concepts with the highest explanatory and predictive power in understanding and forms of people’s behaviour in organization (Epstein and Buhovac, 2014; Lozano, 2015). Cultures that developed in organizations function as stabilizers to stimulate sustainable change and defined as a system which the members of an organization developed and adopted through mutual experience and which help them in better operations (Davidson et al., 2015; Janićijević, 2013). Organizational culture is an intrinsic factor of organizational behaviour (Janićijević, 2013; Muller and Kolk, 2010). This is because of its intrinsic ability to adapt to changing circumstances and influence most aspect of organisational life such as how decisions are made, who makes them, how decisions are allocated, who is promoted, how people are treated and how organization responds to its

environment. Conversely, organizational structure is an extrinsic factor which influences individuals' conduct from the outside, through formal constraints set by division of labour, authority distribution, grouping of units, and coordination (Hung et al., 2011; Janićijević, 2013). The behaviour in an organization is the consequence of the effect of its culture and structure.

Literature indicates that less attention has been given to the influence of organizational culture and organizational structure on construction projects to attain sustainability (Cheung et al., 2011; Shore and Cross, 2005). This paper aims to fill in the existing gap in organizational behavior literature by investigating the relationship between organizational culture, organizational structure and sustainable construction. Moreover, organizational control has been construed as a potential moderator on the relationship between organizational culture and sustainable construction as well as organizational structure and sustainable construction (Bock et al., 2012). A future research will focus on the relationship between organizational culture and organizational structure.

2.0 SUSTAINABLE CONSTRUCTION

It has been shown that greenhouse emission set by the Kyoto protocol has become a growing interest in academic research of climate change (Pettenger, 2013). For example, the built environment is a complex system that the environment constantly shifts into a new pattern of behaviour and requires a huge amount of management's effort that brings the actors together to achieve a systematic change (Benn et al., 2014). Sustainable development focuses on need of both current and future generations (Goyal et al., 2013). Then, sustainable construction is a sustainable development that considers social, environmental and economic objectives (Kibert, 2016). The review of the literature indicated that a clear understanding of the definition of high-performance green-building, the implementation of building assessment or building rating system that provides detailed criteria and grading system for those advanced buildings is important to make it sustainable (Kucukvar and Tatari, 2013; Tan et al., 2011).

Previous research has established that construction activities have significant impact on the community and environment, however, green construction is being promoted to mitigate these issues (Shi et al., 2013; Zuo and Zhao, 2014). Green Construction Guideline issued by China's Ministry of Construction (MOC) in 2007 defined green construction as " the process of ensuring quality, safety, and other basic requirement, the use of scientific management and technological process in engineering construction, to maximize the conservation of resources and reduce the construction, to maximize the conservation of resources and reduce the construction activities which will bring negative impacts on the environmental, and to achieve the savings of energy, land, water and

materials including environmental protection" (Zuo and Zhao, 2014). A high-performance commercial green building is defined by the office of the energy efficiency and renewable energy of the United State Department of Energy, as building that "uses whole-building design to achieve energy, economic, and environmental performance that is substantially better than standard practices" (Kibert, 2016). The approach to green building by management are different and depends on how the process is implemented or how the performance is evaluated (Zuo and Zhao, 2014). Therefore, management in construction organisations believe in the understanding of the contents and definition of green building, the quantification of cost and benefits as well as the measurement to be called "green".

3.0 ORGANIZATIONAL CULTURE

Conventionally, culture is commonly known as the broader values and normative patterns which guide worker behaviour, practices and policies (Ouchi, 1979). Numerous definitions for organizational culture can be found in the literature. However, these definitions have taken at least three different perspectives including academic perspective, marketing perspective and human resources management perspective. From the academic perspective, Schein (1990:11) defined organizational culture as "a pattern of basic assumptions that a group has invented, discovered or developed in learning to cope with its problems of external adaptation and internal integration, and that have worked well enough to be considered valid, and therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems". From the marketing perspective, Kim et al. (2004:341) expressed organizational culture as the shared values and norms of the organization's member. From the human resources management perspective, Tuan (2012) defined organizational culture as a continuous process of identity building/re-building and meaning-making within an organization, which allows its social integration as well as sustainability of its subdivisions. Alvesson (2012) maintained that managers and consultants must emphasize on the importance and understanding of corporate culture for the growth and success of organizations. However, if organization neglects culture, it will find it difficult to stay current, inaccurately predict the future, and finds it difficult to survive if organisation is threatened (Cameron and Quinn, 2005).

Organisational culture has been recognised as factor that influences in the analysis of organisation in various context (Dauber et al., 2012). For many years, the impact of organisational culture on organisational performance (Rasula et al., 2012; Uddin et al., 2012; Valmohammadi and Roshanzamir, 2015) and to establish competitive advantage has been attracting the interest of scholars (Cameron and Quinn, 2005; III and Hollenbeck, 2014). For example Cameron and Quinn (2005) and Porter (2011) established that the success of organisation is not

only determined by specific external conditions such as barriers to marked entry, rivalry in the organisation, supplier and buyer power. The conclusion demonstrated that company values is more important than the market forces (Cameron and Quinn, 2005, p. 4).

3.1 Organizational culture and sustainable construction

Empirical research for the relationship between organisational culture and sustainable construction are limited. Specifically, some of the studies have taken a micro view of the construction related aspects of organisational culture (Benn et al.,2014; Metcalf and Benn, 2013; Reilly). It is clear from the literature that cultures developed in organisations can function as stabilizers to stimulate sustainable change and recommended as a system of which the members of organisation have adopted through mutual experience and which help them survive (Cameron et al., 2014). Therefore, organisations do not remain the same for years, the efficiency of the skills, knowledge, and experience possessed by members of organisations determine organisational success. As discussed earlier, refusal to acknowledge organisational culture leads to difficulty in organisation to stay current and make accurate prediction of the future, and to survive threats (Cameron and Quinn, 2005). It has been reported that corporate culture reflects in the way an organisation conducts business, treats its employees, customers and the wider community, as well as the commitment of its employees towards collective objectives (Chhokar et al., 2013).

Most studies on the relationship between organizational culture and sustainability have considered the impact of organisational culture on corporate behaviour and organisational performance. For example, Eccles et al. (2012) investigated the effect of a corporate culture on sustainability performance outcomes among a matched sample of high sustainability and low sustainability organisations. Organisations are classified as high sustainability if they have adopted strong commitments to environmental and social performance policies long before the study and low sustainability did not. They reasoned that the boards of directors of the two organizations were more likely to be responsible for sustainability and top executive incentives were more likely to be a function of sustainability metrics. The research established that high sustainability organizations significantly perform better than their counterparts over the long-term, in terms of their performance in stock market and accounting. The performance noted as stronger in sectors where the customers are individual unlike companies where competition is based on brands and reputations.

Prajogo and McDermott (2011) examined the relationship between Cameron and Quinn's (2005) four cultural dimensions (group, developmental, hierarchy, and rational cultures) and four types of performance (product quality, process quality, product innovation, and, process innovation). Data were collected from middle and senior managers of Australian firms who have the past and present knowledge of

organisational practices relating to quality. The study revealed developmental culture is the strongest predictor among the four cultural dimensions based on the relationships with the three of the performance measures. The study also revealed that rational culture plays a role in predicting process quality in the relationship with product quality, group and hierarchy cultures. It contributed to previous empirical studies which linked the competing values framework with a specific measure of performance.

Ahmad (2012) has expanded the base of knowledge and empirically tested the relationship between the components of organisational culture and performance management practices. The study explored the impact of the relationship with the use of regression and correlation analysis to statistically analyse the data obtained through the 60 questionnaires administered through a random sampling procedure. Findings showed dimensions of organisational culture have significant positive relationship with performance management practices. The findings were to assist human resource managers, practitioners and strategists to better understand organisational performance practices and to explore the impact of organisational culture dimension on performance management practices, theoretically and practically.

In summary, while the reviewed studies have made substantial contributions to the organizational behaviour literature by empirically demonstrating the impact of organisational culture on performance and sustainability. However, their findings are inconclusive. The findings necessitate the introduction of a potential moderator towards understanding the relationship between organizational culture and sustainable construction. Based on this moderating effect, this present study proposes the following: ***Proposition 1: Organizational culture will be positively associated with sustainable construction.***

Next following section will establish the relationship between organisational structure and sustainable construction.

4.0 ORGANISATIONAL STRUCTURE

“All complex organizations are built up from units of organizations, and consist of many units of “working” or “basic” organizations, overlaid with units of executive organizations; in addition, the essential structural characteristics of complex organization are determined by the effect of the necessity for communication upon the size of a unit organization” (Barnard, 1968, p. 113).

The study of organization and management of construction, showed that organizational structure is the basis by which a firm is physically organized to carry out the task it has set (Langford and Retik, 1996). The definition was developed from Woodard (1965) contingency theory which suggested that organizational structures depend on parameters of the environment. Organizational structure explains how information flows and is aggregated inside organizations, allowing

organizations to accomplish goals that would be otherwise unattainable by any of its individual members (Csaszar, 2012). Structure is a dynamic factor because it can change over time due to new organizational conditions, so that staff could have access to and acquire new and varied knowledge that would help them to solve a range of problems, fluctuations and diverse situations (Pemsel and Müller, 2012). Therefore, structure is not an organizational uniform condition, because different parts of an organization face different environmental pressures and may need to respond by developing distinct practices, policies and structures. Additionally, structuring makes organizations to rely on ways of controlling the actions of people inside them in some forms of hierarchy, lines of authority and communication and give the information to the employees including manager's guidance whom they are accountable to/for (Brooks, 2009, p. 190; Champoux, 2016).

Previous research has established that organizational structure consists of organization of production means and rational design of environment (Cosh et al., 2012), this are the working personnel, and division of the task to every detail (organization of interior relations and determination of time sequence of task). Basically, in any firm there are two dimensions of organizational structure, configurational and structural. The configurational issues was operationalize by Rummler and Brache (2012) to clarify that organizational hierarchies are flat or tall, with activities assigned to each hierarchy. Generally, organizational configuration dimensions are normally represented by organizational chart and structural dimensions to indicate the extent of formalization and centralization. Centralization is measured by the extent to which the chief executive involves others in key decision-making (Cosh et al., 2012; Foss et al., 2015) while formalization refers to the extent to which rules and sanctions or penalty, roles, authority relations, line of communications, norms and procedure are defined within an organization (Yang and Ng, 2015).

4.1 Organisational structure and sustainable construction

Some of the empirical studies on organisational structure-sustainability relationship include the study conducted by Millar et al. (2012) that gave an overview of sustainability, its management and problems in the policy of organisations. It revealed the perception of how organisations deal with sustainability challenge and how to balance short term vision of organisation change with stability and strategic goals, as well as day to day implementation of domestic responsibilities with international responsibilities. The study provides insights into how policies are influenced nationally and internationally and how policies foster relations that influence the change in attitude and behaviour that is required for sustainability.

Fulford and Standing (2014) have examined the factors that impact collaboration in project networks in construction organisations. The study revealed the findings from the review of a panel of experts expressed the

desperation in the project management process may lead to sub-standard information. However, this threatens the achievement of project's efficiency and lack the strength of relationship to create a trust and shared values network in the organisation. It is recommended that both value engineering and lifecycle costing should be included in design processes, standardised procedures and information. Moreover, Wolf (2013) investigated the extent to which sustainability embedded organisational structures and the role of employees in the process of organisational change. The study found that the structural implementation of sustainability is positively related to firm performance and the involvement of employees moderates this relationship to some extent.

Similarly, Wu and Low (2010) have examined project management processes and practices to create green building through managing people in organisational structure. The study suggested the holistic solution to achieve the concept of sustainable development in the life cycle is to think green by adopting green building practices. However, project management in construction industries should consider both the actual practice and brainstorming in periodic meeting to fulfil the green requirement through appropriate employee's training leading. For example, facilities manager and operators need proper information about the influence of sustainability on the large energy consumption through devices, equipment and vehicles level during project. Based on this, the following proposition is offered: ***Proposition 2: Organizational structure will be positively associated with sustainable construction.***

The following section will explain the moderating effect of the relationship between organizational culture, organizational structure and sustainable construction.

5.0 ORGANISATIONAL CONTROL

Literature from administrative management school, organisational sociologists and organisational psychologists (Prajogo and McDermott, 2011; Linnenluecke and Griffiths, 2010; Schneider and De Meyer, 1991) revealed development of an integrative organisational control model of organisational culture, organisational structure and the external environment. Intrinsically, control is defined as "attempts by the organisation to increase the probability that individuals will behave in ways that will lead to the attainment of organisational objectives" (Flamholtz et al., 1985, p. 35). Literature has shown that organisation can result to a diminishing return in the long run at an organisational level if it fails to match controls with an organisation's unique context (Ouchi, 1979). Employees may manipulate data, report false information, and/or more generally behave in ways inconsistent with the best interest of the organization as a result of control (Dunnette and Hough, 1991). Thus, control of work behaviour is claimed to be achieved by four control mechanisms such as planning ,measurement, feedback and evaluation-

reward (Ouchi, 1979). Each core control mechanism impacts work behaviours and outcome. Flamholtz et al. (1985) maintained that contextual factors such as organisational culture and organisational structure function as control mechanism on work behaviour. Control literature is through three main traditions such as the sociological perspective, the administrative perspective and, the psychological perspective. The perspective of sociology tends to be the entire organisation and the larger groups in it, control is accomplished through structural mechanism of rules, policies, hierarchy of authority (Weber, 2009) or coordinate units (Davids, 2009). The administrative perspective tends to focus on individual or departments within the organisation, with little concern for comparative studies across organisations. Control mechanisms frequently employed by the administrative theorist are plans, measurement, supervision, evaluation and feedback. And lastly, psychological approach is primarily (but not exclusively) the individual, it tends to rely on the mechanisms of goal and standard setting, extrinsic or intrinsic rewards, feedback or interpersonal influence (Eisenhardt, 1985). The concern is about individual behaviour in relation to group or organisational objectives.

Many scholars suggested the way to adopt corporate sustainability principle is through the adoption of a sustainability-oriented organizational culture. However, empirical studies on the embodiment of a sustainability-oriented organizational culture and the possibility of organisation to display a unified sustainability-oriented organizational culture maintain that there is tendency for organisation to become more sustainable through organisational change. For example, Linnenluecke and Griffiths (2010) referred to the traditional concept of organisational culture to assess what constitutes a sustainability-oriented organisational culture. The study shows that employees from different types of culture show different orientations and understand corporate sustainability differently. The study emphasized those different aspects in the pursuit of corporate sustainability range from a focus on internal staff development, resource efficiency, environmental protection or stakeholders. Generally, it is possible for organizations to display a united sustainability-oriented organisational culture if it has only one dominant culture with same set of shared assumptions, values and beliefs. The study suggested several avenue and directions for future research including further exploration of the relationships between organizational culture and corporate sustainability.

Although, sustainability has become a common discourse and external reporting in organisations, less attention is paid to the process which management control systems contribute to a deeper integration of sustainability within organisational strategy. Gond et al. (2012) addressed this gap by adopting a configuration approach to form a theory on the roles and uses of management control systems and sustainability control systems in the integration of sustainability within organisational strategy. The authors built up (Simons, 1994) levers of control framework, management control systems and a sustainability control systems to

diagnose and interact. The study indicated this ideal-type of configurations to give an explanation of their impact on the triple bottom line (Slaper and Hall, 2011) as well as the description of the mechanisms which allow organisations to move from one configuration to another. The framework postulate several developments empirically, such as benchmark to assess actual organisation's level of integration of strong management implications in the future study. The framework supports the role of management control systems and sustainability control systems in the integration of sustainability within strategy. The present study incorporates organisational control theory as a potential moderator on the influence of organizational culture and organizational structure on sustainable construction. This is in line with Baron and Kenny's (1986) affirmation that a moderator variable is usually incorporated when the relationship between a predictor and a criterion variable is found to be unexpectedly weak or inconsistent. Moreover, Jaworski (1988) strongly maintained that the effectiveness of various control mechanism may be contingent upon internal and external contingency variables. This suggests the need for a moderator. Consequently, to better understand the influence of organizational culture and organizational structure on sustainable construction, this study proposed that organisational control might moderate the relationships.

Previous studies have examined the moderating role of control on the relationship between people in organisation and managerial effectiveness. Employee and management are only source of competitive advantage (Armstrong and Taylor, 2014; Campbell et al., 2012). For example, it leads to a renewed focus on human resources strategies can ensure retention, commitment, as well as reduction of stress and maximum effectiveness of managerial personnel. Findings from the investigation of the moderating effect of control in relationship between organisational role stress and managerial effectiveness supported the notion that organisational role stress was negatively related to managerial effectiveness and internal control moderated organisational role stress and managerial effectiveness relationship.

The framework developed by Flamholtz et al. (1985) on organisational control may provide insight into the moderating role of organisational control on relationship between organisational culture, organisational structure and sustainability. Theorists have advocated the position that organisational structure is developed as a response to the problem of control and several dimensions of organisational structure; span of control, functional specialisation, vertical and horizontal differentiation, centralisation, formalisation, and standardisation may serve as further control function (Blau, 1970; Blau and Schoenherr, 1971) Therefore, organisational structure in itself is a control mechanism (Wang et al., 2011). Based on this, the following proposition is offered: ***Proposition 3: Organisational control will moderate the relationship between organisational culture, organisational structure and sustainable construction.***

This leads to the proposition of a research framework as discussed in the next section. The research framework serves as the basis for a subsequent field work.

6.0 PROPOSED RESEARCH FRAMEWORK

Based on the earlier discussions, the research framework for this study illustrating the moderating role or organisational control on the influence of organisational culture and organisational structure on sustainable construction is depicted in Figure 1

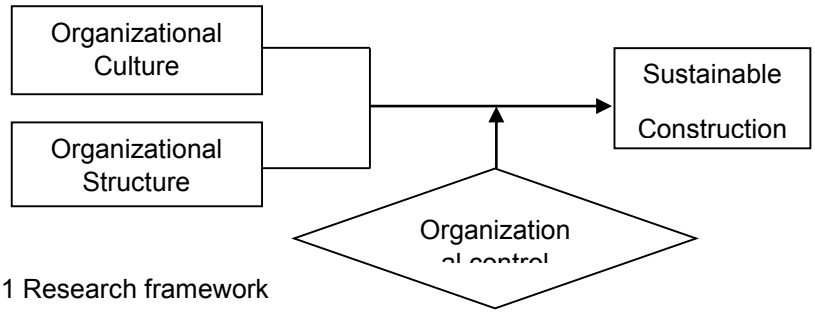

Figure 1 Research framework

To explain the moderating role of organisational control on the relationship between organisational culture, organisational structure and sustainable construction, the present paper put it forward that the extent to which organisational culture and organisational structure influence sustainable construction depends upon the dimensions of decision making in the organisation and the control of individual or group behaviour to achieve organisational goal through culture (Chen et al., 2011; Han and Woods, 2014). Given the empirical support for the organisational control across organisational settings, it is put forward that this theory would provide an empirical support for the moderating role organisational control on the influence of organisational culture and organisational structure on sustainable construction in construction firms.

7.0 CONCLUSION

This paper has proposed the moderating role of organisational control on the relationship between organisational culture, organisational structure and sustainable construction as depicted in Figure 1. If the proposed framework is validated among construction companies in South Africa, and which the subsequent study will focus on. The findings will provide important insight to managers and practitioners into the role of organisational culture, organisational structure, and organisational control in achieving sustainable construction in construction industry.

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A Field study investigating the development of green buildings in developing countries: A sustainable project management approach

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Abstract

Purpose
This paper aims to analyse the results of a field study, conducted by the authors, to explore the barriers to green building development in developing countries and the role of project management strategies in overcoming these barriers.

Design/methodology/ application
The research methodology was designed to build a comprehensive background on barriers to green building development and the role of project management in green building delivery. A survey questionnaire was conducted and analysed to enhance understanding of green building barriers.

Research findings and practical implication
The research identifies the barriers to green building development in developing countries. The lack of a proper project management framework

hinders the successful implementation of green construction projects in developing countries.

Research limitations
The research primarily addresses the barriers to Green Building pertaining to project management in developing countries.

Originality / Value
The research addresses the practical development of Green Buildings in developing countries from a management perspective, focusing on how project management can overcome the barriers to successful delivery of green buildings. The research also adds to the original body of knowledge through the gathering of available and fragmented literature on the subject of green building delivery barriers and challenges and the enhancement of the understanding of the practical field's view on the subject

Keywords: Green building; sustainable project management; green building rating systems; challenges; barriers.

1. Introduction

The rapidly developing nature of the global environment, along with awareness of the negative implications of civilisation on the planet, has led to the increasing demand of green projects. It has become irrefutably clear that climate change is real, and so going green is no longer a choice, but a necessity. The construction industry accounts for 40% of the usage of global energy, and 40% of natural resources (AlSanad, 2015), which puts the construction industry in a good position to impart environmental change. However, obstacles continue to exist in the path of green buildings, such as the difficulty to deliver a green building project within the planned budget and scheduled constraints. It is more difficult to pursue green buildings in developing countries due to the lack of awareness in regards to green processes and reluctance of local practitioners to abandon the traditional and reliable construction methods. Previous and parallel research shows a perception gap in relation to factors of green building project implementation. For example, Li et al. (2011) specifies the technical and innovation-oriented factors as the main category of challenges that project management should focus on. Another study conducted by Hwang (2013) notes that planning-related factors are the main category of challenges. On the other hand, Ametepey et al. (2015) outlines cultural barriers and the lack of governmental support as the most significant challenges to green building delivery. The paper thus aims to narrow down the gap through investigating the barriers to implementation of green building projects in developing countries and how project management principles and processes can overcome them.

2. Research Objectives and Methodology

In order to achieve this aim, a research methodology that consists of a brief overview of the literature and a survey questionnaire was designed. The research methodology achieves three objectives:

- Building a comprehensive background on the barriers to green building development and the role of project management in green building delivery through literature review
- Analysing the relevance of the barriers identified in literature review to green building development in developing countries from the perspective of field practitioners through conducting a survey questionnaire.
- Providing recommendation for project managers to overcome barriers to green building.

3. Literature Review

3.1 The construction industry

The construction industry has a major impact on the the socio-economic development of the country. It is responsible for the infrastructure and productive facilities, and contributes to the global Gross Domestic Product (GDP) through an annual output that amounts to US $4.6 trillion. This accounts for around 8-10% of the global GDP (Samari et al., 2013). Developing countries also have a higher workforce in the construction industry, and construction products are spread throughout the country to develop entrepreneurship and transfer technology to all citizens. On the other hand, the construction industry also has a major impact on the environment. The construction industry consumes 40% of the total energy produced globally (See figure 1), 40% of raw materials, 25% of all timber, 16% of water consumption and 40% of natural resources (AlSanad, 2015). The construction industry also accounts for the generation of 30-40% of solid waste and 35-40% of CO2 emissions (Serpell et al., 2013). Moreover, on a global scale, 23% of air pollution is due to activities of the construction industry (Yamany, 2013).

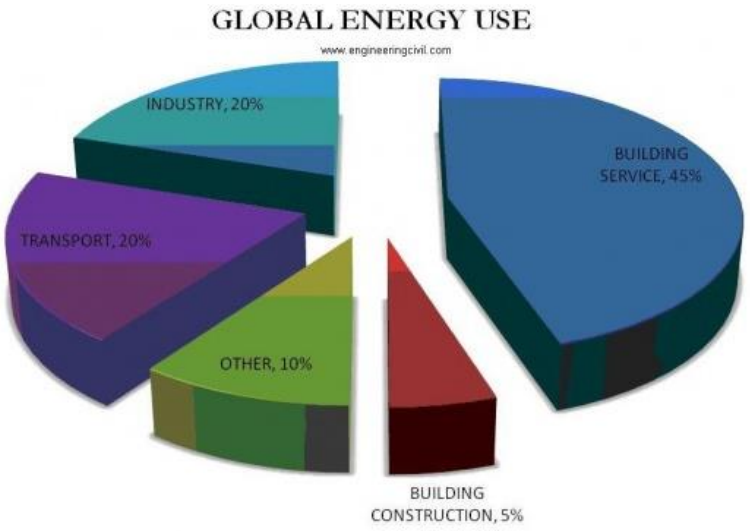

Figure (1): Global energy use by sectors (Raja & Kannan, 2014.)

3.2 Green Buildings

A green building project can be defined as an environmentally friendly structure that is designed, built and operated with the minimization of its impact on the environment in mind. A properly implemented green project will save cost, increase user comfort and satisfaction, and guarantee a healthier environment for all kinds of occupants. The green building trend is thought of as an attempt to balance the private and the social costs of construction (Matisoff et al., 2016). The purpose of green buildings is to reduce the negative impacts of construction upon the environment and improve occupant healthy quality through addressing sustainable site planning, water efficiency, energy efficiency, conservation and materials recycling (Samari et al., 2013). Performance of green building is measured through certification systems, which are third-party certifier that reduce cost of obtaining information on green building and allow for a credible verification of its environmental performance.

3.3 Barriers to green building development

Thorough overview of the literature on the barriers to green building developed led to the compilation of barriers from previous researches conducted in Chile (Serpella et al., 2013,) Malaysia (Samari et al., 2013), Singapore (Hwang & Tan, 2012); (Li et al. , 2011), Kuwait (AlSanad, 2015), South Africa (Olubunmi, 2015),

Ghana (Ametepey, 2015), China (Qian et al., 2015) (Shi et al., 2013), Egypt (Yamany, 2013); (Ismaeel, 2013); (North South Exchange Consultants, 2012), Saudi Arabia (Al-Yami & Price, 2006), and Brazil (Kasai & Jabbour, 2014). The identified barriers were classified into three major categories in relation to their effects on the three dimensions of sustainability: Social, economic and environmental. The most commonly cited 25 barriers identified in the literature review, presented in Table 1, were then chosen to be analysed in the survey questionnaire.

Barriers	Source	Country	Barrier Code
Economic Barriers			
Financial Barriers			
High Investment Cost	(NSCE, 2012) (Hwang & Jian, 2013)	Egypt Singapore	B3
Inadequate financial budget	(Li et al., 2011) (Gou et al., 2013)	Singapore China	B4
Cost risk associated with using new technology	(Chan et al., 2016) (Qian et al., 2015) (AlSanad, 2015)	International China Kuwait	B7
High cost of green materials and technology	(Gou et al., 2013) (Hwang & Tan, 2012)	China Singapore	B5
Long pay-back period	(Ampetepey et al., 2015) (Gou et al., 2013) (Chan et al., 2016)	Ghana China International	B8
Unequal distribution of benefits	(Gou et al., 2013) (Hwang & Tan, 2012)	China Singapore	B6
Scheduling Barriers			
Longer time need to apply green technology	(Chan et al., 2016) (Shi et al., 2013) (Gou et al., 2013) (Hwang & Jian, 2013) (Hwang & Tan, 2012)	International China Singapore	B24
Longer time needed to approve new technology	(Chan et al., 2016) (Gou et al., 2013) (Hwang & Tan, 2012)	International China Singapore	B9
Technical Barriers			
More rigorous design and construction phase	(Li et al. , 2011) (Samari et al., 2013) (Gou et al., 2013)	Singapore Malaysia China	B10
Need for additional site precautions	(Olubunmi, 2015) (Chan et al., 2016) (Qian et al., 2015)	South Africa China	B11
Environmental barriers			
Supply chain barriers			
Fragmentation and shortage in green supply chain	(Chan et al., 2016) (Shi et al., 2013) (Gou et al., 2013)	International China	B12
Governmental and legislation barriers			
Lack of financial incentives	(Kasai & Jabbour, 2014) (Chan et al., 2016) (Samari et al., 2013)	Brazil International Malaysia	B25

	(AlSanad, 2015) (Serpell et al., 2013) (NSCE, 2012) (Gou et al., 2013)	Kuwait Chile Egypt China	
Post construction liability and insurance	(Qian et al., 2015) (Shi et al., 2013) (Gou et al., 2013)	China	B13
Lack of governmental support	(Samari et al., 2013) (AlSanad, 2015) (Gou et al., 2013)	Malaysia Kuwait China	B14
Lack of building codes and policy	(Chan et al., 2016) (Samari et al., 2013) (Ametepey et al., 2015)	International Malaysia Ghana	B15
Lack of governmental involvement in promotion of awareness	(Qian et al., 2015) (Chan et al., 2016) (Serpell et al., 2013) (NSCE, 2012)	China International Chile Egypt	B16
Extra legal liability associated with green buildings	(Qian et al., 2015) (Shi et al., 2013) (Gou et al., 2013)	China	B17
Unstable nature of political conditions	(Serpell et al., 2013) (AlSanad, 2015) (Osaily, 2010)	Chile Kuwait Palestine	B18
Knowledge-related barriers			
Lack of common knowledge and terminology	(Shi et al., 2013) (Serpell et al., 2013) (Gou et al., 2013)	China Chile	B19
Lack of knowledge within local construction practitioners	(Chan et al., 2016) (Shi et al., 2013) (Serpell et al., 2013)	International China Chile	B20
Lack of environmental awareness	(NSCE, 2012) (Chan et al., 2016) (Samari et al., 2013) (AlSanad, 2015)	Egypt International Malaysia Kuwait	B23
Human-resource related barriers			
Lack of demand and express interest from clients	(Chan et al., 2016) (Ametepey et al., 2015) (Kasai & Jabbour, 2014)	International Ghana Brazil	B22
Need for careful review of available information	(Qian et al., 2013) (Chan et al., 2016) (Samari et al., 2013)	China International Malaysia	B21
Need for skilled project managers	(Li et al. , 2011) (Gou et al., 2013)	Singapore China	B1
Need for more extensive decision-making, management and scheduling process	(Serpell et al., 2013) (Gou et al., 2013)	Chile China	B2

3.4 Green building project management

Management is considered the most influential factor of project success. Project managers are directly responsible for 34%-47% of the project's success (Hwang & NG, 2013). The purpose of green management is to meet and satisfy both the user's and the natural environments' needs and requirements. Due to the presence of various barriers and the requirement for a higher level of details in green building implementation, traditional project management

processes are not suitable for green construction (Serpell et al., 2013). In order to deliver certified green buildings, it is important for project managers to be aware of the management-related requirements outlined in certification systems as well as the knowledge areas that tackle the barriers to green building delivery. For example, high cost premium and difficulty to remain within project budget constraints are amongst the barriers towards green building projects. UK's BREEAM also mentions life cycle costing as a requirement for green building projects to be certified. Therefore, in order to successfully deliver a certifiable green building, project managers need to utilize principles cost management to tackle the issue of high cost premium and to ensure that the project does not exceed its assigned budget. The literature review process identified the key knowledge areas to green building delivery as health and safety management, risk and quality management, procurement management, stakeholder management and cost management.

4. Data Analysis

4.1 Survey Questionnaire Purpose

The purpose of the survey questionnaire is to achieve the third objective for the research paper, which is the analysis of the relevance of the barriers identified in literature review to green building development in developing countries from the perspective of field practitioners.

4.2 Survey Questionnaire Sample and Design

The survey questionnaire process:

- Determine survey goals
- Select survey method
- Implement the survey sampling plan
- Design the survey for the identified sample
- Conduct a pilot study
- Organize and store data

A pilot study was conducted on the survey questionnaire to test the suitability of the design before distribution to the intended sample. The population of interest for the survey questionnaire was the 44 identified Architectural Design Firms (ADFs) in Egypt, which were used as the sample for the survey. Out of the intended sample, 34 responses were received.

4.3 Survey Questionnaire Main Findings

List of main survey questionnaire findings:

- The concept of green building is familiar and well-recognized amongst practitioners in the field, as 100% of respondents stated they are familiar with the concept of green building.

- 64.7% respondents stated that they were involved in green building projects, which shows that there is a discrepancy between the number of practitioners familiar with green building and the number involved in green building projects.
- Only 50% of respondents who were involved in green building projects pursued or acquired green certification for their projects.
- US's LEED (Leadership in Energy and Environmental Design) is the most commonly known, pursued and acquired green certification for green building projects in the field of study (See Figures 2 & 3).

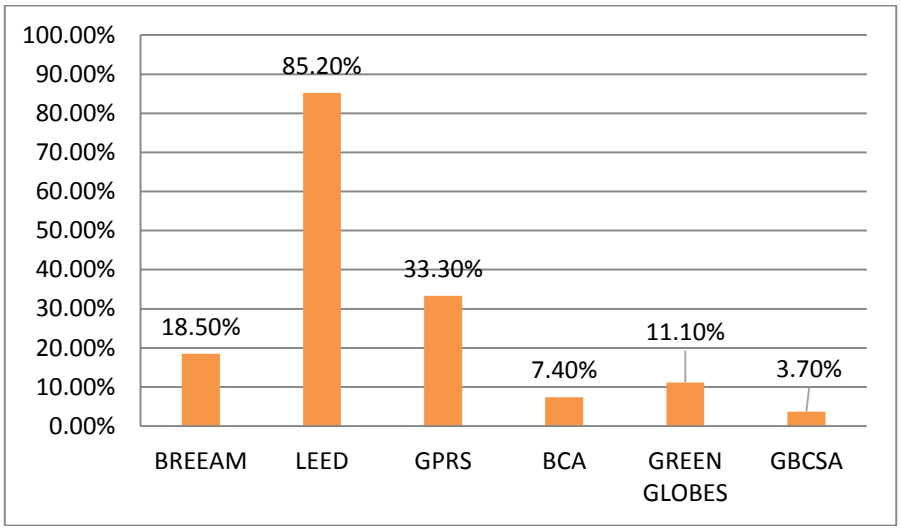

Figure (2): Level of familiarity of respondents for various green building certification systems.

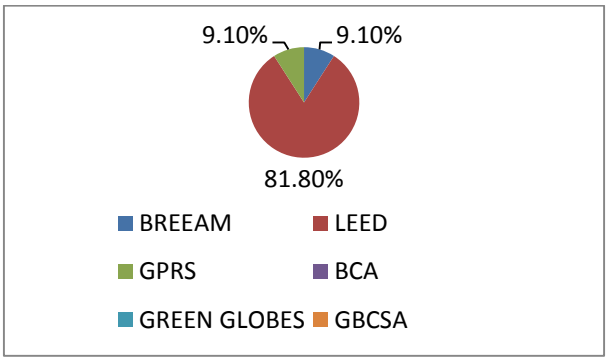

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Figure (3) Frequency percentages of green building certification systems targeted by respondents' in their green building projects.

- 52.9% of the respondents perceive the local certification system available in their country as capable of addressing green building requirements in the local context.
- 52.9% of respondents have experience with project management, with the majority having managed more than 10 projects throughout their career.
- The test of the research hypothesis revealed that 94.1% of respondents believe that project management can assist in the delivery of green building, which supports the hypothesis.

Table 2 shows the analysis of the response in regards to the impact of the 25 most cited barriers in the literature from perception of respondents.

Financial barriers, such as high investment costs and inadequate financial budget, are perceived to be the biggest challenge to green building delivery amongst respondents. (See Figure 4).

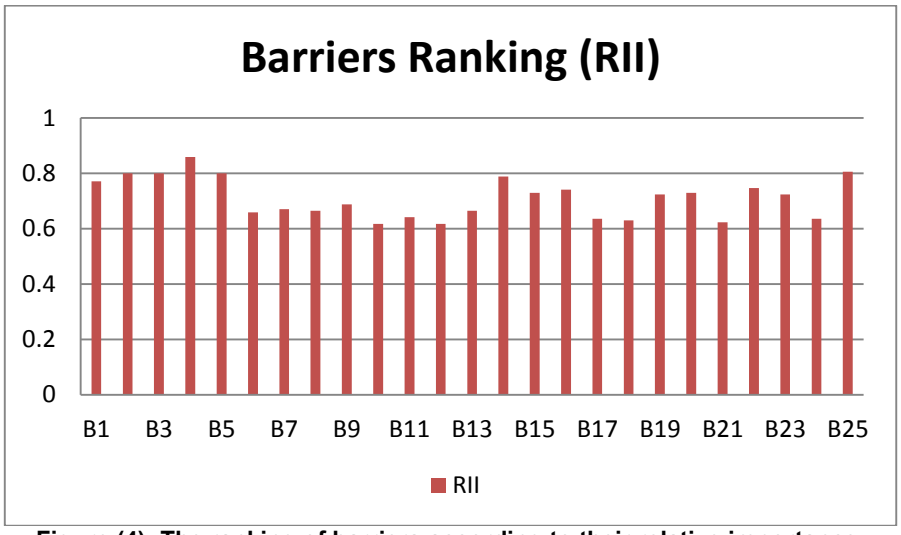

Figure (4): The ranking of barriers according to their relative importance index.

Table 2: Measure of Central Tendency, Measure of Dispersion, Number of Respondents Scoring and Rank for barriers to green building delivery.

Barrier Code (1)	Mean (2)	Median (3)	Mode (4)	V (5)	S.D. (6)	RII (7)	Rank (8)	Number of Respondents Scoring (9)			Final Rank (10)
								1-2	3	4-5	
B4	3.85	4	5	0.401104	0.633328	0.77059	1st	4	8	22	1st
B25	4.00	4	5	0.441176	0.664211	0.80000	2nd	3	8	23	2nd
B2	4.00	5	5	0.441176	0.664211	0.80000	3rd	6	4	24	3rd
B3	4.29	4	5	0.540403	0.735121	0.85882	3rd	1	4	29	4th
B5	4.00	4.5	5	0.441176	0.664211	0.80000	3rd	4	7	23	5th
B14	3.29	3.5	4	0.306839	0.55393	0.65882	4th	8	9	17	6th
B1	3.35	3	5	0.312436	0.55896	0.67059	5th	11	7	16	7th
B22	3.32	3	4	0.30951	0.556337	0.66471	6th	9	9	16	8th
B16	3.44	4	4	0.322741	0.568103	0.68824	7th	8	7	19	9th
B15	3.09	3	4	0.295263	0.543381	0.61765	8th	12	8	14	10th
B20	3.21	3	3	0.300351	0.548043	0.64118	8th	9	11	14	11th
B19	3.09	3	4	0.295263	0.543381	0.61765	9th	12	8	14	12th
B23	3.32	3	5	0.30951	0.556337	0.66471	9th	11	8	15	13th
B9	3.94	4.5	5	0.424384	0.651448	0.78824	10th	7	3	24	14th
B7	3.65	4	5	0.355689	0.596397	0.72941	11th	7	6	21	15th
B8	3.71	4	5	0.367393	0.606129	0.74118	12th	6	9	19	16th
B13	3.18	3	3	0.298697	0.546532	0.63529	12th	10	11	13	17th
B6	3.15	3.5	5	0.297298	0.54525	0.62941	13th	13	4	17	18th
B11	3.62	4	5	0.350219	0.591793	0.72353	14th	9	6	19	19th
B17	3.65	4	5	0.355689	0.596397	0.72941	15th	11	3	20	20th
B24	3.12	3	3	0.296153	0.544199	0.62353	15th	10	11	13	21st
B18	3.74	4	5	0.373626	0.61125	0.74706	16th	6	6	22	22nd
B21	3.62	4	5	0.350219	0.591793	0.72353	17th	8	8	18	23rd
B10	3.18	3	4	0.2986	0.5465	0.635	18th	11	8	1	24th

				97	32	29				5	
B12	4.03	4.5	5	0.449954	0.670786	0.80588	18th	5	4	25	25th

- The perception of lack of education, training and awareness as barriers to green building delivery was a recurring theme in open-ended responses.

- Quality management, Integration management and Cost management are perceived as the key project management knowledge areas to the successful delivery of green building projects (See Figure 5).

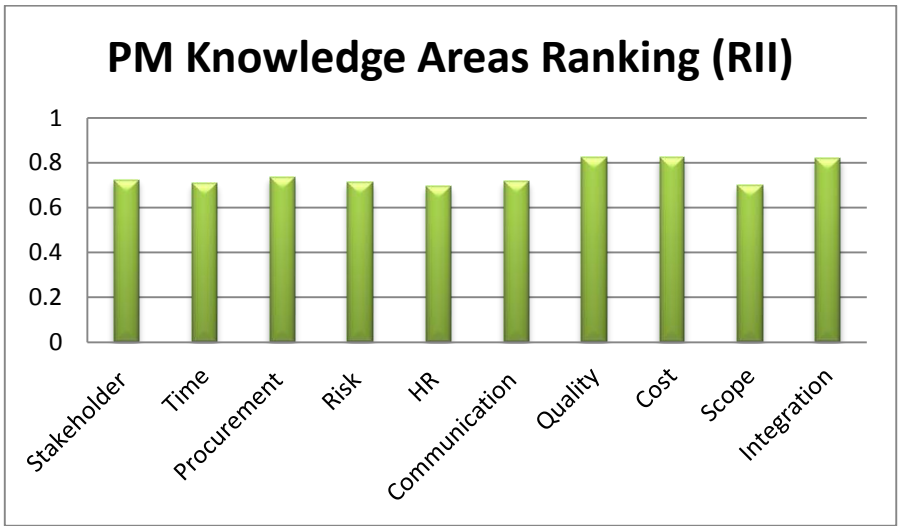

Figure (5): The ranking of project management areas according to their relative importance index.

The survey questionnaire identified additional barriers to the ones found in literature review such as: lack of green building-centric courses in undergraduate studies and desire of stakeholders to achieve a quick Return on Investment. The questionnaire also identified essential project management skills for green building delivery such as: Personal knowledge and Awareness, decision-making skills, communication skills, negotiation skills and leadership skills.

5 Conclusions and Recommendations

This paper presented the barriers to green buildings delivery in developing countries through a brief overview of literature review and analysis and results of the field study. The paper focuses on the results of the field study, which outline that the main barriers to green building delivery are economic barriers, thus supporting literature review findings. The field

study also shows that cultural barriers such as the lack of education on green building, the lack of awareness of the importance of green building benefits among stakeholders, and the lack of training and knowledge among practitioners have a major impact on the delivery of green building. In light of the field study, several solutions are proposed in this paper as re commendations to overcome the barriers to green building delivery through project management. These are:

1. Emphasis on the role of project manager in raising the awareness of the client and key stakeholders from the initiation of the project in relation to green building objectives and benefits.
2. Preparation of a feasibility study and environmental guidelines from the onset of the project as well as incorporation of training and education regarding green buildings within the project scope.
3. The formal incorporation of green certification documents within the preliminary contract to be approved by all involved parties.
4. Inclusion of training seminars on the first day of the project briefing for the promotion of awareness and education.
5. Establishment of a clear and accessible electronic process map for the provision of a concise vision of all phases and roles of involved parties that can be communicated to stakeholders and referred to throughout project.

Additional recommendations include the emphasis of the role of governmental involvement in supporting the green building delivery process in the form of providing financial incentives for green building stakeholders and providing environmental awareness programs.

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An Analysis of Sustainable Rating Systems in Respect to Communities for Implementation in Developing Countries

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ABSTRACT

Purpose of this paper
This paper aims to analyse rating tools in respect to communities in order to understand the challenges that apply to developing nations in achieving sustainability at neighbourhood level.

Design/methodology/approach
An analysis on community sustainable rating systems was conducted using a content analysis based on criteria and sustainability indicators. This was then further compared to challenges faced by developing countries. These are identified through intensive literature review and statistics from developing countries. Challenges and opportunities for sustainability are then realised for developing countries.

Findings
Preliminary findings show that there are deficiencies in socio-economic aspects within the rating tools for green communities, which are critical in the implementation of sustainability in developing countries. Sustainability evaluation requires comprehensive adaptations thereby making sustainability context –specific.

Practical implications
This analysis constitutes a critical step in the process of creating a more contextual framework which can guide decision making and planning for achieving sustainable communities in developing countries.

What is original/value of paper.
The in-depth analysis of existing neighbourhood rating systems is conducted with the aim of understanding the challenges to promote the sustainability of communities or neighbourhoods in the context of developing countries.

Keywords: **Sustainable Communities, Neighbourhood Rating Systems, Developing Countries**

1. INTRODUCTION

Sustainable development has been a common goal for urban development for many countries. (Bakar and Cheen, 2013; Chan and Lee, 2006) The Brundtland Commission Report (1987) defined sustainability as meeting the needs of the present generation without compromising the needs of future generations with regards to the use of natural resources and the accountability of energy usage.

Sustainable development therefore, involves ecological, cultural, economic and technological aspects. A number of developed countries have then adopted, at building level, sustainability policies and rating tools, these include: BREEAM (Building Research Establishment Environmental Assessment Method) which was established in 1990 developed by the British Research Establishment (BRE) and was established to form a comprehensive means of simultaneously assessing a broad range of environmental considerations in buildings (Haapio, 2008).

Thereafter, United States of America Green Building Council established in 1993 unveiled the LEED (Leadership in Energy and Environmental Design) in the year 2000. LEED then became a standard for environmental sound buildings in America and applied globally. (USGBC, 2014) Japan also developed designed standards and guidelines, CASBEE (Comprehensive Assessment System for Building Environmental Efficiency) for building systems (Bakar and Cheen, 2013), which was established between 2002 and 2005, then revised in 2014 (JSBC, 2014) Additionally the Green Building Council in Australia (GBCA) formed Green Star Australia, for example Green Star – Design & As Built, which was released in 2015. Building rating tools from their respective green building councils thereafter evolved to develop community rating system in the prospects of achieving sustainable urban development. However, shortcomings with the building rating tools where experienced and which were brought forward over into community rating tools. (Berardi, 2012)

Further to this problem, it has been established that sustainability is context specific and one countries' sustainable development is most likely to differ from another country's sustainable development (Wu *et al*., 2017). The limits of adaptability of existing systems to different countries have been considered, and the need to redefine and adapt the assessment,

particularly in developing countries (Berardi, 2013; Georgiadou, Hacking and Guthrie, 2012)

Therefore, starting from a community level rating system, a critical analysis will assist in creating more appropriate defined accommodation of different nation's communities and cities. Furthermore this gives a platform for developing countries to "leap frog" into sustainability. (Creutzg *et al.*, 2016; Zeijl-Rozema *et al*., 2008)

Sustainability, in the context of buildings, connects with the objectives of the Habitat Agenda and the Urban Agenda (2016) which are the blueprint for sustainable development in the 21st century. Sustainable urban development was then adopted by 179 nations. Aspects of construction, design, operation and demolition have a substantial impact on the environment and its natural resource use and sustainable rating tools were used to monitor and mitigate these aspects. (Bakar and Cheen, 2013; Panitchpakdi, 2012) Oosterveer and Spaargaren (2010) confirms that government authorities in developing nations are faced with the dilemma of growing populations with inadequate infrastructure which include services for water, sanitation and solid waste.

This research specifically examines current Neighbourhood Development Sustainability rating tools, established in developed countries. These tools are analysed with regards to the challenges experienced in developing countries for a possible implementation in developing countries.

1.1 Existing Neighbourhood Sustainability Assessment Systems

Neighbourhood Sustainable Assessment (NSA) Tools are designed with the aim of ensuring informed decision making for sustainable development, therefore their competence makes it important. Previous research conducted by Sharifi and Murayama (2012) mentioned that a number of sustainability rating tools for neighbourhoods were "Spinoffs" of Green Building rating tools. For example, LEED ND is derived from the LEED for buildings, BREEAM Com, from BREAM for buildings and CASBEE UN from CASBEE and Green Star Australia Guide for Local Government, from Green Star – Design & As Built. Considerably, there are also rating tools that were originally made to become community rating systems from the onset, these include: HQE 2 R, Eco city and SCR, which originated from developed countries. The purpose of these was to cater for neighbourhoods and communities directly. It has further been contended that these tools are based on priorities and conditions of their countries and regions of origin, different climatic conditions including social and economic settings. (Sharifi and Murayama, 2012) Unique benchmarks are to be used for specific locations and are discovered to be more effective in the effort to adapt to different climatic social and environmental conditions. Therefore a framework based on a direct derivations of the context becomes important and can be developed, for especially for developing countries. (Zeijl-Rozema *et al.,* 2008; Diaz-Sarachaga *et al.,* 2016)

1.2 Sustainability in developing countries

In the majority of developing countries there is deficit infrastructural development. Hence governments in these countries require infrastructure investment to improve their development goals (Diaz-Sarachanga *et al.,* (2016b). However, both Diaz-Sarchaga, (2016b) and Ugwu and Haupt, (2005) contend that protective Socio-economic development is higher on the agenda for developing countries compared to environmental concerns. The difficulty lies when developed countries' sustainability rating systems are superimposed on developing countries, which differ in socio-economic and infrastructural requirements in comparison to their developed nation counterparts.

However, Creutzig *et al.,* (2016) state that the majority of developing countries have yet to develop their infrastructure. Countries in this situation are included in the following continents: Asia, Africa, Australia and North America and parts of Europe. Countries in these continents lack the capacity urban planning and strong institutions for implementation. Additionally, these differences include progressive levels, for example, the majority of European nations went through of phase of industrialisation. In which, developing countries are following suite in order to achieve economic development. (Shafaeddin, 1998)

The industrialisation phase of developed countries promoted economic growth by means of infrastructural developments. However, it is worth mentioning that infrastructural and socio-economic factors are interlinked and therefore one cannot function without the other, more especially when it comes to sustainable development. (Diaz-Sarchaga, 2016b) For example a proper functioning transportation assists and is interlinked to the economic and social aspects of the country. (Pantelidou *et al*., 2016)

2. METHODOLOGY: A FRAMEWORK OF SUSTAINABILITY ASSESSMENT OF URBAN COMMUNITIES

2.1 Establishing a rating system for urban development

Sustainability assessment with regards to communities include Environmental (Natural Resources, Housing and Built Environment, Infrastructural Services and facilities), Economical (employment availability and access, business, local training and skills, house prices and affordability); Social Sustainability (access to area, crime and safety, mix in terms of income, tenure and ethnic) and Infrastructure Sustainability (local authority services, community activity and local partnerships) (Berardi, 2013). The importance of interactions between these aspects of

sustainability has given rise to the establishment of rating systems for urban development (Berardi 2011; Conte and Monno 2012).

Nevertheless, these current urban development sustainability systems are unique for developed countries, therefore the need for sustainability assessment indicators are to be examined for possible implementations into developing nations. (Arcadis, 2016; Berardi, 2013; Bentivegna *et al.,* 2002; Xing *et al*. 2009; Mori and Christodoulou 2012) Sustainability Rating Tools, LEED ND, BREEAM Communities, CASBEE – UN and Green Star Communities Australia where identified by authors for consideration of a reference framework with additional urban specific settings. The framework alterations are to be considered with respects to challenges faced by developing countries. This therefore provides the opportunity to contextualise sustainability by using levels of relevance, to each rating tool criteria.

2.2 Challenges and Aspects faced by Developing Nations

Developing countries have been facing the challenge of urbanisation and growing populations. Sustainability Rating Tools LEED – ND, BREEAM Communities, CASBEE – UN and Green Star Communities Australia where provided in a content analysis with respects to challenges faced by developing nations. In this content analysis, the main criterias and subcriterias in each rating tool were identified with their aspects.

However, research conducted by Diaz-Sarachanga *et al.*, (2016a), Berardi (2013), Sharifi and Murayama (2012) and Oosterveer and Spaargaren (2010) have concluded that socio economic factors and infrastructural limitations are experienced in developing countries.

These social economic services and environmental facilities are obtained with a high cost element attached to it (Diaz-Sarachanga *et al.*, 2016b). Inadequate facilities further lead to health hazards and waste materials causing pollutions (water, air and soil). This makes the obtaining sustainable communities even more paramount.

The opportunity to “leapfrog” is supported by the African Union (2016) that whilst developing nations are urbanising, there is a great potential for economic, social and spatial structural transformation that can contribute to great advances in the diverse developing nations urban communities. The Australian Green Building Council (2013) for example, have formulated a guide for governments which included the input of the stakeholders in its formulations, these included aspects such as town planning, social planning, economic and asset management. According to Diaz-Sarachanga *at al.,* (2016a), some aspects that were considered in development of a rating system for developing countries, included the following:

- Cultural Aspects such as building design and historical influences,
- Food Systems and Food Control Infrastructure

- Agriculture and Farming
- Growing Populations and shortage of skilled Human Resources
- Government Regulations
- Health (work - life balance)/Open Parks
- Energy Supply Systems, like coal and hydro power
- Waste Management Systems
- Water Shortage and draughts
- Diverse Climatic Conditions, Topology and soil erosion, Diverse species and Drainage and Rainwater
- Natural Resource Use And Management
- Drainage and Rainwater Disposal/Harvesting Systems
- Urban Planning Systems and Land Availability
- Transportation Infrastructure
- Economic Aspects - Includes Exchange Rates, Debt and Economic capacity of the country

These fifteen (15) challenges were considered by authors in the inclusion under requirements, namely; Society, Environment, Economy and Management with regards to sustainability indicators that present key issues in the attempts of achieving sustainability in developing nations. Diaz-Sarachanga *at al.,* (2016b).

3. COMPARISON ANALYSIS BETWEEN URBAN SUSTAINABILIY SYSTEMS

A content analysis was conducted based on a summary of challenges in developing countries which were compared in relation towards the four neighbourhood rating systems namely: LEED ND, BREEAM Communities, CASBEE UN and Green Star Communities Australia. With regards to Cultural Aspects for example, LEED ND scored the highest (6) in terms of addressing this challenge compared to BREEAM Communities and Green Star Australia, with a value of (4) each. In Figure 1, the scale between 0 and 14 is allocated and was derived from the weighted criteria with regards to challenges in developing countries and the depth in which it is considered by each rating tool as shown in Table 1. The values in the scale (0-14) in Figure 1 refers to the degree of significance in accordance to the community rating systems main and sub main criteria against challenges retrieved from developing countries. These levels of significance are represented in the contour lines in Figure 1. The maximum weighted value is 14 is the most considered aspect while the least considered values include points 5, 4,3,2,1 until zero (0).

Challenge faced by Developing Countries	Leadership in Energy and Environmental Design- Neighbourhood Development (LEED ND)	Building Research Establishment Environmental Assessment Method (BREEAM) Communities	Comprehensive Assessment for Built Environment Effeciency (CASBEE)	Green Star Australia Community
Social and Cultural Aspects	6	4	1	4
Food Systems and Food Control Infrastructure	2	0	0	0
Agriculture and Farming	1	0	0	1
Growing Populations and Human Resources	1	1	0	3
Government Regulations	3	6	0	4
Health	7	1	0	2
Energy Supply Systems	7	1	1	1
Waste Management Systems	2	0	0	1
Water Shortage and draughts	8	0	0	1
Diverse Climatic Conditions	6	6	2	3
Use and management of natural resources	3	6	0	3
Drainage and Rainwater Disposal/Havesting systems	3	2	0	0
Urban Planning Systems/ Land availability	12	13	4	3
Urban Planning Systems/Transportation infrastructure	14	13	3	2
Economic Aspects	1	5	4	6

Table 1: Challenges and Community Rating Tools [Scale 0 (low) -14 (high)]

Figure 1: Comparison of Rating System Vs Challenges

According to the graphic manifestation in Figure 1, Transportation Infrastructure ranks first (scale14) for LEED ND in terms of level of appearance and significance with respect to the 15 challenges faced by developing countries. Urban Planning Systems as well as Land Availability and Transportation Infrastructure both have a level of significance of 13 on the scale for BREEAM Communities.

Firstly, it is further observed from Figure 1, that LEED ND is applicable to the majority of challenges faced by developing countries and secondly, BREEAM Communities also comprises of factors that would be beneficial and prominent for developing nations. LEED ND has the most impacts with regards to Urban Planning Systems and Transport Infrastructure (scale 14) followed by Urban Planning Systems and Land Availability (scale 12).

This illustrates that these factors could be addressed by LEED ND for application in developing countries. In terms of Urban Planning

Systems/Land Availability (scale13) and Transportation Infrastructure (scale13), BREEAM Communities both consider these aspects equally. This makes BREEAM Communities also adaptable for a possible a sustainability framework in developing countries. CASBEE UN is the least factored with respects to developing nation considerations. Rehabilitative aspects and land reclamation methods are usually accounted, given in the Asian continents' toxic environments which is a major challenge, due to its mammoth industrialised rates. (Bakar and Cheen, 2013). CASBEE UN is therefore most appropriate in the Asian regions.

4. DISCUSSION OF FINDINGS

From the analysis, it has been discovered that Land and Nature presents an opportunity for developing countries. This explains the occurrence levels in the graph in Figure 1. This aspect in terms of developing countries can be explored in order to obtain sustainable solutions. For the purposes of developing a framework for developing nations, the land and nature aspects can be an opportunity to enhance the environmental tier of sustainability by for example creating more parks within cities. Other aspects can include the provision of added nature reserves for local and international visitors (tourism), this promotes the socio-economic sub-index of sustainability.

Opportunities for developing countries to "leap frog" into sustainability can also be achieved by realising the strengths of developing nations, such as Land availability and biodiversity. Therefore sustainability for developing nations can be used as an prospect for socio economic advancement, such as increase the creation of employment which promote sustainability, for example the use of recycled materials.

In terms of road and infrastructure, considering that transport infrastructure accounts towards the majority of emissions as opposed to infrastructure construction and operations. Opportunities exists with regards to the implementation of an efficient public transportation. (Pantelidou *et al.,* 2016). All these aspects which present opportunities, can be used in developing nation governments and non-government organisations in guiding them with regards to sustainable decision making and planning.

Further to this, sustainability evaluation requires unique adaptations. A framework for developing countries can therefore be established using the problems and opportunities which exist with their particular context.

This makes community rating systems the forefront of achieving sustainability through governance, urban and community planning to address aspects of modern life. Therefore the solution lies in a more a holistic development strategy encompassing a wide range of issues is able to reduce costs and financial burden with respects infrastructural development thereby creating a safe, healthy and happy environment. This

will minimise problems resulting to poor and inefficient urban planning and design aspects. The provision of financial and lifestyle benefits of this wholehearted approach can be demonstrated to governments, developers, public and private sectors.

5. CONCLUSIONS

This report aimed at providing an in-depth analysis of existing rating systems which include: European BREEAM Com, CASBEE UN, American LEED ND as well as Green Star – Communities from the Green Building Council in Australia. Indeed the researchers have discovered deficiencies in terms of appropriate assessment of socio economic aspects of implementing sustainability in the development country context. Developing countries have opportunities to "leap-frog" into sustainability by means of developing community rating systems which are context specific to their region.

Sustainability Rating Tools LEED ND, BREEAM Communities, CASBEE UN and Green Star Communities Australia where identified by authors for consideration of a reference framework with additional urban specific settings. The framework modifications are to be considered with respects to challenges faced by developing countries. This therefore provides the opportunity to contextualise sustainability by using levels of relevance, to each rating tool criteria. Ways in which challenges are decreased or mitigated in terms of sustainability were realised and opportunities for sustainability advancement.

This gives these countries the advantage in terms of developing sustainably in a larger scale (community) then city, compared to the conventional, sustainable (green) buildings approach. Furthermore, infrastructural development will improve the economy by means of job creation during construction, maintenance and operations of these sustainable systems, thereby improving sustainable development.

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Barriers to the effective implementation of sustainable construction in the South African construction industry

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ABSTRACT

Purpose: This paper investigates the barriers to the effective implementation of sustainable construction in South Africa.

Design/methodology
A field questionnaire survey was conducted to collect data regarding factors that constitute barriers to the effective implementation of sustainable construction in SA. The targeted respondents were construction professionals in the Gauteng Province of SA. A total number of 111 questionnaires were obtained and data were analysed using the Statistical Package for Social Sciences (SPSS) software. Mean value and standard deviation were obtained.

Findings
The study reveals that major barriers to the implementation of sustainable construction in SA are high initial cost of construction, negative perception of cost of green construction materials and lack of training /education on sustainable design. The study further reveals lack of interest from the client, which is possibly due to perceived high cost of renewal materials. Other issues are related to difficulty to obtain financing from banks for sustainable projects, lack of interest from project team members and lack of incentives for sustainable construction projects.

Research limitations
The study includes only participants in Gauteng province of South Africa and this may affect its generalisation.

Practical implication
This study provides an understanding of barriers to the full uptake of sustainable construction in SA. Thus, sensitising the construction industry on the pitfalls to avoid for effective implementation of sustainable construction in SA.

Value
The study adds value to the conference theme in that it addresses green building aspects in the area of sustainable construction.

Keywords: sustainability, implementation, construction industry.

1. INTRODUCTION

Sustainable development has become a very important subject and core of several studies and practices worldwide (Yilmaz and Bakis, 2015). Its rigorous pursuit in many countries arise from the realisation that sustainable development is capable of enhancing the environment as well as improving the social wellbeing and quality of life of people (Saleh and Alalouch, 2015). Thus, the sustainability concept is receiving more and more attention in different facet of human endeavours including construction (Ugwu and Haupt, 2007; Okoye and Okolie, 2013; Saleh and Alalouch, 2015; Elmualim and Alp, 2016). However, despite the increased importance placed on sustainable development globally, the implementation of its concept remains a challenge in South Africa (Emuze et al., 2015). Over the past few decades, there has been a significant increase in the global environmental awareness (Elmualim and Alp, 2016). The increased global environmental consciousness arise from the emergent of several environmental problems such as climate change, air pollution, water problem, global warming, energy problem, deforestation and habitats loss, degradation, ozone layer depletion just to name a few. These emergent problems have resulted in the global call for radical shift towards environmental responsiveness (Emuze et al., 2015; Asif, 2016). Consequently, sustainability was identified as an important concepts which should be incorporated in all human activities in order to alleviate the impact of environmental problems (Sourani and Sohail, 2005; Asif, 2016).

In line with this call, several countries around the globe have long embraced the concept of sustainability. Unfortunately, the implementation of sustainable construction policy has not been easy, especially in the developing countries. In addition, adapting to sustainable design, sustainable production and sustainable construction practices in some of these countries has been slow in its uptake ((Elmualim and Alp, 2016; Emuze et al., 2015). Thus, the industry is being robbed of the benefit associated with sustainable construction practices. While there has been a remarkable advances towards the achievement of sustainable development in South Africa, the reality is that there is still much to be attained

(Department of environmental affairs and Tourism, 2008). In addition, the implementation of sustainability concepts still face a lot of challenges in South Africa (Emuze et al., 2015). Thus, some studies were conducted in some part of South Africa to investigate the limiting factors to effective implementation of sustainability concepts in South Africa. In line with the urgent need to promote the concepts and implementation of sustainability in South Africa, this study investigates the barriers to sustainable construction in the South African construction Industry with focus on the Gauteng province being the province with largest construction activities in South Africa.

2. LITERATURE REVIEW

Construction industry is the largest and most fragmented industry in the world with a vast number of construction activities yearly (Elmualim and Alp, 2016). The industry consumes a huge volume of natural and non-renewable resources such as energy, raw materials, land and water in the operation of its activities. These resources engender wastes that are potentially dangerous and cause environmental pollution (Asif, 2016; Nwokoro and Onukwube, 2011).Thus, the construction industry is recognised as the most hazardous industry, the largest pollutants and destroyer of natural environment (Okoye and Okolie, 2013; Wallbaum and Buerkin, 2003; Wooley, 2000). Literature reveal that both the building and the construction sector contribute significantly to the occurrence of global warming energy crisis and environmental pollution which are some of the most prominent challenges that face the entire world today (Asif, 2016). Moreover, there are carbon emissions from the construction activities. This carbon emission further added to the rapidly increasing global warming and weather variations (Kolev, 2009). All these pose serious threats to the global ecosystem and also have serious impacts on human life, the environment and socio-economic development (Oke et al., 2017; Muneer et al., 2008).

These negative impacts have become an issue of serious concern and alerted the world of the need for balanced ecosystem. Several researchers have also stressed the need to give serious attention to resources consumption through radical shift in human practices (Asif, 2016). Thus, the call for sustainable development in construction has been loud and clear worldwide (Hussin et al., 2013). Sustainable development is an ecologically-focused concept (Elmualim and Alp, 2016). Its purpose is to address the link between the economic growth and the natural ecosysytem and the consequences that economic activities can have on the environment (Bangdome-Dery and Kootin-Sanwu, 2013). Thus, sustainable development is defined as “a development which meets the needs of the present without compromising the ability of future generation to meet their own needs” (WCED, 1987). The main focus of sustainable construction is to ensure that construction products are delivered with minimum environmental impact on people. The construction industry is particularly

expected to play a significant role in the mitigation of environmental problem through sustainable construction. This is because, the building and construction sector accounts for more than 40% of energy and material consumption and also generates a huge amount of waste from its activities (Oke et al., 2017). Moreover, the built environment industry is found to be mostly responsible for the environmental pollution (OECD, 2013). Regrettably, the form of construction development in the past ignored the reality of natural resources and environmental issues (Emuze et al., 2015). This neglect results in a lot of negative consequences to the environment and the quality of life of people. All these points attention to the urgency of sustainability interventions. Ofori (2007) emphasised the need for the global construction sector to be familiar with sustainable development and transforming its traditional structures into modern sustainable construction.

For this to be achieved, there is need to first identify the prevailing situation within a particular community and best approach to providing a sustainable building environment. In South Africa, There has been a tremendous advances towards the achievement of sustainable development. The reality though is that there is still much to be attained. (Department of environmental affairs and Tourism, 2008). The World Summit on Sustainable Development (WSSD) was held in Johannesburg, in September, 2002. Thereafter, the South African government has made efforts in establishing policy in favour of sustainable development. However, the earlier studies on sustainable development in SA revealed that the scope of application is still poor eventhough there is drive towards sustainable design and construction in South Africa. Thus, this study investigates the barriers that has been limiting the effective sustainable development practices in South Africa.

3. RESEARCH METHODOLOGY

This study employed a quantitative research method. The research was conducted in the Gauteng Province of South Africa (SA). The Gauteng province was selected because it has been recognized as the province with highest record of construction activities. The targeted respondents were the construction professionals within the Gauteng province. These respondents as shown in Table 1 are construction professionals including quantity surveyors, construction/project managers, architects and engineers that are usually involved in construction projects within Gauteng province. Table 1 indicates the demographic analysis of the respondents. The analysis revealed that the respondents have considerable experience within the construction industry and are involved at both private and public construction sectors. They also worked in consulting firms, contracting firms as well as in government establishment. Within the past three years, 39.6% of the respondents were involved in 1-4 projects, 22.5% were involved in 5-6 projects, while 17.1% were involved in 7-8 projects and 20.7% were involved in more than 8 projects. The objectives of this study were achieved using questionnaire survey which attracted one hundred

and eleven (111) responses. A thorough review of the relevant literature was carried out to identify the limiting factors to the effective implementation of sustainability concepts. A total of twelve factors were identified and documented in Tables 2. These factors were presented in questionnaire form which attracted (111) one hundred and eleven responses. There are two main parts within the questionnaires. The first part was the introductory section while the second section deals with the ranking of the identified possible barriers to sustainable construction in SA. The professionals were requested to rank their perception of the factors on a 5 point Likert scale comprising effect level of strongly disagree =1, disagree = 2,neutral = 3, agree = 4 and strongly agree 5. The mean score (MS) for each variable was established and ranked from highest to the lowest as shown in Table 2. The determination of the significance of each of the factors was based on adopting a hypothsised mean of 3.5 drawing from Sherif and Kaka (2003) and Ahadzie et al., (2008). Consequently, based on the five-point Likert scale a factor was deemed to be a barrier to effective implementation of sustainability in SA if it has a mean item score of 3.5 and more.

Table 1: Demographic data of the respondent

	Frequency	**Percentage %**
Profession of the respondents N =111		
Engineers	24	21.60
Quantity surveyors	29	26.10
Construction/project managers	36	32.40
Architects	22	19.90
Working experiences		
1-5 years	30	27.10
6-15 years	45	40.50
Above 16 years	36	32,40
Construction Industry Sector		
Private	23	19.82
Public	14	11.71
Consultants	34	29.79
Contractors	24	21.62
Government	19	17.12

4. RESULTS AND DISCUSSION

As aforementioned the purpose of this study is to investigate the barriers to sustainable construction in South Africa. Twelve factors were extracted from literature as depicted in Table 2. Based on factors identified from the review of literature, The respondents were asked to rank barriers facing the implementation of sustainable construction practices in Gauteng province of SA. The ratings given by each of the respondents were calculated to arrive at a mean score for each of the listed factors. The mean scores was ranked from highest to the lowest and was used to determine whether the respondents considered a particular factor to be a limiting factor or otherwise. In order to provide a clearer picture of the respondents' views, the mean ranking of each factor is also shown in Table 2.

Table 2: Barriers for the implementation of sustainable construction practices

Factors	Std	Mean	R
High cost of construction	0.762	4.27	1
Negative perception of cost of green construction materials	0.848	4.19	2
Lack of training/education in sustainable design	0.844	4.15	3
Lack of expressed interest from clients (owner/developers)	0.907	4.15	4
High maintenance cost of renewal materials	0.865	4.13	5
Lack of knowledge where to find information on sustainable building methods	0.882	4.12	6
High cost of green construction materials	0.850	4.12	6
Lack of training/education in sustainable construction processes	0.802	4.11	8
Difficulty to obtain financing from banks for sustainable projects	0.907	4.06	9
Non availability of green construction materials	0.948	4.03	10
Lack of interest from project team members	0.769	4.01	11
Lack of incentives for sustainable construction projects	0.976	3.95	12

From the results obtained as shown in Table 2, high cost of construction ranked first with a mean score of 4.27, Negative perception of cost of green

construction materials ranked second with a mean score of 4.19, lack of training/education in sustainable design ranked third with a mean score of 4.15, lack of expressed interest from the developers and clients ranked fourth with a mean score of 4.11, high maintenance cost ranked fifth with a mean score of 4.13, lack of information on sustainable building methods and high cost of green construction both ranked sixth with mean scores of 4.12, lack of education in sustainable process, difficulties in obtaining financing from banks, non availability of green construction materials, lack of interest from project team members and lack of incentives for sustainable construction projects ranked eighth, ninth, tenth and eleventh with mean scores of 4.06, 4.03, 4.01 and 3,95 respectively. According to the findings, all of the factors identified have high mean scores and are perceived by the respondents to be significant barriers to the effective implementation of sustainable construction in the gauteng province of SA. Cost issues appears to be the most significant barrier facing SA in implementing sustainable construction policy. The areas of concern in relation to cost issues include: the high cost of implementing sustainable construction, negative perceptions of the green building cost, the high cost of sustainable materials and the high cost of maintenance of renewal materials. This findings is similarly with the case observed in earlier studies carried out in some other parts of SA as well as in most other developing countries. The studies of Jacobs (2011), Wilreker (2011), Emuze et al., (2015), Saleh and Alalouch (2015) and Elmualim and Alp (2016) are testaments to this allusion. The issue of cost in relation to sustainable construction is very critical. Most often, the barriers stems from the concerns that clients and developers have on who pays the additional cost associated with sustainable procurement (Emuze *et al*., 2015). Literature reveals that sustainable construction practices increases initial cost (Kat, 2003). These initial cost and the increased overall cost associated with sustainable projects is a limiting factor. Without doubt, making profits is one of the reasons driving any developers to invest his money on a particular project. While some investors and developers are aware of the need for sustainable construction and have ineterst in pursuing such, the high initial cost of procurement and the overall additional cost are placing a significant barrier on the implementation of sustainable construction practices. For instance, whenever a developer procures a particular building projects, such a developer aims to make some level of profit on his investment. However, the buyers who are looking for houses to buy, usually opt for the house with the least cost without considering the fact that more expensive houses might have been procured with a higher standard of methods and materials which would have inevitably affected the final cost of the project. Thus, the investors are critical to incorporate sustainability construction due to the additional cost involve and this create a significant barriers to the investors from considering sustainable construction. Apart from cost issue, lack of adequate knowledge and information on sustainability concepts as well as problem relating to education, training and experience were also found to be a critical challenge in the implementation of sustainable construction in SA. While it

is through that both government and industry are aware of the need for sustainable construction, literature revealed that its uptakes in SA have been slow. Moreover, professionals are lacking in the experience and knowledge of the application of sustainability concept (Emuze, 2015). The professionals lack of knowledge might be due to the fact that the concept is new and is undergoing a developmental stage within the industry. Nonetheless, the successful implementation of sustainable construction practices in any country still hinges on adequate knowledge, sufficient information and aggressive awareness creation (Miyake, 1996; Abidin, 2010; Saleh and Alalouch, 2015). Thus, it is important that more commitment should be channel toward spreading knowledge through informative campaings to different construction stakeholders. Delving further into the findings of this study, other limitations towards effective implementation of sustainable construction in SA are materials issues, technical knowledge barrier, problem with financing of sustainable construction and difficulty in obtaining loan for sustainable construction. It has long be recognised that one of the various factors that limit the realisation of sustainable practices is lack of knowledge among construction professionals and limited availability of sustainable materials (Abidin and Powmya, 2014; Shi *et al.,* 2013). On the one hand, the limited supply of sustainable materials and the high cost of the available ones significantly pose a serious challenge to effective uptake of sustaianble construction. On the other hands there are difficulty in ascertaining the performance of the available materials. This in turn affects the determination of the materials cost effectiveness and thus raising resistance to the adoption and implementation of sustainable construction application (Saleh and Alalouch, 2015). For any country to enjoy the benefits associated with sustainable construction, all the identified challenges must be adequately dealt with and overcome. The importance and benefits of sustainable construction must be made known to all construction stakeholders as well as the general public. The concept must be clearly stated and adequate explanation should be provided for proper understanding by the public. Thus, interactions with all the construction industry professionals to discuss the need to adopt more sustainable approaches within the industry practices need to be stressed.

5. CONCLUSION

Sustainability concepts has become vitally important subject worldwide and its application is gaining more and more acceptance in all facet of human activities including construction. Notwithstanding, the SA construction industry is still facing difficulties in the implementation of sustainability concepts. Consequently, this paper focused on identifying the barriers to effective implementation of sustainable construction in the South African construction industry. Twelve factors were identified from the literature and were examined. The data were gathered from the Gauteng province of SA being a province with largest record of construction activities. From the

obtained results, issues relating to high cost of sustainable materials, high cost of sustainable construction, high maintenance cost, lack of training/education in sustainable design, lack of expressed interest from clients (owner/developers), lack of knowledge where to find information on sustainable building methods, difficulty to obtain financing from banks for sustainable projects, non availability of green construction materials as well as lack of interest from project team members and lack of incentives (funding) for sustainable construction projects were found to be the major barriers to effective implementation of sustainable developments in SA. Although, the result of this paper is gathered from the Gauteng province of SA, the previous studies in the other parts of SA revealed similar challenges. Thus, it is very important that various construction stakeholders, government and non government organisation rise up to seek for possible measures that can mitigate these barriers and provide better support and information that can encourage diffent stakeholders to embrace sustainability ideas in order to advance the concept of sustainable development in SA.

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Challenges to Implementing Environmental Management Plans in Construction projects in South Africa

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ABSTRACT AND KEYWORDS

Purpose of this paper
The paper explores the challenges associated with the execution of environmental management plans (EMPs) on construction projects and the responsible project team members.

Design/methodology/approach
An integrative review of a purposive sample of literature exploring the inhibitors to proper application of EMPs on construction projects in South Africa and to identify the responsible project team members.

Findings
The study is part of a research degree project at theoretical study stage. Evidence from literature reviewed thus far indicates a lack of effective implementation of EMPs during construction phases of projects due to various challenges, such as alleged lack of adequate knowledge and positive attitude of project stakeholders, weaknesses and threats of the EIA process, and barriers to EMS implementation.

Research limitations/implications (if applicable)
Research is currently at a theoretical study stage.

Practical implications (if applicable)
The study highlights deficiencies in existing studies with regards to a comprehensive view on challenges to EMPs in construction projects, especially in the context of South Africa.

What is original/value of paper?
The study identifies the need to explore the compliance perspective on EMP implementation in construction projects in South Africa. The study also identifies the need for a more comprehensive conceptual framework to explore related issues of EMP implementation in projects generally.

KEYWORDS:
EIA, EMPs, EMS, Sustainable construction, Challenges, Project team

1. INTRODUCTION

Construction sites are often criticized for their undesirable impacts on the surrounding biophysical environment and the residents (Fuertes et al., 2013); and the social-economic dimensions of the environment (Celik and Budayan, 2016). This is mainly due to pollution and consumption of natural resources (Irizarry et al., 2012). Consequently, construction activities though crucial for socio economic development, creates negative perceptions due to the accompanying environmental damage (Tshiki, 2015).

Construction companies can play a crucial role in promoting sustainable development by assuming the responsibility to minimize the negative impact of their activities on environment and society (Tan et al., 2011). One way is to apply environmental management in projects, to ensure minimal environmental impacts for compliance with anticipated requirements of legal permits (Project Management Institute (PMI), 2003). This would depend on role players whose decisions result in the adverse impacts of construction activities. The role players generally refer to the project team, which includes the contractor, project proponents, the design team, and others ((Yusof et al., 2016b).

In developing countries, there is a paradox around sustainable construction due to high demand on infrastructure for socio-economic development (Halliday, 2007; Wessels et al., 2015). As noted in literature, the critical connection between development and the environment is ignored in many cases in the developing world (Halliday, 2007).

South Africa as a context faces enormous sustainability challenges despite embracing the sustainability concept (Morrison-Saunders and Retief, 2012). The country needs to balance the dire need for socio-economic development, and protecting the environment. The country's economic growth is largely dependent on the extraction of natural resources, resulting in gradual degradation of quality and functionality of such resources (Department of Environmental Affairs, 2012 a).

Environmental management practices can be legislated, in the case of environmental impact assessment (EIA), or adopted organisational policies, in the case of environmental management systems (EMS) such as ISO14001 (Bennett et al., 2016). The environmental management practices

are carried out through Environmental Management Plans (EMP) are considered as the practical link between EIA and EMS (Glasson et al., 2011). An EMP document which is prepared during the EIA process guides impact mitigation and management throughout the entire project life cycle (Baby, 2011). Literature however notes failure in environmental management by construction companies due to lack of (EMS) (Christini et al., 2004). Similarly Craigie in Wessels (2013) revealed cases of serious non-compliance at highly recognized ISO 14001 (EMS) certified facilities in South Africa.

2. THE STUDY

Most authors such as (Baby, 2011; Bennett et al., 2015) discuss the use EMPs more from a regulatory perspective. Thus there is scarcity of information from the compliance perspective; how the construction industry translates EMPs into their EMS.

In South Africa, existing research identifies gaps in sustainable construction legislation and the practice (Windapo and Goulding, 2015); high construction waste production and suboptimal implementation of waste management plans (Chikezirim and Mwanaumo, 2013); and cases of non-compliance to environmental management regulations in the construction industry (Department of Environmental Affairs (DEA), 2015).

Without much literature on the compliance perspective, there is scarcity of information on the root causes of documented cases in the context of South Africa. The current study is therefore focused on exploring the challenges to implementation of EMP on projects by construction companies. In so doing the negative influences resulting in non-compliance can be understood, leading to the formulation of suggested approaches improvements.

3. RESEARCH DESIGN FOR THE STUDY

An integrative literature review (Saunders et al., 2015) was used to address the issue of challenges associated with the proper execution of EMPs, searching with the following key words; sustainable construction, EIA, EMPs, challenges, and project team construction projects. The main focus was on EIA and environmental management systems in the construction industry. These two main knowledge areas were integrated in order to get a clearer view of the challenges around EMP implementation.

3.1 Findings and Discussions

Following the initial review of literature, the study identified some key categories under which to classify the factors which could negatively influence EMP implementation. Since EMPs link EIA and EMS, challenges of EMP implementation emanate from the EIA and EMS. Effectiveness of

EIA systems can be assessed using the strengths, weaknesses, opportunities and threats. Currently identified challenges to EIA systems, are discussed as weaknesses and threats of EIA, borrowing from SWOT analysis as described in Jha-Thakur and Fischer (2016); barriers to EMS in construction; and issues around key project participants. The findings are discussed below.

3.1.1 Identifying project participants in relation to EMP implementation

The paper identifies some of the key professionals involved with the implementation of EMPs on construction projects. In South Africa, environmental management plans are mandatory for both full and basic EIA authorization. Follow-up and monitoring of impacts during project implementation are also mandatory and are performed by the DEA and relevant national and provincial authorities (Campion and Essel, 2013). The proponent is responsible for effective management of impacts and usually outsources this task to an environmental specialist, environmental control officer or consultant, who then provides audit reports to the regulatory authorities (Patel and Giordano, 2014). However Morrison- Saunders et al (2012) note a great need to demonstrate the importance of EIA to proponents since they usually display negative perceptions about the EIA process. Independent Environmental Control Officers (ECO) are employed both on mandatory and voluntary basis (Department of Water Affairs and Forestry DWAF, (Wessels, 2015). The environmental control officer is responsible for ensuring the EMP is executed with due care and that all conditions in the environmental authorisation or record of decision are adhered to (Aucamp, 2009; Wessels et al., 2015). However it is the role of contractors' project managers to control the environmental impacts of project activities (Zutshi and Creed, 2015). There is also a client's project manager who performs his functions on behalf of a client, and in pursuit of the client satisfaction in the project (Walker, 2015).

Project managers have been blamed for focusing more on time, cost and quality while neglecting environmental impacts (Mishra et al in (Wang et al., 2015). However Nyihirani et al. (2014) in a Tanzanina study, highilighted low levels of awareness, and knowledge on EMPs, as reasons for EIA non-compliance.

3.1.2 Threats to the EIA process

Threats to the EIA process include; the lack of accurate measurement of indirect and cumulative impacts (DEA, 2016); Politicians viewing EIA as an obstacle to much needed socio-economic development, and public and private proponents viewing EIA as just a hurdle and therefore less important than profit even after authorisation, in South Africa (Sandham and Bond, 2015); Proponents'/developers' disregard for EIA recommendations due to lack of understanding of the purpose and

authenticity (Moja and Mnguni, 2014); and perceived cost and time constraints (Wessels et al., 2015).

3.1.3 Weaknesses of EIA systems

For the weaknesses, Morgan (2012) noted that the process is frequently blamed rather than the practitioners and other stakeholders involved (Morgan, 2012). DEA (2012) highlighted poor integration of environmental issues into development programmes, and skills shortage in South Africa's the environmental sector. Constraints from underfunding an understaffing at South African provincial and local authorities are compromising effective enforcement of monitoring and auditing (Sandham et al., 2005). Thus the follow-up stage is regarded as the weakest area of EIA (Wessels, 2013).

Other weaknesses noted in South Africa include; poor mitigation of social impacts due to more emphasis on biophysical impacts (Mafune in Wood, 1999), especially the disregard of social impact assessment in the EIA processes carried out locally (Bowd et al., 2015); lack of objectivity and independence of EIA Practitioners and ECOs (Sandham and Pretorius, 2008); lack of commitment to mitigation and monitoring of impacts in environmental impact reports (Sandham et al., 2013); lack of public environmental awareness and participation in the EIA process, and focus on non-relevant issues (Sandham and Bond, 2015).

3.1.4 Barriers to EMS in the construction industry

From literature on EMS implementation such as Campos et al. (2016), Owolana and Booth (2016), Schmidt and Osebold (2017), and Shen and Tam (2002); the following perceived and actual barriers to adoption and implementation of effective environmental systems in construction were derived. The identified barriers are associated with implementation of EMS by construction firms:

> Lack of knowledge about relevant EMS; lack of relevant training programs; senior management's resistance and employees' resistance to change habits and old work patterns; general low environmental awareness in the industry; lack of trained and experienced staff; lack of engagement and commitment of management; high cost of employing environmental consultants; lack of competition in the area of EMS adoption; perturbation of work flow; lack of client support; complexity and volume of documentation; cost increase due to registration and certification; time and cost constraints for adequate implementation of environmental protection; significant increase in management and operation costs; lack of cooperation of subcontractors due to lack of experience and familiarity; lack of supplier cooperation; limited influence of contractors in choosing environmental friendly materials; non-specification of environmentally friendly materials; lack of required technologies within organizations; lack of monitoring; the need to adapt EMS standards to suit the

construction industry more; and lack of government enforcement and incentives.

4. CONCLUSION

The study purposed to investigate challenges around EMP implementation, with special focus on South African. A definite gap in the implementation of EMPs in construction projects in South Africa has been identified through existing literature. Further review of literature led to the identification of categories for classification of relevant factors: weaknesses and threats of EIA, and barriers to EMS in construction. It was also determined that key project participants and the factors directly related to them need to be identified. Following the outlined methodology, the key factors contributing to the challenge of the implementation of EMPs on construction projects were identified and categorised accordingly. However considering the factors there is a major gap in the lack of adequacy of information from the compliance perspective. Currently the regulatory perspective is addressed for the most part. The regulatory perspective concentrates improving the EIA process, while viewing contractors as passive agents follow all the requirements stated in the EIA outcomes despite the quality of EMPs. Since contractors carry the burden of implementing recommendations stated in EMPs, their challenges are also critical to the success of impact management.

The current study is presented at a literature review stage. No comprehensive framework for studying issues of EMP implementation, has been identified, which consciously accommodates both regulatory and compliance perspectives. It is therefore necessary to study EMPs from a compliance perspective in order to create a clearer picture of the challenges around implementation of EMPs. It is further suggested that a conceptual framework for identifying challenges of implementing EMPs on construction projects, from both regulatory and compliance perspectives is required. It would therefore be beneficial to develop the conceptual framework; gather and analyse empirical evidence on the challenges to implementing EMPs in South African construction projects, from a compliance perspective; gauge possible mitigations for compliance side challenges, from stakeholder views; and to derive recommendations for policy and regulatory changes, and most importantly improvements in compliance.

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Delivering construction projects using innovative building technologies

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ABSTRACT

Purpose
This paper presents a project delivery model developed for use by public sector clients tasked with using innovative building technologies (IBTs) in lieu of conventional building technologies (CBTs) in the delivery of social infrastructure projects.

Methodology
The data were obtained from international and national construction procurement literature; Agrément South Africa publications; and CSIR Built Environment research on IBTs. A comparative analysis of the fit between the standardised contracting and procurement arrangements for CBTs; and Agrément South Africa Conditions of Certification for IBTs identified which activites to maintain; which activities to alter; and gaps to fill to align public sector project delivery with The Conditions of Certification. The insights gained from the analysis served as an input to develop an IBT-specific project delivery model.

Findings
Substituting CBTs with IBTs has major implications for contracting and procurement arrangements, in particular, choice of contracting strategy, scope of professional services and form of contract.

Limitations
The research is only applicable to Agrément South Africa certified building systems, herewith referenced as IBTs.

Value
This paper contributes to South African research on non-standardised construction subjects. The findings are of value to policy-makers, researchers and construction stakeholders

Keywords:
Building technologies, public sector, project delivery, construction procurement, social infrastructure

Sub Theme:
Public sector procurement and contracting

1. INTRODUCTION

1.1 Background

An important national objective for South Africa in the post-1994 period is to eradicate the backlog of social infrastructure, particularly with regard to clinics, schools and student residences. The South African building sector has a critical role to play in achieving this objective. Unfortunately, the sector relies predominantly on conventional building technologies (CBTs), that is, brick and mortar constructions that are slow to build due in large part to the time-consuming curing periods associated with wet work.

In April 2013 the Council for Scientific and Industrial Research: Built Environment (CSIR BE) made a presentation to the Presidential Infrastructure Coordinating Commission (PICC) highlighting the potential role that Agrément South Africa (ASA) certified innovative building technologies, hereafter, “IBTs” could play in speeding up the delivery of infrastructure projects. Following this presentation, PICC commissioned a preliminary CSIR BE study which was completed in July 2013. The study found that as compared to CBTs, the advantages accruing from project delivery with IBTs include but are not limited to a lower construction costs; a shorter construction period; and enhanced building quality (Van Wyk, 2013).

In August 2013, Cabinet resolved that IBTs be used for the delivery of some of government’s social infrastructure projects, that is, schools, clinics and student residences. The resolution stipulated that the porportion of social infrastructure programmes completed using IBTs would gradually be phased in to 60% over a period of three to five years, starting with the implementation of a limited number of IBT-based schools and clinics in the 2013/2014 financial year (Van Wyk, 2016).

Given its long standing acceptance as the standard in South African, the public sector project delivery model has been developed and

standardised over time with brick and mortar construction in mind. Hence, public sector clients tasked with implementing the Cabinet resolution require information and guidance on infrastructure project delivery with IBTs.

1.2 Innovative building technologies defined

The use of building materials and technologies in South Africa is controlled by the National Building Regulations and Building Standards Act 103 of 1977, hereafter, “The Act”. There are three routes to compliance with The Act, namely, meet the deemed-to-satisfy provisions of the regulations; undertake rational design; or undergo Agrément South Africa (ASA) certification (ASA, 2010).

The deemed-to-satisfy provisions, which are supported by building standards published by the South African Bureau of Standards (SABS), are concerned with standard subjects (ASA, 2001) referenced in this paper as CBTs. The rational design provisions of The Act are concerned mostly with safety.The mandate of ASA is to evaluate and certify the fitness-for-purpose of non-standard subjects – building materials; building components; and building systems – to which the deemed-to-satisfy provisions of The Act cannot be applied directly, and for which no SABS standards exist. The Board of ASA grants two types of certificates to non-standard subjects – an Agrément Certificate or a Minimum Agrément Norms and Technical Advisory Guide (MANTAG) Certificate. The term innovative building technologies (IBTs) as used in this paper is limited to building systems that have been granted an Agrément Certificate and are listed at https://www.agrement.co.za

1.3 Objective

This paper presents a project delivery model developed for use by public sector clients tasked with using innovative building technologies (IBTs) in lieu of conventional building technologies (CBTs) in social infrastructure project delivery. The IBT-specific project delivery model forms part of the research output from a study that developed guidelines for key construction stakeholders on how to use IBTs in project delivery.

1.4 Methodology

1.4.1Data sources

The data were obtained from international and South African construction procurement literature; Agrément South Africa sources; and CSIR Built Environment research relating to the use of IBTs.

1.4.2 Data interpretation

The existing project delivery model for CBTs comprises three core processes – project initiation; project implementation; and project completion (SAICE/CIDB, 2004a; CIDB, 2007a). The contracting and procurement activities which could potentially influence the success or failure of project delivery are carried out during project initiation and project implementation. Project completion is limited to contract completion and reporting – hence, a switch in building technology from CBTs to IBTs should not influence project completion. The contracting and procurement activities, termed "contracting arrangements" and "procurement arrangements" in this paper, have been used as a basis to conduct a comparative analysis of CBTs and IBTs with a view to identify:

- Activities to be maintained when CBTs are substituted with IBTs;
- Activities to be altered when CBTs are substituted with IBTs; and
- Gaps in the existing activities that need to be filled to align public sector project delivery with the Conditions of Certification for IBTs.

The insights gained from the comparative analysis of CBTs and IBTs were used as an input to develop the IBT-specific guidance and project delivery model presented in this paper.

2. COMPARATIVE ANALYSIS OF CONVENTIONAL AND INNOVATIVE BUILDING TECHNOLOGIES

This section uses the contracting and procurement arrangements which underpin South African project delivery to conduct the comparative analysis of CBTs and IBTs. The contracting arrangements are concerned with selecting contract strategies; pricing strategies; and forms of contract. The procurement arrangements identify the processes to be followed to solicit tender offers from and to conclude contracts for the provision of professional services; and construction and/or maintenance services.

2.1 Contracting arrangements for The Works

2.1.1 Works contract strategy

A contract strategy is the strategy which is adopted by an organisation to procure engineering and construction works, hereafter "The Works" in the most advantageous and cost effective manner (SAICE/CIDB, 2004a). Contract strategies differ from each other in the way that the risks for design and construction are shared (Wearne, 1989; CIDB, 2007a); and what degree of completeness of design is required before construction starts (CIDB, 2007a). The Contract strategy has a major impact on the time to construct, the cost to construct and the quality of a given project (Bower, 2003).

Box 1[1]: Exerpt from Agrément Conditions of Certification for building systems[2]

"The building system described in this certificate must (i) be designed by the Certificate Holder; (ii) be erected by the Certificate Holder or a Licensee[3], provided that the Licensee is appointed by the Certificate Holder and registered as such with Agrément South Africa; (iii) be constructed in accordance with the technical description set out in Part 3 of the Agrément Certificate, the Certificate Holder's detailed specifications and the quality management documentation; (iv) comply with the Conditions of Certification. Any person required to check on details of construction must refer to the documentation listed above, which is available from the Certificate Holder".

The Design-by-Employer contract strategy, in terms of which the building contractor undertakes only construction on the basis of full designs issued by the employer (SAICE/CIDB, 2004b), has been the historic approach to delivering CBT projects in the public sector. However, the Agrément South Africa Conditions of Certification, hereafter, "The Conditions of Certification" call for the IBT certificate holder to bear both the design and constructions risks; or assign the construction risks to a licensee. Hence, the traditional Design-by-Employer contract strategy is not suitable for delivering IBT projects.

This study investigated the fit between the Conditions of Certification; and other standard contract strategies endorsed by the *CIBD*

[1] This statement appears in Part 1 of the Agrément Certificate of every IBT.
[2] In this paper, IBT is used interchangeably with building system.
[3] The Lincensee is a building contractor who is (i) registered in an appropriate category of the CIDB Register of Contractors; (ii) has been certified by the Certificate Holder as a Licensee; and (iii) has been registered as such with Agrément South Africa prior to site handing over.

Standard for uniformity in construction procurement (CIDB, 2010), hereafter, *CIBD Standard for uniformity*. The findings are that Design-build and Develop-and-construct contract strategies assign both design and construction risks to the building contractor (CIDB, 2007a); and hence, align most closely with The Conditions of Certification. Nevertheless, Design-build and Develop-and-construct are not suitable contract strategies for IBT projects. The single point of accountability for design and construction on which these alternative contract strategies are founded implies that the construction risks cannot be assigned to a licensee. Thus, the provision of construction services on IBT projects would be set aside for only IBT certificate holders, potentially violating the fairness requirement of South African procurement regulations.

This study concluded that a non-standard contract strategy which requires the IBT certificate holder and a licensee to bear the design risks and the construction risks respectively would provide the best means to comply with national procurement prescripts and The Conditions of Certification of IBTs.

2.1.2 Works pricing strategy

A pricing strategy is the approach adopted by the Employer to secure financial offers and to remunerate the building contractor in terms of the building contract (SAICE/CIDB, 2004a). The standard pricing strategies recommended for use with the Design-by-Employer contract strategy are bills of quantities, activity schedule and target cost (CIDB, 2011; CIDB, 2005).

As compared to the abundant guidance on pricing strategies for CBTs, The Conditions of Certification are silent on pricing strategies for delivering IBT projects. However, this study found that the three standard pricing strategies are compatible with The Conditions of Certification. Furthermore, target cost, which is predicated on single point responsibility for construction and maintenance, is the best pricing option for deliverying IBT projects; and creating an enabling environment for the predicted building service life to be achieved.

2.1.3 Works form of contract

The standard forms of contract recommended for use by public sector clients delivering CBT projects are (CIDB, 2005):

- General conditions of contract, 2004 edition (GCC 2004);
- Joint Building Contracts Committee Series 2000 contract (JBCC 2000);

- International Federation of Consulting Engineers contracts, 1999 edition (FIDIC 1999); and
- New Engineering Contracts, third edition (NEC3).

The GCC 2004 and JBCC 2000 standard forms of contract are most suitable for use with the Design-by-Employer contract strategy (CIDB, 2005). The FIDIC 1999 and NEC3 standard contracts make provision for the full range of contract strategy options including Works designed by the employer; Works designed by the contractor; and Works designed by a management contractor.

Based on analysis of the literature, this study found that each of the standard Works contracts endorsed by the *CIDB Standard for uniformity* assumes two contracting parties – the employer; and one building contractor. However, a public sector employer delivering projects with IBTs is obliged to conclude contracts with two contractors, namely, The IBT certificate holder, to provide a design service termed "technical design service" in this paper; and a licensee, to provide construction services.

The study concluded that the standard forms of contract are appropriate for procuring construction services from the licensee; and that a Service Level Agreement represents the best available means to procure a technical design service from the IBT certificate holder.

2.2 Contracting arrangements for professional services

It is common practice for public sector clients to appoint professional service providers (PSPs) – typically, architects, civil/structural engineers and quantity surveyors - to act as Employers' agents in the delivery of The Works. The contracting arrangements for PSPs require the employer to decide on the professional services contract strategy; and to use this information to select a project-specific professional services contract (PSC).

2.2.1 Professional services contract strategy

The risks accepted by the public sector employer in respect of The Works will determine the type of professional services required; the scope of professional services; and hence, the professional services contract strategy. The traditional position when delivering CBT project is that the employer bears design risks; and the contractor bears construction risks (Wearne, 1989).

However, The Conditions of Certification shift both design and construction risks to the IBT certificate holder. This study found that the

implications for the professional services contract strategy on IBT projects are that:

- The design professionals – architects and structural engineers – should provide a reduced scope of professional services, tailored to avoid conflict with the design mandate of the IBT certificate holder
- The non-design professionals – quantity surveyors and project managers – are not affected by the new design mandate of the IBT certificate holder

2.2.2 Professional services form of contract and pricing strategy

Public sector clients delivering CBT projects have a choice of two standard professional services contracts (PSCs), namely, the NEC3 Professional Services Contract and the CIDB Professional Services Contract (CIBD, 2010).
Based on the findings from the previous section, design professionals, that is, architects and engineers will be subjected to reduced scope of professional services due to the new design mandate of the IBT certificate holder. Any reduction in scope of professional services should however not preclude the use of an amended version of a standard PSC when delivering IBT projects.

2.3 Procurement arrangements

2.3.1 Works and services procurement procedure

A procurement procedure is the procedure selected for the solicitation of tender offers in a specific procurement (SAICE/CIDB, 2004a). A public sector client tasked with delivering CBT projects would solicit tender offers for the provision of two types of services, namely: standard professional services; and standard construction and/or maintenance services. However, when delivering IBT projects, the Conditions of certification oblige the public sector client to procure a third type of service – a design service – from the IBT certificate holder.

This study scrutinised standard procurement procedures set out in The *CIDB Standard for uniformity* and found none to be suitable for procuring a technical design service from IBT certificate holders. Previous research by Ampofo-Anti et al (2013) highlighted the need to first select an appropriate IBT – based on climate considerations, building performance; and supply chain management information; and thereafter, obtain technical design inputs from the certificate holder. Based on this consideration, the

present study concluded that a Call for Expression of Interest provides the best means to first select the most appropriate IBT for project delivery and thereafter obtain the desired technical design service from the certificate holder.

2.3.2 Works and services tender evaluation methods

Historically, price was the sole criterion relied on to solicit tender offers from potential service providers. However, the inclusion of other, additional criteria to facilitate the selection of the most advantageous tender is now widespread internationally (CIDB, 2007b). Thus, the Preferential Procurement Policy Framework Act (PPPFA) No. 5 of 2000 and its Regulations of 2001 require all procurement to adhere to a preference point system whereby tenders are evaluated on the basis of quality (functionality), preference and price.

The *CIDB Standard for uniformity* endorses four standard tender evaluation methods, namely, Method 1: Financial offer; Method 2: Financial offer and preferences; Method 3: Financial offer and quality; and Method 4: Financial offer, preferences and quality. The appropriateness of using standard tender evaluation methods to evaluate tender offers for the provision of professional services, construction services and technical design services on IBT projects was investigated. The results confirm that the standard tender evaluation methods are applicable to tender offers for professional services; and construction services but not to a Call for Expression of Interest in respect of technical design services.

2.3.3 Quality strategy

Quality relates directly to the goods, service or supplies being procured (CIDB, 2007b). The introduction of quality into the solicitation and evaluation of tender offers provides a viable means of managing construction risks without violating the requirement that procurement of goods and services be fair, equitable, transparent, competitive and cost effective (CIDB, 2007b). The South African construction procurement literature, including, but not limited to the *CIDB Standard for Uniformity* (CIDB, 2010) and *SANS 294: Construction procurement processes, methods and systems*, 2004 provide abundant guidance on appropriate quality strategies and quality criteria as pertains to the procurement of standard services for CBT projects. Given the non-standard nature of IBTs similar guidance is lacking.

This research study investigated the requirements for incorporating quality into the procurement of IBT projects. The results indicate that the available guidance on quality strategies for standard services does not

conflict with the Conditions of Certification. However, the procurement of technical design services from IBT certificate holders would need to comply with Agrément South Africa (ASA) quality requirements, in particular (ASA, 2010; ASA 2001) an IBT that is shortlisted for tender award must be listed as “Active” on the Agrément South Africa website; and must be certified for erection of buildings in the occupancy class of the proposed project. Furthermore, the IBT certificate holder should have an ASA approved quality assurance system in place which conforms to an ISO 9000 standard.

3. SUMMARY OF REQUIREMENTS FOR PROJECT DELIVERY WITH IBTS

Using IBTs instead of the more familiar CBTs as a basis to implement social infrastructure projects would cause a fundamental shift in the public sector approach to project delivery – from an employer-led to a contractor-led approach. The major impacts on the established contracting and procurement arrangements are that PSPs must be appointed to provide partial services only; and the IBT certificate holder, who bears the risks for design and quality of the finished buildings, becomes an additional party to the building contract. It follows that the public sector employer must appoint two building contractors when delivering IBT projects – the IBT certificate holder, to provide technical design and quality management services; and a licensee, to provide construction services and preferably, future maintenance services. The choice of contracting and procurement arrangements needs to be guided by the Conditions of Certification for IBTs.

4. RECOMMENDED MODEL FOR PROJECT DELIVERY WITH IBTS

To maintain the established tradition of employer-led project delivery in the South Africa public sector, a new, IBT-specific version of the Design-by-Employer contracting strategy depicted in Figure 1 is proposed. To satisfy the Conditions of certification for IBTs, a two-step contractor appointment strategy is proposed.

In the first step, the Employer uses a Call for Expression of Interest, advertised at the initial design stage, to select an appropriate IBT for the delivery of the proposed project. The Employer enters into a Service Level Agreement (SLA) with the IBT certificate holder for the provision of technical design services. PSPs are also appointed at the initial design stage, based on reduced scope of services, standard procurement procedure and standard forms of contract. The PSPs prepare the conceptual design. To meet the Conditions of Certification, design

development and design documentation are carried out by the PSPs with significant inputs from and sign off by the IBT certificate holder.

In the second step, the PSPs complete the procurement documentation with sign off by the IBT certificate holder. The Employer uses a standard procurement procedure to solicit tenders for the construction of the proposed project; and enters into a contract with the building contractor for the construction and maintenance of the proposed IBT project. To satisfy the Conditions of Certification:

- The building contractor is trained and certified as a Licensee by the IBT certificate holder prior to site handing over;
- The IBT certificate holder carries out site audits from time to time during the construction process;
- The PSPs supervise the construction process provided that no variation orders are issued or executed without prior consultation with and sign off by the IBT certificate holder.

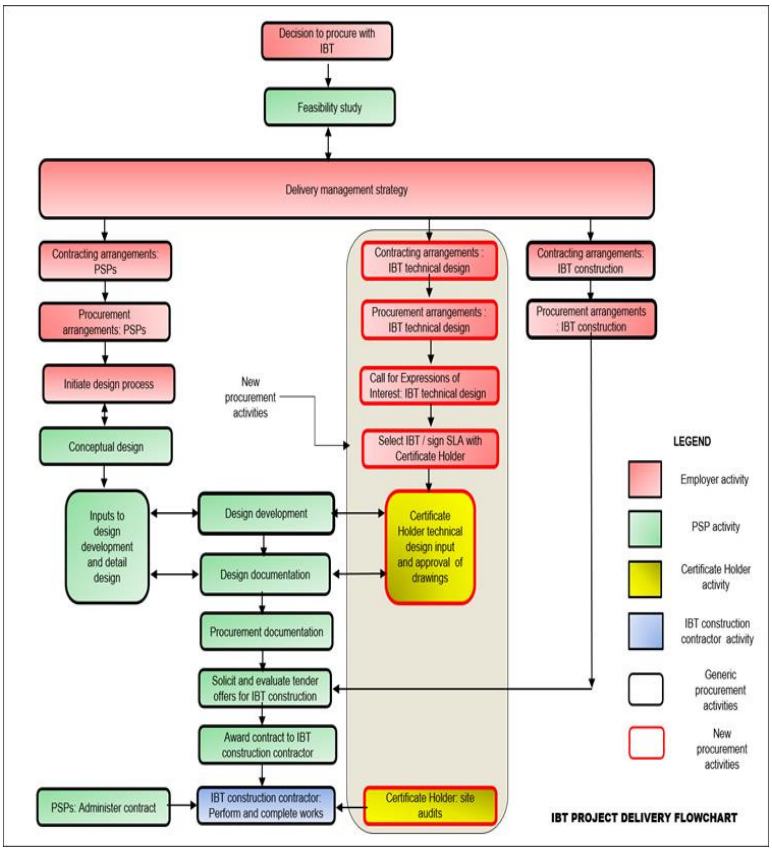

Figure 1: IBT delivery flowchart

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Industry perceptions on cost implications of going green in sustainable human settlements

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ABSTRACT AND KEYWORDS

Purpose of this paper
This study is aimed at determining how the delivery of human settlements in South Africa can be enhanced to become more sustainable in terms of costing. It also seeks to establish the social and economic implications of going green in human settlements as well as determine the barriers and challenges.

Design/methodology/approach
The various benefits, drivers, barriers and methods of green construction, with specific reference to sustainable human settlements (SHS), were sourced from literature. An empirical study was followed up using face-to-face interviews with purposively selected SHS development stakeholders in the Free State and Gauteng provinces.

Findings
Key findings highlights barriers and challenges of housing delivery which includes a lack of knowledge, skills or experience regarding the cost and effective implementation of green construction practices and procedures related to SHS that may have a negative influence on the construction industry's reputation regarding green building.

Research limitation/implications
This study was limited to the Free State and Gauteng regions and interviews were conducted with stakeholders that were actively involved in human settlement projects.

Practical Implications
It is expected that the outcome of this study will be a valuable source of information for construction industry stakeholders in promoting 'greening' in the industry. Developers, implementers and decision-makers may find information useful for planning and implementing environmentally friendly human settlements.

Value of paper
The study provides useful insights and information for developers, implementers and decision-makers regarding the cost of going "green" which includes building methods, materials and design of use in planning for SHS. Knowledge of the possible green construction practices and procedures in the construction industry may be beneficial to improve the quality of life for housing beneficiaries.

Response to conference theme
Green Building

KEYWORDS: Green construction, sustainable human settlements, cost, drivers and barriers of green construction.

1.1 INTRODUCTION AND BACKGROUND

South Africa faces a challenge regarding the acceleration of housing delivery. Although many plans and programmes regarding this issue are currently in place, pitfall exists in the implementation (Sutherland *et al*., 2016). The challenges faced by the South African Government include the housing backlogs and social and economic segregation (South African Cities Network, 2014). The need for additional funding and land availability adds to this challenge.

Integrated Human Settlement Development seems to be the most appropriate way of delivering housing in a sustainable manner and to simultaneously address the development goals of the South African Government (South African Cities Network, 2014). According to President Jacob Zuma, the provision of housing within sustainable, integrated settlement is a critical pillar of the country's growth and development strategy (Times LIVE, 2010: Online).

This research aimed at determining how the delivery of human settlements in South Africa may be enhanced in terms of costing to become more sustainable.

The study contributes to the conference theme in that it addresses green building aspects in terms of low income housing and the accompanying delivery challenges.

2.2 CHALLENGES AND OPPORTUNITIES OF SUSTAINABLE HUMAN SETTLEMENT DEVELOPMENT

2.2.1 Barriers to sustainable human settlement development?

Sustainable development should attempt to minimize the barriers and maximize the drivers of sustainability. Several authors identified barriers to sustainable development as summarized in Table 1 below.

Table 1: Barriers to sustainable design and construction

Economic	Social	Environmental
Cost premiums	Rules of competition and tendering	Lack of awareness from clients (owner/developer)
Cost of energy from ESKOM and local governments	Public policies that fail to encourage the most energy-efficient approaches and practices	Limited sustainable knowledge and understanding from contractor and subcontractors
High cost of materials and products	Possibilities to apply integrated design processes	Lack of knowledge and understanding from design professionals
Split incentives between building owners and users	A lack of knowledge and ignorance	Unfamiliarity of materials and products
Affordability	A lack of demand and drawbacks	Limited supply of materials and products
Recovery of long-term savings not reflected in service fee structure	Concerning warranties and risks on non-standard sustainable materials and methods	Inefficient awareness and understanding of energy efficiency
Access to finance	Tendency to maintain current practices	
A lack of transparency of energy use and cost	Conflicting public policy and/or regulations	
A lack of adequate offers	Lack of an integrated work environment among stakeholders	
Long payback periods	Awareness	
	National and provincial government capacity	
	Government regulations	
	Functioning of value chains	
	Delays and poor enforcement of policies and building codes	
	Complexity and fragmentation in the building value chain	

Source: (Adapted from Klunne (2002), Ahn, *et al.* (2013), Hakkinen and Belloni (2011) and WBCSD (2009))

The World Business Council for Sustainable Development (WBCSD, 2009) suggest that major barriers of green building are those that allow and encourage inefficient use of space heating, including: construction

practices that produce inadequate building envelopes and building codes that are weak; lack of systematic and rigorous enforcement of building energy codes; a lack of incentives to save energy and out-date heating system design and a lack of proper heating controls. Henn and Hoffman (2013) asserts that the integrative approach to green construction represents a new process that promises tight integration of systems.

2.2.2 International critical factors for success

A variety of critical success factors (CSF) have been established for the delivery and provision of sustainable social housing developments in various countries. Ihuah, *et al.* (2014) ranked CSF as indicated in the Table 2.

Table 2: Critical success factors for sustainable public housing delivery and provision in Nigeria

Rank	Critical Success Factors (CSF)	Rank	Critical Success Factors (CSF)
1	Competent project team	**12**	Project understanding
2	Land issues	**13**	Project mission/common goals
3	Effective housing policy implementation	**14**	Project information/communication
4	Housing project ownership	**15**	Project team composition
5	Top management support	**16**	Adequate project planning
6	Adequate project fund and resources	**17**	Weather condition
7	Adequate project monitoring and feedback	**18**	Project risk management
8	End users involvement/inclusion	**19**	Cultural difference
9	Project manager/leader authority	**20**	Adequate project control
10	Realistic project cost and time estimates	**21**	Project site condition
11	Building materials and its increasing cost	**22**	Project problem solving abilities

Source: (Ihuah, *et al*., 2014)

From Table 2 it may be observed that the most prominent CSF for sustainable public housing delivery and provision are competent project teams, land issues and effective housing policy implementation. The least prominent CSF that are highlighted include adequate project control, project site conditions and project problem solving abilities. It would be beneficial to focus efforts on improving CSF that are ranked as more prominent.

3.1 METHODOLOGY

Creswell (2013) states the qualitative research is an approach for exploring and understanding the meaning that individuals or groups ascribe to a social or human problem. In the present study, the emphasis is on

obtaining information from various stakeholders concerning their experiences during their participation in the delivery of SHS in South Africa. Accordingly, the qualitative approach appears to be most suitable for this kind of data elicitation as it enables the individuals to share their experiences without restrictions.

As this study was aimed at identifying the perceptions of stakeholders in SHS developments, a phenomenological research design was adopted and purposive sampling method used. In accordance with Saunders *et al*. (2009) and Creswell (2013), this sampling was chosen in order to select knowledgeable participants who have participated on SHS developments particularly the case studies in order to add value.

The data presented was obtained from interviews conducted with various key persons identified during the study on a "snowballing" basis. Only persons with authority and relevant experience in SHS developments were interviewed. The sample distribution is shown in Table 3 and was deemed adequate for the purposes of the study. The principle of voluntary participation was upheld in the interviews.

Table 3: Demographics of interviewees

Interviewee	SHS Involvement	Occupation	Highest Education Level
1	Cosmo City and Savanna City	Development Director	Degree
2	Cosmo City and Savanna City	Property Development Manager	Post Graduate Degree
3	Cosmo City and Savanna City	Architect	Post Graduate Degree
4	Cosmo City and Savanna City	Town Planner	Degree
5	Social Housing	Project Manager	National Diploma
6	All SHS projects in Motheo and Xhariep District, Free State Province	Senior Home Inspector	National Diploma
7	Mdantsane Cluster and 5 projects in Free State Province	Contract Manager	National Diploma
8	Various projects in Free State, Eastern Cape Province	Operations Manager	National Diploma

Source: (Greyling, 2016: Author's Own Compilation)

The interviews were recorded textually and then organized by breaking them into smaller units. Thereafter, the statements were grouped into categories of which 12 themes emerged following the interview transcription. However, for purposes of this paper only 5 of the 12 themes are discussed due to limited scope as shown in Table 4.

4.4 FINDINGS

The findings are shown in Table 4 and discussed below.

Table 4: Emerging themes from the Interviews

Theme No.	Theme
1	Knowledge and experience among stakeholders
2	Social factors and perceptions in sustainable human settlements
3	Economic factors and perceptions in sustainable human settlements
4	Environmental factors and perceptions in sustainable human settlements
5	Challenges and barriers to sustainable human settlements

Source: (Greyling, 2016: Author's Own Compilation)

4.4.1 Theme 1 - Knowledge and experience among stakeholders

Theme 1 is about the knowledge and experience levels of the various stakeholders who participated in the study regarding green construction in SHS. The question asked assessed the level of knowledge and experience particularly relating to the planning and implementation of greening strategies in housing developments.

The majority of respondents rated their own knowledge and experience, in terms of planning and implementation of green construction practices in SHS, as limited. From responses it was clear that knowledge and experience was even more limited among participants in the Free State province, when compared with participants in the Gauteng province. Many participants in the Free State reported that they had not previous or current projects been exposed to greening.

It emerged that Cosmo City was one of the very first integrated human settlement developments in South Africa and consequently, the experience among stakeholders with regard to greening was practically nil. It appeared from interviewee responses that, knowledge regarding the planning and implementation of greening on construction projects was higher when compared to housing projects only.

One of the participants emphasized that they would rather appoint knowledgeable people in the area of greening. Another participant highlighted that inputs from various project participants adds to the overall knowledge base. From responses it emerged that there is also a need for end-user (beneficiary) and community education.

Respondents had various opinions regarding information sources that are currently available in terms of greening in SHS. Some respondents were in agreement that most suppliers are concerned, principally with marketing their specific product and can provide little information on technical aspects regarding their product. The common sources which respondents would use were found to be; internet, speaking with other consultants, suppliers, sub-contractors, practical visits of similar projects, CSIR, DHS, GBCSA and proven technologies.

Limitations within the current information sources were also discussed. Respondents were in agreement that the information does exist, however the visibility of the information is limited.

The findings captured under this theme suggest that there is still to a large extent limited knowledge among SHS stakeholders of green construction practices within SHS. This suggests that information should be

made more visible to all stakeholders and this should happen on a variety of forums. There is also a great need for improved information sources and it may be suggested that there is need and opportunity within the SHS industry to provide quality information to stakeholders. It was also emphasised that experience with green construction practices within SHS should become increasingly better as industry is shifting towards green construction strategies.

The interview responses are supported by literature, which lists a lack of knowledge, limited sustainable knowledge and understanding from the contractors and design professionals, unfamiliarity and limited supply of sustainable materials and products, lack of an integrated work environment among all stakeholders and a lack of awareness as barriers to sustainable development (Klunne, 2002, Ahn, *et al*., 2013, Hakkinen and Belloni, 2011 and WBCSD, 2009)

4.4.2 Theme 2 - Social factors and perceptions in sustainable human settlements

In this theme various perceptions, specifically regarding socials aspects in SHS are discussed. The focus of this theme is on the perceptions of and impacts on the beneficiaries of SHS.

Respondents were in agreement that communities should be approached for their inputs in SHS. It was found that there is a lack of education among beneficiaries regarding green construction and the benefits inherent to them. It emerged that beneficiaries do not want social housing, which was supported by the statement: “they (the beneficiaries) literally run away when they see that they have been awarded units in social housing”. The study established that there needs to be a change in the perceptions of beneficiaries of subsidized housing. They need to view it as gaining an asset. It was confirmed by some respondents that decisions to implement green strategies on a project are dependent on the end-use perceptions and that end-user perceptions receives some consideration.

It also emerged that there are questions that, should greening be implemented in SHS and the units are then sold or rented, would the end-users be able to afford the higher premium that a green unit would be charged. There is also a perception in the industry that green construction reduces the use of labour, and that the DHS is vested in providing job opportunities and that this may be the conflict which leads to the lack of implementation of green construction in SHS.

There is a lack of education among beneficiaries regarding green construction within SHS. This should be addressed; however, the correct forums are to be established. It was also highlighted that the communities should be provided an opportunity for inputs in terms of the development of new SHS projects. Community involvement should also be encouraged in terms of job creation and contractors are to make use of labour intensive practices, whilst still using green construction practices, to ensure community upliftment.

The findings above are corroborated by the literature, which lists end-user involvement and inclusion as well as cultural differences as critical factors for the successful delivery an d provision of sustainable social housing developments (Ihuah, *et al*., 2014).

4.4.3 Theme 3 - Economic factors and perceptions in sustainable human settlements

This theme exposes the perceptions among stakeholders regarding high costs in terms of the implementation of greening in construction-related projects.

There was a general feeling that the costs involved in green construction is higher than conventional construction. This can be seen by the typical interviewee response: “There is definitely a financial implication, specifically solar geysers cost more than normal geysers”. Respondents also emphasized that the higher subsidy quantum on SHS is proof that green construction is more expensive. One respondent commented that greening increases total development costs by between 15 – 20%. Respondents confirmed that the installation of certain greening strategies, such as solar geysers, glazing and insulation, does in fact add to the project costs. It emerged that the subsidies on projects such as Savanna City were increased from R68,000.00 to R110,000.00 specifically to allow for greening.

From interviewee responses, it became clear that the financial implications are the main consideration in the decision to go green on a development. This can be evidenced from typical interviewee response: “As is stands currently greening is more expensive when compared with traditional building methods and materials”. It was also noted that the provincial government was the financier on the Savanna City project and that the decision to implement greening was based on the additional allowances from the financier. It was emphasized that sustainability revolves around economies and not around greening.

From interviewees it was suggested that capital investments need to be compared to the possible savings that may be gained from green installations. It also emerged that professional fees are also increased as some professionals load their fees on green construction projects, contributing this increase to additional services. It was stated by respondents that there was consensus among all project stakeholders regarding the cost implications of going green and it was proposed that the fact that the provincial government increased the subsidy amount is evidence that even they are in agreement.

Some respondents stated that stakeholders do not shy away from greening as there is a realization that it must be made to work. It was also reasoned by respondents that stakeholders should see greening strategies as part of the development costs. From responses, specifically relating to the Savanna City project, it was revealed that quantity Surveyors were

urged to become creative when catering for sustainable development, specifically in terms of economic implications.

There is a perception that an increased demand in green developments would reduce the costs of green construction. The study established that LCC is to be included for the initial capital outlay to be justified.

Other revelations from the study include that there are passive green principles that may be implemented in SHS that do not contribute to the costs. However, the majority of participants vigorously stated that there is simply no money for implementing green construction in SHS.

It seems that financial resources currently govern the implementation of green strategies in SHS. Government should consider increasing the subsidy quantum to specifically allow for greening strategies. There is a need for professionals to become involved in ensuring the implementation of green construction practices within SHS. Designers are to become involved in implementing design principles that have little implication on the project costs. Quantity surveyors (or other estimating parties), should become informed of lifecycle costing and should implement this on projects and present it to the clients/decision-makers to justify the initial capital outlay required for greening strategies within SHS.

The literature substantiates these findings. Various authors listed the following as barriers to sustainable development; cost premiums, high costs of sustainable materials and products, affordability, access to finance such as bridging finance (Klunne, 2002, Ahn, *et al*., 2013: 39, Hakkinen and Belloni, 2011 and WBCSD, 2009).

4.4.4 Theme 4 - Environmental factors and perceptions in sustainable human settlements

This theme focuses specifically on environmental factors in SHS. It also looks at perceptions of various stakeholders in terms of the environment.

From responses, it emerged that consensus exists that green construction is viewed as a good idea. It was found that respondents agreed that there was scientific evidence to prove that green construction should be seen as a priority. However, it was also noted by respondents, that there was a certain hype regarding greening that have taken people by storm.

There was a general agreement that there is high pressure on the national electrical grid and some severe measures need to be taken in order to manage the increasing electricity demands. The study revealed that respondents were considering other alternative power sources, including gas and wind.

Respondents revealed that greening was implemented on the Cosmo City project to a very limited extent, but was included in the Savanna City project. Many respondents, especially those active in the Gauteng Province, revealed that most environmental measures taken in SHS,

included the provision of green areas, such as trees, parks, cycling and pedestrian lanes. It became evident that besides solar geysers, very few measures considered green construction practices.

It seems that there is some consensus within the industry that greening is seen and a good idea. This is supported by numerous literature sources that recorded scientific evidence such as St. Claire (2011). There is base knowledge on the fact that green construction is necessary and that there is a need for environmental protection. This is affirmed by the literature (Kibert, 2016), which lists the protection of nature and one of the principles of sustainable construction.

4.4.5 Theme 5 - Challenges and barriers to sustainable human settlements

Theme 5 discusses the challenges and barriers to SHS. The challenges and barriers are given from the perceptions of a variety of stakeholders that participate in SHS delivery.

The general agreement among respondents were that budget constraints were the chief challenge/barrier. Some other respondents argued that financial challenges could be overcome by seeking funding elsewhere, but that the biggest problems were responsibility, sustainability and practicality. It was revealed that initiatives were planned and not implemented due to a lack of funding and responsibility in implementation and maintenance.

The study also revealed that a challenge faced was that beneficiaries were not interested in social housing or green initiatives. It emerged that government is looking to speed of delivery, due to an increasing housing backlog, rather than green. There was a general feeling that government was not enlightened and suggestions to remedy this, included that professionals should approach government to reveal the pros and cons of green construction to government officials.

Another challenge/barrier that emerged, was a general lack of knowledge within the industry stakeholders, as was evidence by the statement: “If knowledge was good, it (green construction) would have been implemented”. The study also revealed that limitations existed within current information sources as green is over-marketed, there is green washing among suppliers, there is a lack of integrity and visibility of information is lacking.

The barriers presented during the literature study by various authors, including; Ahn, *et al.* (2013), Hakkinen and Belloni (2011) and WBCSD (2009), correlate with the responses to the interview questions. To a large extent the barriers that emerged during the interviews were also captured in the literature review.

Barriers need to be addressed and all stakeholders should contribute to ensure that this is done. Barriers, such as stringent guidelines, requires to be addressed by designers. Other barriers, such as budget constraints are to be effectively addressed by quantity surveyors (or other estimating

parties). Each of the barriers are to be addressed by parties knowledgeable in those specific areas which may ensure enhanced overcoming of barriers.

5.1 CONCLUSIONS

The aim of this study was to determine how the delivery of human settlements in South Africa can be enhanced to become more sustainable in terms of costing. The study also sought to establish the social and economic implications of going green in human settlements and to determine the barriers and challenges.

In terms of costs, it was found that there is a lack of involvement from various stakeholders to propose solutions, green construction is avoided due to a lack of understanding and evidence of the initial capital outlay required, some interventions do not necessarily contribute to an increase in costs. Therefore, the study concludes that contractors should be included in making suggestions for green construction implementation, lifecycle costing should be included to justify initial capital outlays and strategies which have little cost implications, such as passive solar design should be implemented.

There are several barriers and challenges which emerged such as budget constraints, limitations in information sources, general lack of knowledge, government management and prescriptive guidelines. This suggests that an integrated approach to the current housing problem is required and each barrier should be addressed by parties knowledgeable in that specific area. This may assist in enhancing the success with which barriers are overcome.

6.1 RECOMMENDATIONS

A number of recommendations for policy are made. Awareness needs to be created and promoted in the construction industry regarding green building options, influences, cost and the importance of taking action. Clear governmentally enforceable environmental building frameworks should include guidelines, programmes and implementation plans. Incentives and grants may be an option. Environmentally friendly awareness programmes will be beneficial to promoting greening aspects.

Some recommendations for practice are also suggested. Building professionals stand to make a contribution to the current climate crisis by using their knowledge regarding design, materials, practices and costs to implement and improve current standards regarding greening in low-cost human settlement developments. The different motivational elements for professionals should be taken into account and appropriately employed in order to create more involvement from professionals regarding “green” buildings. Continuous professional development is essential for informing

"green" designs and specifications. Continuous assessment of existing buildings should be exercised to inform retrofitting strategies.

Areas for future research are recommended. More extensive study using statistical analysis be under taken to investigate the actual costs versus green construction costs relating to SHS. A study using a wider sample and/or more case studies be undertaken. The aspect of government officials' perceptions was not examined in the present study; further research is needed to establish or examine how government officials' perceptions affect SHS.

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Perimeter Walls Solar Heat Gain, a Mechanism for Building Design

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ABSTRACT AND KEYWORDS

Purpose of this paper
The perimeter walls of a house are one of the components of the thermal envelope that protect the inner space from the ambient weather conditions. This study analyses the solar heat gain (SHG) through the perimeter walls with respect to the orientation of the house.

Design/methodology/approach
A pyranometer mounted on the perimeter walls was used to measure the global solar irradiance on the outer surface. Simultaneously, global horizontal solar irradiance was monitored by a pyranometer on an outdoor weather station. The perimeter walls inner and outer surface temperatures were also measured using type K thermocouples.

Findings
The preliminary findings portray the performance of the house between the month of October and December (summer season). An average outdoor temperature of 18.6°C and a corresponding indoor average temperature of 24.1°C were observed. With an average daily global horizontal irradiance of 224.13 W/m^2, the total SHG per surface area were 333.52 W/m^2, 383.92 W/m^2, 282.02 W/m^2 and 63.41 W/m^2 for the north, east, west and south walls, respectively.

Research limitations/implications (if applicable)
Solar heat gain through the roof and fenestration is other solar contribution in a house. Heat transfer through floors, partition walls, equipment, infiltration and ventilation are other source of the sensible load to be considered.

Practical implications
In a west of north orientated house, rooms or spaces that do not require thermal conditioning should be located at the south or east of south end of the floorplan. Active area like the living room, bedrooms, etc. should occupy the north, east of north and west of north.

What is original/value of paper.
The findings of this study show the influence of building orientation with respect to the sun on the thermal performance of the various zone of a passive solar house in a South African context. It is significant to local builders, architects and householders.

Keywords:
Solar radiation, Sol-air temperature, Solar heat gain, Building orientation, Floor planning.

1. INTRODUCTION

The components of thermal envelope comprises of the perimeter walls, roof, floor, windows and doors. They are responsible for maintaining the indoor thermal comfort of a house. Studies (Jin et al. 2012; Daouas 2011; Wong et al. 2010) have shown that heat flow through the perimeter walls create significant thermal load. Hence, the perimeter walls have considerable influence on the energy consumption and thermal comfort of a house. Whereas, perimeter walls can serve as a source of energy through passive solar design. Energy stored in the walls during the day by solar radiation, can be used to heat the inner space of the house at night. Thereby offsetting the heating period required to maintain indoor thermal comfort (Goia et al. 2015). The performance of the perimeter walls depend on their thermophysical properties, thickness, and orientation (Asan 1998).

The quest for optimum perimeter walls performance has resulted in various research over the years. Ulgen investigate the thermal behaviour of opaque wall materials under solar energy change. He found that the magnitude of time lag and decrement factor required to inform builders concerning building material and positions forming of walls are influence by heat storage and thermal diffusivity (Ulgen 2002). Meng et al studied the effect of retro-reflective materials on building indoor temperature. They argued that the indoor thermal conditions can be improved by covering the outer wall surface with reflective material. Hence the summer solar radiation will be reflected backward. They found that the peak indoor air

and inner surface temperatures were reduced by 8.0°C and 10.0°C, respectively. (Meng et al. 2016).

Through passive solar design with respect to the orientation of a house, solar energy can be harnessed for indoor space heating in the winter season. The result of the this passive design will be the reduction of the amount of energy required for space heating. The aim of this study is to analyse the solar heat gain on the perimeter walls of a house with respect to its orientation.

2. OPAQUE SOLAR HEAT GAIN

Passive solar heating is the natural flow of thermal energy by radiation, conduction and natural convection without the need of mechanical pumps or fans (Bradshaw 2006). The heating obtain from passive solar heating can be quantified as SHG. SHG can occur in the transparent (glazing) and opaque (walls and roof) components of the thermal envelope. Heat gain through the wall is the sum of the relatively steady-state heat flow and unsteady-state heat gain (Chartered Institution of Building Services Engineers 2000). The steady-state heat flow which do not take the thermal capacity of the wall into account, occurs as a result of a lesser indoor temperature than the ambient surrounding. Under such scenario, heat flow through the wall is given as;

$$Q = U(t_o - t_i) \tag{34.1}$$

Q is the heat gain (W/m²), U is the thermal transmittance coefficient (W/m²K) while t_i and t_o represent indoor and ambient temperature (°C), respectively. It must be said that Equation (34.1) is only valid if the ambient air temperature is greater that the indoor air temperature.

The varying intensity of solar radiation on the wall outer surface result in a unsteady-state heat gain. Hence, sol-air temperature is used to represent the ambient air temperature. In this circumstance, the instantaneous heat gain through a wall, ignoring the effect of thermal capacity is given as;

$$Q_\theta = AU(t_{eo} - t_i) \tag{34.2}$$

Where Q_θ is the solar heat gain through the wall (W), A is the area of the wall surface exposed to solar radiation while t_i is a constant indoor room temperature (°C). t_{eo} is sol-air temperature (°C) and given as;

$$t_{eo} = t_o + \frac{\alpha I}{h_o} - \frac{\Delta q_{ir}}{h_o} \tag{34.3}$$

t_o is the current ambent air temperature (°C), h_o represent the surface heat transfer coefficient (W/m²K) while I is global solar irradiance on the wall surface (W/m²). Δqir is the correction to infrared radiation transfer between a surface and the environment. If the sky temperature is different from t_o (W/m²) and α is the absorptance of the surface for solar radiation.

On an average basis, the mean heat flow Q_m, through a wall can be written as;

$$Q_m = AU(t_{em} - t_i) \tag{34.4}$$

t_{em} is the mean sol-air temperature over 24 hours. Taking thermal capacity of the wall into consideration, the heat gain through a wall is obtained by combining Equation (34.2) and (34.4) and is given as;

$$Q_{\theta+\phi} = AU(t_{em} - t_i) + AU(t_{eo+\phi} - t_{em})f \tag{34.5}$$

$t_{eo+\phi}$ is the sol-air temperature time lag hours ago while f is a decrement factor.

Time lag is defined as the time required for a heat wave to propagate through a wall from the outer to the inner surface. Whereas, decrement factor is the decreasing ratio of its temperature amplitude during the transit process of a wave penetrating through the wall (Kontoleon & Eumorfopoulou 2008). Time lag ϕ and decrement factor f are given as;

$$\phi = t_{T_{i,\max}} - t_{T_{o,\max}} \tag{34.6}$$

while

$$f = \frac{A_o}{A_i} = \frac{T_{i,\max} - T_{i,\min}}{T_{o,\max} - T_{o,\min}} \tag{34.7}$$

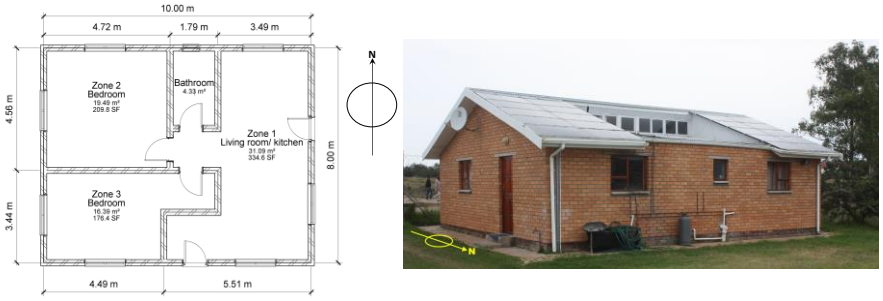
Where $t_{T_{i,\max}}$ and $t_{T_{o,\max}}$ represent the times when the wall inner and outer surface temperatures were at their maximum, respectively. While $T_{i,\min}$, $T_{i,\max}$, $T_{o,\min}$ and $T_{o,\max}$ are the minimum and maximum temperatures on the wall inner and outer surface, respectively.

3. SITE AND HOUSE DESCRIPTION

A passive solar house design and constructed in the University of Fort Hare in a doctorate research project was used as a case study (Ziuku & Meyer 2011). University of Fort Hare is located in latitude 32.8° south and

longitude 26.8° east at an altitude of 540 m in Alice, in the Eastern Cape of South Africa. Alice is in the temperate interior (Zone 2) climate of South Africa (South Africa Weather Service 2017; Overen et al. 2017).

The site is clear of potential Sun rays blockers on the north side, such as tall trees, mountains and high rise buildings. Hence it was found favourable for the house. Deciduous tree was planted on the west side to prevent winter wind. While sufficient space was ensured at the east and south side of the house for passive cooling during the summer season. The floor plan and a photo of the passive solar house is shown in Figure 3.1.



(a) (b)

Figure 3.1 (a) Floor plan of the passive solar house; and (b) a north east view of the house.

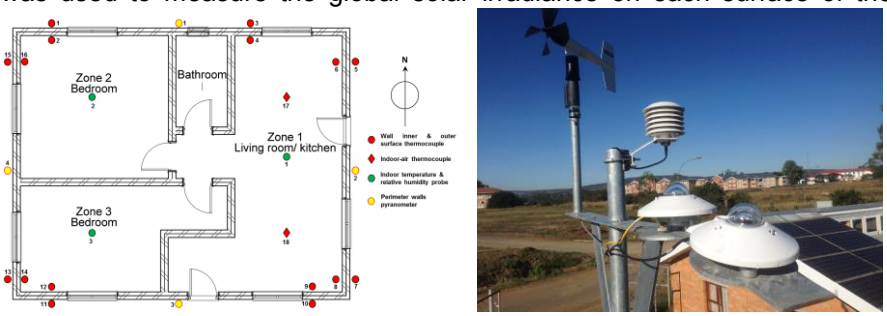
The house has a floor area of 10 m x 8 m (80 m^2). It is is made up of two bedrooms, north and south facing. The open plan living room stretched from the north elevation to the south. Rooms in the house were arranged to take advantage of the sun's path. The two large north facing windows allow solar penetration to the living room through the kitchen and the north facing bedroom during the day. The south end of the living room and the south facing bedroom gets solar access through the clerestory north facing windows. However, the eaves of the roof was designed to prevent the high angle Sun rays in summer season and allows the low angle Sun rays in the winter season.

4. METHODOLOGY

4.1 Meteorological Measurements

A total of 18 type K thermocouples were used to measure the inner and outer surface temperatures of the house perimeter walls. The thermocouple were mounted such that it has direct contact with the walls surface. Two thermocouples were however used to support the HMP60 temperature relative humidity (T_{RH}) probe in measuring the living room/kitchen air temperature. This is due to the huge space (31.09 m^2) involved. A T_{RH} probe was also used to measure the air temperature of the north and south facing bedrooms. The thermocouples and T_{RH} probes measuring the indoor

air temperature and relative humidity were suspended at a height of 0.80 m from the floor. A silicon photovoltaic cosine-corrected (Li-Cor) pyranometer was used to measure the global solar irradiance on each surface of the perimeter walls. The floor plan of the house indicating the various location of the meteorological sensors and the outdoor weather station is shown in Figure 4.1.



(a) (b)

Figure 4.1: (a) location of meteorological sensors in the house; (b) outdoor weather station

A CMP 11 Kipp & Zonen pyranometer was used to measure global horizontal solar irradiance. The ambient temperature and relative humidity were measured by a shielded HMP 60 T_{RH} probe, shown in figure 4.1 (b). The weather station is elevated above the roof by approximately 1 m, to avoid reflected Sun rays and radiated heat from the roof.

All sensors were connected to a data acquisition system (DAS) for configuration and periodic data collection. The DAS consist of a Campbell Scientific CR1000 data logger and AM 16/30 relay analogue multiplexer. A 12 Volt power supply was used to power the DAS.

4.2 Thermal Zoning

According to the International Organization for Standardization (ISO) 13790, thermal zoning is the partitioning of building into different zone, with separate thermal energy calculation for each zones (ISO 2008). It should be noted that the house used in this study do not meet the criteria for thermal zoning. Hence, similar concept was used to evaluate the perimeter walls solar heat gain of each zone of the house. As such, the floor area of the house was split into zones based on orientation and usage. Figure 4.2 shows the various zones of the house.

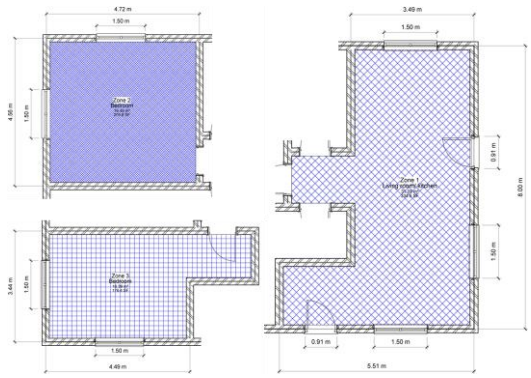


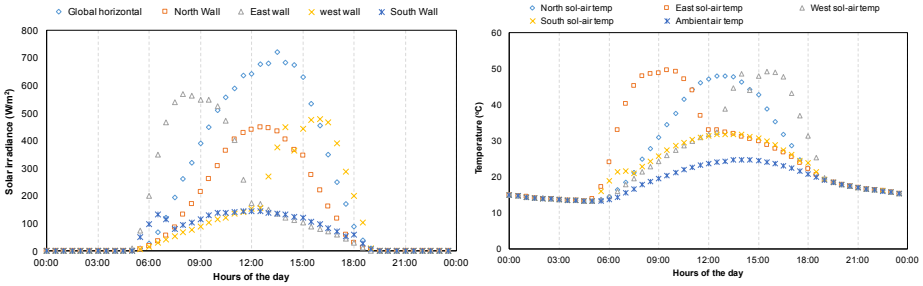
Figure 4.2: Thermal zoning of the house

From Figure 4.2, the living room/kitchen is identified as zone 1. While the north and south facing bedrooms are represented by zone 2 and 3, respectively. The rooms in the house will be addressed by their respective zones going forward.

5. RESULTS AND DISCUSSION

During the monitoring period, the house was occupied be one of the University staffs and his immediate family. His family comprises of the wife, two children (boy and girl) between the age of 10 and 6 years and an infant. Like the husband, the wife is a working class lady while the two children attend school. The infant remains at home with the housekeeper. On weekends, the house is usually occupied by all family members and visiting friends.

Meteorological monitoring was conducted from October to December, 2016. For scientific calculations and energy analysis, this period is often



considered as part of summer season (South Africa Weather Service 2012). The data obtained from the meteorological measured were populated in a spreadsheet, from which a sequential computation of the sol-air temperature to solar heat gain (SHG) of the house were done. Figure 5.1 shows a 3-month mean hourly profile of the global horizontal and global solar irradiance of the perimeter walls outer surface. As well as the resultant sol-air temperatures of the perimeter walls.

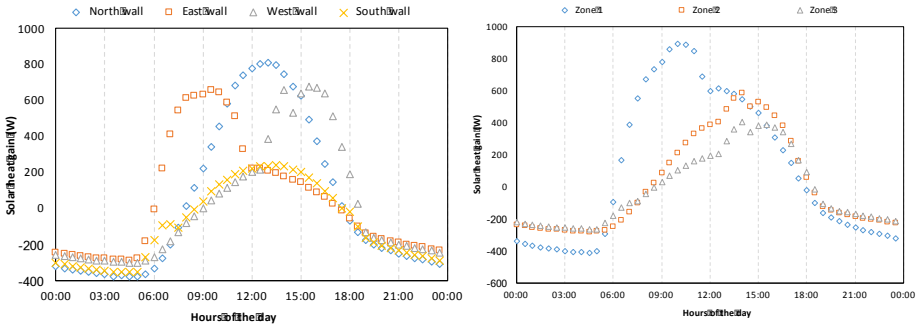
(a) (b)

Figure 5.1: Hourly global horizontal and global solar radiation; (b) sol-air temperature of the perimeter walls

From Figure 5.1 (a), the Sun was present between 5h00 to 19h30. Within this period, the east wall had the highest solar irradiance of 568.48 W/m^2 at 8h00. The south wall received the least solar radiation, attaining a maximum of 145.82 W/m^2 at 11h30. However, between 5h00 to 8h00, a spike was seen in the south wall solar irradiance. Thus, it can be said that the house is oriented approximately west of north. Also, the dip in the west wall solar irradiance distribution, result from shadow of the deciduous tree planted at the west side of the house.

Equation (34.3) was used to determine the sol-air temperature of the perimeter walls.The unpainted brick wall surface was assumed to be dark, thus a value of 0.053 m^{2}K/W was used for $\frac{\alpha}{h_o}$. Whilst $\frac{\Delta qir}{h_o}$ is 0°C, given that the wall is a vertical surface (Kalogirou 2014). Figure 5.1 (b) agrees with Bradshaw difinition of sol-air temperatue. He defined sol-air temperature as the effect of the ambient temperature on the indoor thermal condition of a house in the present of solar radiation (Bradshaw 2006). In Figure 5.1 (b), when solar radiation is absent, the air temperatures around each of the perimeter walls were equal. Otherwise, the air temperature (sol-air temperature) around each of the walls varies according to their respective surface solar irradiance.

The computed sol-air temperatures of the perimeter walls were substituted into Equation 34.2 to evaluate the SHG through the walls. The surface areas (A) of each wall were obtained from section 3. A 270 mm cavity brick wall heat transfer coefficient (U) of 1.53 was assumed (Szokolay 2014). Figure 5.2 shows the SHG through the perimeter walls and the SHG in each zone of the house.



(a) (b)

Figure 5.2: (a) Perimeter walls solar heat gain; (b) Zonal solar heat gain

In Figure 5.2 (a), the area of the graph below zero indicate the amount of heat lost through the walls. While areas above zero represent amount of heat gain. Comparing Figure 5.1 (a) and 5.2 (a), during the absent of solar radiation, the perimeter wall tend to loss heat. It must be said that the heat is not always lost to the ambient environment. At a point where the indoor air temperature is lesser that the walls inner surface temperature, heat stored in the walls during the day is transferred to inner space. Thereby creating a stable indoor temperature and increasing the indoor and outdoor temperature variation.

The SHG in each zones of the house varies according to their orientation, exposed surface area of boundry walls, and floor area. Figure 5.2 (b) shows the SHG in the various zone of the house. The description of each zone and SHG per floor area is summarized in Table 5.1.

Table 5.1 Summary of zonal solar heat gain of the house.

Zone	Perimeter walls	Exposured surface area (m^2)	Floor area (m^2)	Heat gain/floor area (Wh/m^2)
1	North East South	8.28 17.05 2.72	31.09	24.04
2	North West	8.57 8.05	19.49	17.42
3	West South	8.02 8.45	16.39	12.85

The influence of the house orientation was noticed in Figure 5.2 (b). Given that zone 1 bounded by the north, east and south walls; its SHG increase rapidly from 6h00 to 11h30. Likewise, zone 2 and 3 with the west wall as a common boundary, their SHG peaks at approximately 15h00. The SHG peaks in each zone correspond with the solar irradiance peaks of the outer surface of the boundary walls, shown in Figure 5.1 (a).

Furthermore, Zone 1 had the highest SHG of 11.2 kW while the lowest was obtained in zone 3 with 3.20 kW. It should be noted that the SHG and SHG per floor area shown in Figure 5.2 (b) and Table 5.1, only depict heat gain through the walls. As a result, the measured indoor air temperature do not completely concur with Figure 5.2 (b) and Table 5.1. The measured indoor air temperature of the each zones are shown in Figure 5.3 (a).

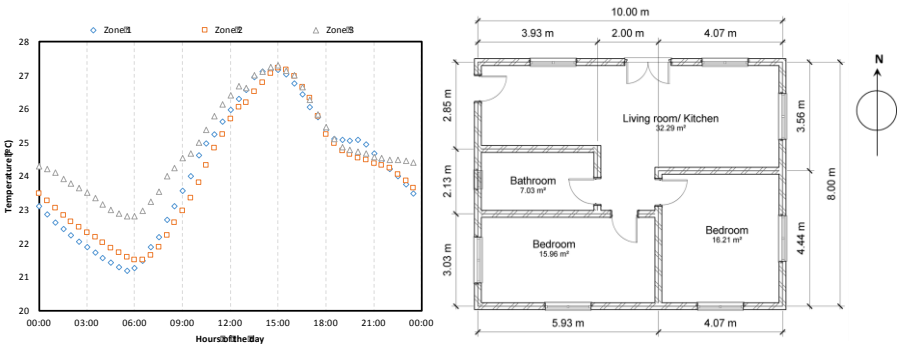


Figure 5.3: (a) Zonal air temperature; (b) Alternative floor plan

As stated earlier, the house was design to achieve even solar distribution in all zones. Hence, the clerestory windows were used to channel solar radiation to the southern end of the house. In this regard, zone 3 (south facing room) has the larger portion of the clerestory window. As a result, significant amount of heat is generated during the day in zone 3. This result in the relatively higher temperature in Figure 5.3 (a). Also, heat generated by human metabolism at night time increases the indoor air temperature of zone 2 and 3 between mid-night and the early hour of the morning.

Based on the finding of this study, an alternative floor plan of the house is given in Figure 5.3 (b). The relatively SHG in zone 1 can be used to create a more stable indoor air temperature for zone 2. While the kitchen and bathroom where thermal conditioning are not required occupies the upper southwest side. With the clerestory windows, zone 3 had a considerable good performance. As such, zone 3 remain at the same position. The alternative floor plan is target to archive passive heating to minimise winter space heating.

6. CONCLUSIONS AND RECOMMENDATIONS

The findings of this study indicate that a house facing west of north, the north, east and west walls receive significant SHG, while the south wall has a relatively low SHG. Considering these findings and ignoring the impact of the clerestory windows, rooms or spaces that do not require thermal conditioning should be located at the south or east of south end of the floorplan. Active area like the living room, bedrooms, etc. should occupy the north, east of north and west of north. In this way, solar heat generated during the day can be utilize for space heat at night.

Further studies focussing on the winter behaviour of a house is recommended. Also, conducting a similar experiment using a typical South African residential house (without clerestory windows) should be considered. Lastly, studies on other sources of heating in a house should be performed to conclusively specify the thermal impact of the walls.

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Policy Analysis of Carbon Emissions in Housing Stock using System Dynamics Modelling Approach

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ABSTRACT

Purpose of this paper
The purpose of this paper is to carry out policy analysis simulation using system dynamics modelling approach for carbon emissions in the United Kingdom's (UK) housing sector. This is with a view to ensuring policy makers made informed decisions.

Design/methodology/approach
In order to investigate the problem, the research adopts the pragmatist research strategy involving collection of both qualitative and quantitative data to develop the system dynamics model.

Findings
The findings from the study indicated that for all policy scenarios ('baseline', 'efficiency', 'behavioural change', 'economic', and 'integrated' scenarios) considered by the research, a maximum of 42.50% reductions in carbon emissions can be achieved by 2020, while a maximum of 63.15% reductions are envisaged by the year 2050 below the base year of 1990.

Research limitations/implications
The research in this paper is based purely on modelling of the demand side of carbon emissions in the housing sector of the economy.

Practical implications
The results in the paper can direct policy decisions by testing different policy scenarios that are likely to affect carbon emissions.

What is original/value of paper
The paper is unique in that the outcomes from the simulation performed will allow policy makers to make informed decisions regarding future policy formulations concerning carbon emissions within the UK housing sector.

Response to conference theme
The study in this paper is relevant to Green Building sub-theme of the conference.

Keywords: Carbon emissions; housing sector; policy analysis; simulation; system dynamics.

1. INTRODUCTION

Many policy strategies have evolved over the years in developed countries about reducing the climate change effects due to carbon dioxide (CO_2) emissions. This is mainly because climate is changing owing to energy use behaviours around the globe, which has been argued that there is capability of making temperatures rise by up to 6°C (UNDESA, 2010) thereby resulting in extreme weather conditions. Governments around the world are making frantic efforts in ensuring that threats from CO_2 emissions is curtailed by all means. Among those efforts is the ambitious Climate Change Act of 2008 by the UK government targeting 80% reduction in CO_2 emissions by the year 2050 as against the base year 1990.

The Office of National Statistics (2009) estimated that about 26% of CO_2 emissions are ascribed to domestic buildings alone. This then makes the housing sector an important sector within which a deep cut in CO_2 emissions can be achieved. As such, the UK government has targeted a number of policy interventions in ensuring that there is a reduction in CO_2 emissions profile within the housing sector of the economy. These policy initiatives include energy-efficient improvements to dwellings, energy tariffs, energy subsidy for uptake of technology like micro-generation, green deal, amongst others. Despite these various policies initiated to reduce energy consumption in buildings, much result has not been accomplished.

Consequently, a new system-based approach to analyse the effectiveness of these policies is still needed. This is because the relationship between buildings, occupants' behaviour, and the environment in and around buildings should be a key component for any policy analysis. Therefore, the objective of this paper is to conduct policy analysis simulations using a system dynamics approach for carbon emissions in the UK housing sector with a view to ensuring policy makers make informed decisions.

2. ENERGY POLICY AND EMISSIONS TARGETS WITHIN THE UK HOUSING SECTOR

Over the years, the UK energy sector has witnessed tremendous improvements and changes in energy policy. Principally, energy policy has been shaped by two major factors. Firstly, as a result of market liberalisation of 1980s, which sees the State controlled energy companies privatised and the Department of Energy dismantled. Secondly, the rising threats of climate change effects as highlighted by the Rio summit of 1992 (Kashyap et al., 2003) has also significantly shaped energy policy within the UK. This singular factor has risen up the agenda in the UK, as a signatory to Rio submit of 1992, to commit to reduction of carbon emissions (ibid). Consequently, the UK Government published its white paper on energy in 2003 entitled "Our Energy Future – creating a Low Carbon Economy". In this white paper, the UK Government is committed to a 60% reduction in carbon emissions by the year 2050 (ibid). Undoubtedly, the world of energy is changing rapidly and as such a constant review of energy policy is inevitable. For example, Energy Review Report of 2006, Energy White Paper of 2007, Climate Change Act of 2008, UK Low Carbon Transition Plan of 2009, and Energy Bill of 2012 – 2013. All these policy frameworks tend to shape energy policy mainly to stem the rising tide of carbon emissions and to its drastic reductions.

As a result of this, the Climate Change Act provides the legally binding pathway towards carbon emissions reductions by reducing 22 per cent of carbon emissions between 2008 and 2012 relative to the base year 1990. In addition, the Act stipulates that reductions of 28 per cent are to be achieved between 2013 and 2017, while 34 per cent reductions are required between 2018 and 2022. Additionally, the Act puts it that 50 per cent of carbon emissions reductions are envisaged for between the year 2023 and 2027, while 80 per cent is to be achieved by the 2050 relative to the base year 1990. These savings are to be achieved within all sectors of the economy.

Different studies have, however, highlighted the potential of the housing sector to contribute significantly to these reductions (Levine et al., 2007; Elforgani & Rahmat, 2010; McManus et al., 2010, Baba et al., 2012). And as such, some of these studies have shown the areas of possible policy targets. For example, Levine *et al*. (2007) highlights the importance of technological developments, cultural, and behavioural choices as possible areas of policy formulation. In the UK, however, a number of policy targets are in place within the housing sector. These policies are targeting both the new and existing homes. For example, there are some policies that are technology led in terms of efficiency improvements. Others are targeted towards the occupants of dwellings, while some are based on energy prices. All these policies have implications that needed to be evaluated before implementation. This study, therefore, firmed up a methodology with capability of testing all government policy formulations before implementing them.

3. RESEARCH METHODOLOGY

The following sub-sections describes the detail of the methodology used for the research.

3.1 Modelling Approach

Many modelling approaches have been developed to analyse and forecast CO_2 emissions within the housing sector. For example, Keirstead (2006) argued that energy policy makers can use a "disciplinary" approach to make informed decisions on energy policy, which may be from the engineering or economic perspective as the case may be. However, Natarajan et al. (2011) contended that the disciplinary approach is inadequate to capture the kind of complexity involved in energy sector issues and this then leads to consideration a collaborative approach that is multi-disciplinary in nature termed "integrated" method. According to Motawa and Oladokun (2015), models on energy policy are developed based on integration of variables about dwellings physical characteristics, occupants' behaviour as well as issues relating to the sociology, economics and environment. Similar to disciplinary approach, Motawa and Oladokun (2015) argued that models from integrated approach are deterministic in nature thereby failing to take the complexity involved in energy policy issues into cognisance. In line with the observations of Motawa and Oladokun (2015), Oladokun and Odesola (2015) reasoned that there is the need to use a methodology that is non-deterministic considering the kind of data (qualitative and quantitative) and complexity involved in this research. That is why the system dynamics (SD) approach was used. Details about system dynamic approach including its justification have been covered somewhere else (Oladokun, 2014; Oladokun and Odesola, 2015; Oladokun and Adewuyi, 2016).

3.2 Model Variables

In order to simulate different policies regarding CO_2 emissions in the housing sector in the UK, the research considered some variables in the model. Among the variables considered are variables that are related to the dwelling system in terms of the physical properties of dwelling (e.g. space heating, lighting, ventilation, amongst others). Also included in the model are variables related to occupants system in terms of occupants' biophysical variables; behavioural variables as well as dwellings' household characteristics. Additionally, the model included variables related to environment system in terms of climatic variables and economic variables. All these variables are seamlessly related together in order to indicate the complexity involved in the interrelationships among the variables as captured within the system dynamics algorithms.

3.3 Data Sources

One of the main contributions of this study is in terms of data sources used for the model. Importantly, the model used both quantitative and qualitative data sources for its development. The majority of the quantitative data are sourced from the main UK government's departments in custody of data relating to variables under 3.2 above. These government agencies include the Department of Energy and Climate Change (DECC), ONS, metrological department as well as data from Building Research Establishment (BRE). However, qualitative data were sourced from the experts in the energy sector in form of interviews in order to get data relating to relationships in some variables that lack empirical data. This is the main strength of the methodology used for this study.

3.4 Reference Modes

One of key elements within SD modelling approach is what is called "a reference mode". A reference mode mimics the historical behaviour of the main variables within the system under consideration in order to project into the future (Sterman, 2000). Therefore, a reference mode depicts a pattern of behaviour that represents the dynamic nature of the problem in question. For this study, the key variable here is carbon emissions. As such, the pattern of behaviour of average annual carbon emissions per household in the UK is as shown in Figure 1 as the reference mode. This shows that the carbon emission has been on the downward trend since 1970. The profile therefore follows a lumpy trend with peaks and troughs on a downward direction.

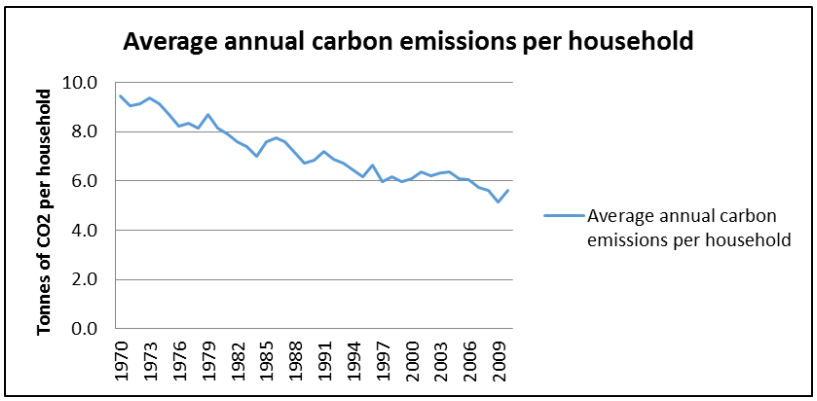

Figure 1 Reference mode for average annual carbon emissions per household (Source: Palmer & Cooper, 2012)

4. POLICY ASSUMPTIONS IN BRIEF

Five policy scenarios were captured in this study. It is therefore important to give a brief summary of the assumptions made for each of them.

4.1 'Baseline' Scenario Assumptions

The 'baseline' scenario is the reference case to all other scenarios. It serves as the base case upon which these all other scenarios can be compared. The main assumptions of the scenario is premised on the fact that there are no much substantive changes made to the current trends in energy efficiency policy. The scenario also assumes that no other policy measures are further introduced apart from the continuation of the existing ones currently in operation. In terms of energy efficiency measures of dwellings, efficiency of heating systems, cooking, lighting and appliances as evidenced from historical data available will continue to follow the current trend, without any specific efforts to upturn the trend.

4.2 'Efficiency' Scenario Assumptions

Energy efficiency measures are then assumed to concentrate on household dwellings and this is technology led. And as such, it is assumed that there will be improvements in the uptake of dwelling insulation measures thereby resulting in the dwelling of each household being thermally insulated with a resulting increased energy efficiency rating of dwellings like SAP rating. Further to these assumptions, airtightness of dwellings will increase and it is again assumed that significant energy savings will arise from this scenario. However, occupants will offset any savings that would have been made by seeking for more thermal comfort thereby increasing their dwellings internal temperature set-point from 19ºC to 21ºC. At this, 'standard' consumption behaviour is still assumed to be maintained by the householders as done under the 'baseline' scenario. Fabric insulation depicted as 'insulation factor' in the model is therefore assumed to increase by 25% beyond the levels set under the 'baseline' scenario.

4.3 'Behavioural Change' Scenario Assumptions

This scenario is also based on major assumptions made under the 'baseline' scenario. The effects of occupants' behavioural change on household energy consumption and carbon emissions are the main policy driver that this scenario illustrates. And as such, frugal consumption behaviour is emphasised by this scenario. That is, their daily habitual behaviours tend towards energy saving in their homes. In addition, it is assumed that this will have effect on the dwelling internal temperature set-point as maintained by the occupants. A set-point of dwelling internal temperature is therefore assumed to be 18.5ºC. Also, within this scenario,

energy prices are assumed to show a limited increase thereby necessitating the energy bills paid by the householders to slightly increase by 5% beyond the level assumed under the 'baseline' scenario. In terms of energy efficiency, the assumption of this scenario is similar to that of 'baseline' scenario that no much substantive changes are made to the current trends in household energy efficiency apart from the continuation of the existing trends. For this scenario, no attempt is made to change any of the parameters within the population/household module. Therefore no special effects are anticipated from the 'number of households' and 'average household size' other than their profile as generated internally within the model.

4.4 'Economic' Scenario Assumptions

This economic scenario is also based on the 'baseline' scenario, but with emphasis on the effects of energy bills on household energy consumption and carbon emissions. The scenario describes a future where the UK Government will formulate a policy freezing the energy prices in order to score some political points. This is assumed to cause a reduction in energy bills payable by the householders. The scenario anticipates the likelihood of this dip in energy bills to free up more disposable income for householders in an attempt to lower the number of those in fuel poverty. With this, the scenario assumes that the householders will seek more thermal comfort as a result of more disposable income, thereby increasing their dwelling internal temperature set-point a little bit, though with 'standard' consumption behaviour. It is necessary to state that the scenario has the potential of illustrating the impact of energy prices surge or dip on the household energy consumption and carbon emissions. Therefore, for this scenario, all other variables are kept as they were for the 'baseline' scenario apart from the following changes made to some of the parameters within the model. The '% increment in energy bills' is set at -5% and the dwelling internal temperature set-point is set to 20ºC.

4.5 'Integrated' Scenario Assumptions

The 'integrated' scenario integrates and harmonises the assumptions made under the 'efficiency', behavioural change, and 'economic' scenarios as they impact on the household energy consumption and carbon emissions of the UK housing stock. The scenario assumes that the energy efficiency improvements as described and emphasised under the 'efficiency' scenario will be maintained. Further, the scenario assumes that householders will display frugal energy consumption behaviour. And as such, they are interested in monitoring their energy usage at home. That is, they exercise some behavioural habit aiming at saving energy consumption at home like turning down heating in vacant rooms, washing at lower temperature, etc. With all these, they are however assumed to maintain a dwelling internal

temperature set-point of 20ºC. Additionally, within this period, energy prices are expected to be frozen as explained under the 'economic' scenario.

5. SIMULATION RESULTS

Based on the policy assumptions briefly explained in Sections 4.1 – 4.5, the policy analysis of carbon emissions was simulated. The results of the simulation were shown in Figures 2-6. The simulation was performed based on end-uses. For example, each policy scenario was simulated for 'space heating' (Figure 2), 'lighting' (Figure 3), 'appliances' (Figure 4), 'cooking' (Figure 5), and 'hot water' (Figure 6) end-uses. For each of the end-uses, all the graphs (Figure 2-6) actually show a downward trend for carbon emissions for all the end-uses based on the reference mode as shown in Figure 1. This, therefore, indicates reductions in carbon emissions profile for space heating, hot water, cooking, lighting, and appliances in the study area. Reductions are greatest in space heating carbon emissions followed by hot water production systems carbon emissions. However, Figures 2-6 show little details about the amount of reductions achieved over the years in relation to the base year 1990. Hence, there is the need for a further analysis.

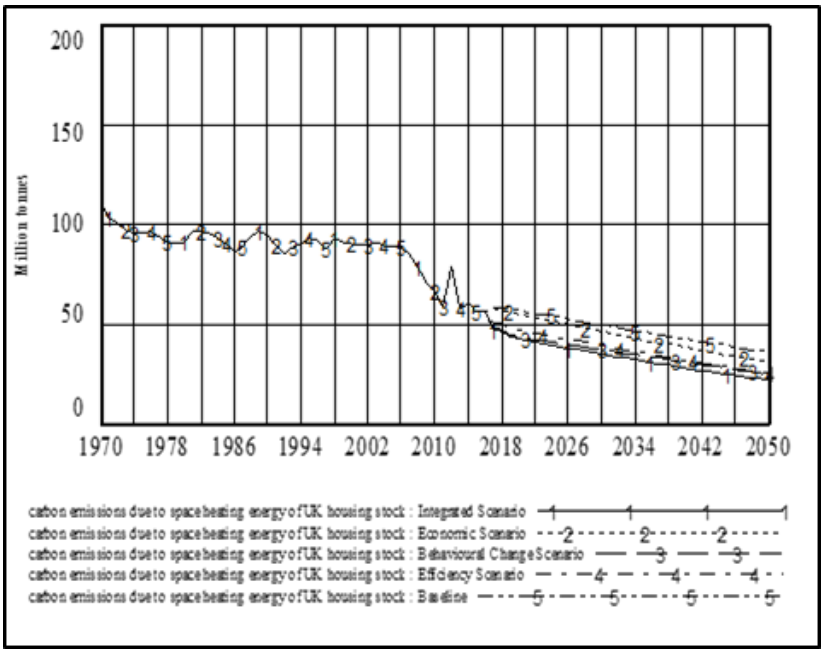

Figure 2 Policy analysis of all scenarios for space heating carbon emissions

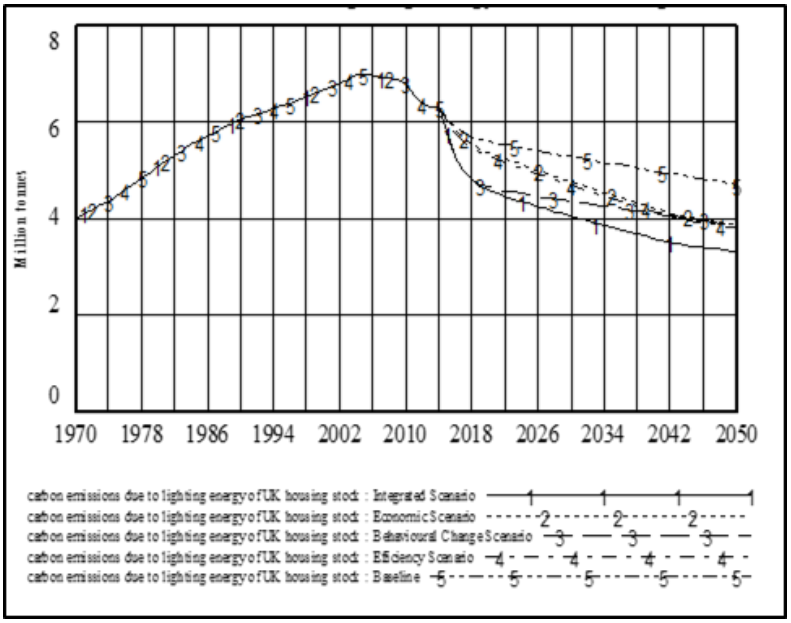

Figure 3 Policy analysis of all scenarios for lighting carbon emissions

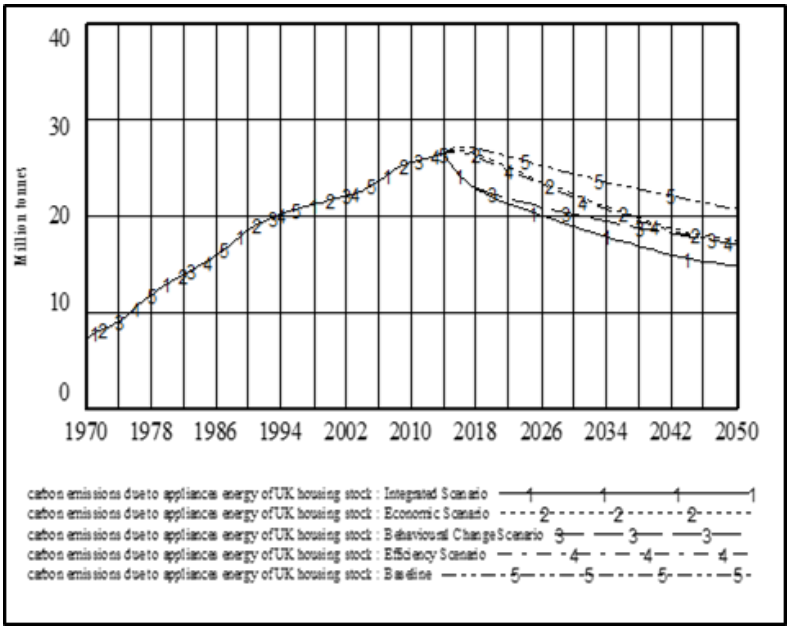

Figure 4 Policy analysis of all scenarios for appliances carbon emissions

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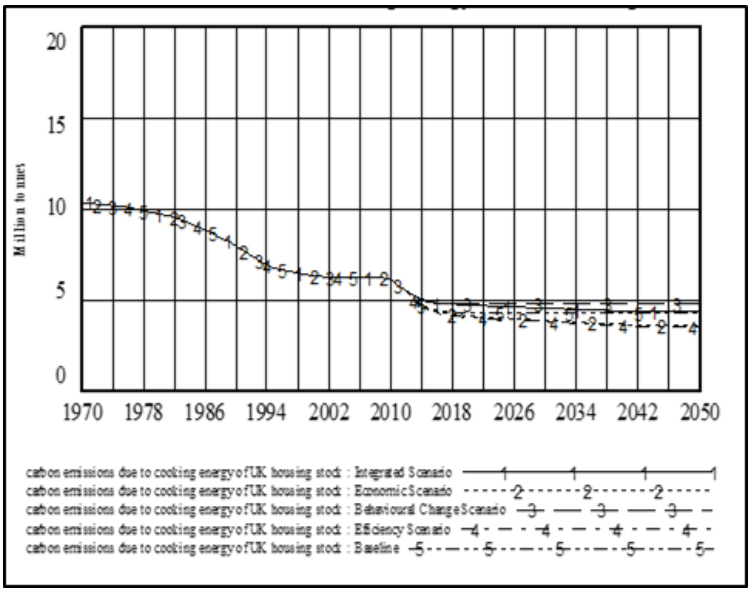

Figure 5 Policy analysis of all scenarios for cooking carbon emissions

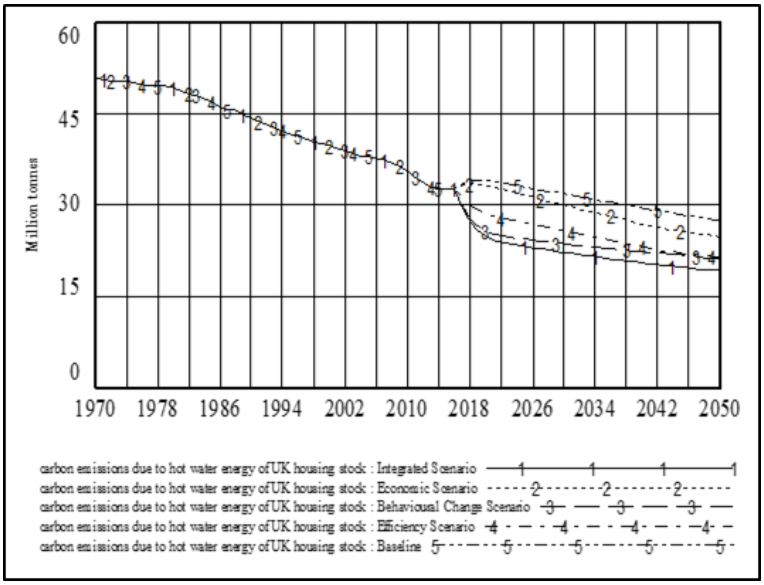

Figure 6 Policy analysis of all scenarios for hot water carbon emissions

Further analysis for remarkable years 2020 and 2050 is shown in Table 1. The insights from the results indicate that by 2020, there is likelihood of getting a total of 29.08% reductions in total carbon emissions based on all the end-uses for 'baseline' scenario, 31.27% for 'efficiency' scenario, 40.95% for 'behavioural change' scenario, 25.86% for 'economic' scenario, and 42.50% for 'integrated' scenario. Also, for the year 2050, the reductions are actually more than that of 2020 for all scenarios. For example, 63.15% reductions are envisaged according to the simulation result in Table 1 for 'integrated' scenario. One of the most significant information deduced from

all the scenarios is that it is unlikely for any of the scenarios to individually meet the required legally binding reductions of 80% cut in carbon emissions.

Table 1 Percentage reductions in household carbon emissions for all scenarios

	Baseline scenario (%)	**Efficiency scenario (%)**	**Behavioural change scenario (%)**	**Economic scenario (%)**	**Integrated scenario (%)**
			Year 2020		
Space heating	-43.70	-45.29	-53.68	-40.27	-55.10
Hot Water	-27.32	-29.44	-41.93	-23.26	-43.96
Cooking	-46.91	-49.18	-40.10	-46.03	-40.86
Lighting	-8.94	-12.58	-23.18	-7.62	-24.34
Appliances	*+42.65*	37.76	20.40	44.38	18.88
Total	***-29.08***	***-31.27***	***-40.95***	***-25.86***	***-42.50***
			Year 2050		
Space heating	-65.64	-69.56	-74.22	-62.64	-77.32
Hot Water	-41.77	-47.09	-52.37	-38.05	-56.56
Cooking	-47.54	-56.24	-39.34	-46.66	-45.02
Lighting	-23.68	-37.25	-36.42	-22.35	-45.53
Appliances	*+10.42*	-7.76	-7.81	12.37	-19.97
Total	***-48.96***	***-55.34***	***-58.47***	***-46.04***	***-63.15***

6. CONCLUSIONS AND POLICY IMPLICATIONS

The research in this paper simulated the effects of different policies on carbon emissions of the entire housing stock of the UK. The policies simulated include: 'baseline', 'efficiency', 'behavioural change', 'economic', and 'integrated' scenarios. The main conclusion from the study indicates that given any of the scenarios it will be very difficult to meet the required legally binding reductions of 80% cut in carbon emissions by 2050 unless it is vigorously pursued. The insights from the simulation indicated that major reductions in carbon emissions are expected from both the space and water heating.

The major limitation of this paper is that it is based purely on modelling of the demand side of carbon emissions in the housing sector of the economy. However, the study in this paper has policy implications for society. The results can direct policy decisions by testing different policy scenarios that are likely to affect carbon emissions. The insights generated from those simulations will allow policy makers to make informed decisions regarding any future policy formulations concerning carbon emissions within the UK housing sector.

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Social Resilience in Urban Areas

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ABSTRACT AND KEYWORDS

Purpose
Climate change will create significant hazards globally. These are usually described in terms of physical phenomenon such as sea level rises, droughts, flooding and erratic weather conditions. However the way these phenomenon are *experienced* is mediated by social vulnerability. Social vulnerability can be described as the complex interrelationship of social, economic, political, technological and institutional factors that influence how an urban community, household or individual experiences climate change. This paper aims to understand how vulnerability can be addressed in order to support the development of urban environments and communities that are more resilient and able to adapt to climate change.

Design
The design of the research consists of the following steps. Firstly, a literature review is carried out to identify the key climate change impacts that are projected for South Africa. Secondly, literature on social resilience is reviewed to ascertain its potential role in enabling communities to adaptat to climate change. Thirdly, analysis is carried out to ascertain urban attributes and mechanisms that may be used to foster social resilience. Finally, conclusions and recommendations from the study are drawn.

Research limitations
The research is limited to the reviews and analysis and makes proposals that need to be piloted and tested in the field. This is one of the recommendations of the study.

Findings based on empirical research
The findings from the paper indicate that significant climate change impacts are projected for South Africa. Through reviews and analysis, it finds that social resilience may play an important role in enabling communities to adapt to climate change.

Practical implications
The practical implications of the study are that it may be possible to foster social resilience in urban settings and achieving this could be an important way of enabling communities to adapt to climate change.

What is original/value of paper
The paper is carried out in a field where there has been limited research to date. It will be of interest to researchers of urban resilience, social systems and urban climate adaptation and mitigation strategies. It will also be of interest to municipal officials within urban areas.

Key words
Social resilience, urban resilience, climate change

1. INTRODUCTION

Climate change will create significant hazards globally. These are usually described in terms of physical phenomenon such as sea level rises, droughts, flooding and erratic weather conditions. However the way these phenomenon are *experienced* is mediated by social vulnerability (Vincent, 2004).

Social vulnerability can be described as the complex interrelationship of social, economic, political, technological and institutional factors that influence how an urban community, household or individual *experiences* climate change (Vincent, 2004). This paper aims to understand social vulnerability in order to support the development of more resilient human populations that are able to adapt to climate change.The paper is structured around the following research questions:

- What are the expected impacts of climate change on South Africa?
- What role has social resilience in adaptating to climate change?
- How can social resilience in urban environments be fostered?

2. CLIMATE CHANGE

Climate change projections have been calculated for South Africa to support the development of urban climate change adaptation and mitigation strategies. Projections are provided at an 8 x 8km grid resolution for the years 2030, 2050 and 2100 (Englebrecht, 2017). This creates a basis for understanding how climate change will affect urban areas. Impacts across South Africa will vary depending on location but broad trends can be summarised as follows:

- Hotter temperatures: Temperature increases of 1 to 2.5°C in the southern coastal areas and 3°C in the northern areas of South Africa are expected for the period 2021 to 2050, relative to temperatures in the period 1961 – 1990.

- Colder temperatures: Minimum temperatures are projected to decrease by 2 to 3°C for the period 2021 – 2050, relative to the period 1961 - 1990
- Very hot diays: An increase in very hot days is projected for the period 2021 – 2050, relative to 1961 – 1990.
- Changes in rainfall: Increases in rainfall are projected in the central interior and east coast, while reductions are expected in the western interior and the north eastern parts of South Africa in the period 2021- 2050, relative to the period 1971 – 2000.
- Extreme rainfall events: Extreme rainfall events are projected over most of eastern South Africa with reductions in these events projected for Lesotho and Kwa-Zula Natal Midlands for the period 2021- 2050, relative to the period 1961 – 2000.
- Increased wind speeds: Increased wind speeds are projected for the northern interior region of South Africa for the period 2021 – 2050, relative to the period 1961 – 2000 (Engelbrecht et al., 2017).

These climate changes will result in significant hazards being experienced South African urban areas such as water shortages, drought, food insecurity, flooding and infrastructure damage from storms and extreme weather events.

Mortimore (1998) points out that climate in Africa has always been variable and that local communities have been able to successfully adapt to this (Dovers, 2009; Burton, Huq, Lim, Pilifosova and Schipper 2002). However, in the past, this change occurred slowly and within a defined range. Current projections will be different as change will occur more rapidly and over a greater range of variability.

Traditional climate change adaptation and mitigation research has a strong focus on climate change models which are used to project environmental risks, such as droughts and flooding, and their potential impacts on human populations. This approach tends not to include the diversity of vulnerabilities that exist within populations in relation to these risks and therefore is only partial reflection of potential impact (Vincent, 2004). It is therefore important to understand social vulnerability and ascertain how different societies react, and adapt, to climate change.

3. SOCIAL VULNERABILITY AND ADAPTIVE CAPACITY

Vulnerability is a contested term and a wide range of definitions have been proposed (Cutter, 1996). Social vulnerability research is increasingly used to describe bottom-up studies of how human populations deal with environmental change (Vincent, 2004; Cutter, 1996). This argues that humans are not merely passive recipients of climate change hazards and instead actively develop mechanisms to resist and cope with hazards when

these occur (Jones and Boer, 2003; Pelling, 2003; Smith, 2001; Blaikie, Cannon, Davis, and Wisner, 1994)

Pelling (2000) argues that the scale and nature of climate change disasters relate to the extent of human exposure to a hazard and the capacity within individual and human systems to cope with this exposure. This 'capacity to cope' however is in constant flux as it is influenced by factors such as the strength of the local economy and changing social and cultural norms (Leichenko and O'Brien, 2002; Clark, Jaeger, Corell, Kasperson, McCarthy, Cash, Cohen, Desanker, Dickson, Epstein, Guston, Hall, Jaeger, Janetos, Leary, Levy, Luers, MacCracken, Melillo, Moss, Nigg, Parry, Parson, Ribot, Schellnhuber, Seielstad, Shea, Vogel and Wilbanks, 2000). Vulnerability can therefore be described in terms of economic, social, political, environmental and technological assets, with climate change impacts being determined by how these assets are allocated (Pelling and Uitto, 2001). From this perspective, vulnerability is a socially-constructed phenomenon governed by institutions and economic factors (Adger and Kelly, 1999).

Gallopin (2003) shows that vulnerability in some situations is beneficial and can lead to positive change. For instance, exposure to moderate flooding may mean that a population moves and avoids impacts associated with severe flooding. The same argument is applied by Walker, Holling, Carpenter and Kinzig (2004), who argues that a crises can lead to the collapse of poor institutions and lead to the birth of new stronger structures and systems. In these types of situations, it can be argued that "resilience is not always a good thing" (Walker et al., 2004)

Measuring vulnerability has proved to complex and researchers have resorted to proxy indicators to represent generic vulnerability. For instance, Brooks et al (2005) proposes the following indicators of vulnerability:

- Population with access to sanitation
- Literacy rate, 15–24-year olds
- Maternal mortality
- Literacy rate, over 15 years
- Calorific intake
- Voice and accountability
- Civil liberties
- Political rights
- Government effectiveness,
- Literacy ratio (female to male)
- life expectancy at birth

A review of these indicators suggest that while they may be effective at capturing "symptoms" of vulnerability in a society they may not be effective at ascertaining whether the society have the key characteristics required for

resilience. Adger and Kelly (1999) argue that a key factor in enabling resilience is related to entitlement. Entitlement refers to how humans use resources and they argue that that the extent to which individuals or communities are entitled to resources determines their ability to cope and adapt to stress (Adger and Kelly, 1999).

Entitlement can be understood in terms of the source of these entitlements, the way they are distributed and the institutional framework within entitlements are structured over time and among groups (Adgar and Kelly, 1999). Entitlements to assets are therefore legitimised by government and formal laws. However, entitlement operates differently at an individual and community scale. At an individual scale, vulnerability can be defined by access to resources, diversity of income sources and status within a household or community. At a community scale, vulnerability is defined by institutions, markets, social security, insurance and infrastructure (Adgar and Kelly, 1999). Therefore, the individual and societal conditions that create resilience or vulnerability are important to understanding the impacts of environmental, political and economic stresses faced by urban areas (Parry and Carter, 1998). The rate of change resulting from climate change will require strong resilience, or adaptive capacity, with affected communities (Brooks and Adger, 2003).

Adaptive capacity can be described as the ability to cope, coping capacity, or the capacity of response (Turner, Kasperson, Matson, McCarthy, Corell, Christensen, Eckley, Kasperson, Luers, Martello, Polsky, Pulsipher and Schiller, 2003; Smit and Wandel, 2006). More detailed definitions refer to actions taken by communities to adjust to changing conditions (Smit and Wandell, 2006). Smit and Wandell (2006) indicate that efforts to improve adaptive capacity of communities to climate change have only been moderately effective and that better results are achieved when adaptive capacity is addressed within broader programmes related to issues such as risk management, land use planning, livelihood enhancements and water management systems, development initiatives. Conway (2004) makes a similarly case and argues that addressing health, education and governance in African countries is a valuable way of improving adaptive capacity. This is supported by work that shows that the most vulnerable sectors of the human populations to climate change are the elderly, the young and those suffering diseases such as HIV/AIDs (O'Brien and Mileti, 1992; Vincent, 2004).

Cannon (1994) and Burton et al (1993) suggest that economic wellbeing plays an important role in adaptive capacity. Economic wellbeing can be defined as access to resources and relates to the ability of individuals, families, groups and communities to secure a livelihood (Blaikie *et al*, 1994). At a national level, a strong economy provides a valuable safety both for anticipatory strategies as well as for coping with post-shock events. At an individual level, access to resources can be used to cope with hazards (Vincent, 2004). Vincent (2004) also argues that rural population who are resource-dependent become vulnerable if this resource is threatened and this often results in rural-urban migration. This ultimately

often increases vulnerability as the social networks that provided adaptive capacity in the rural area do not exist in the urban area (Adger, 2000; Moser, 1996).

Adger (1999) argues that there are strong links between inequality and vulnerability. Inequality reduces the communal allocation of resources and the pooling of risk. The concentration of resources in fewer and private hands, limits the extent to which these can be available to address a hazard (Adger and Kelly, 1999). How resources are distributed is fundamentally related to local institutions and therefore the nature and structure of these are an important factor in determining local vulnerability. Local institutions may formal (such as agencies of the state) or informal (such as cultural) and directly affect vulnerability by governing economic activity and property rights (Adger,1999).

Cash, Clark, Alcock, Dickson, Eckley, Guston, Jager and Mitchell (2003) argues it is important to construct suitable institutions and organisational structures to address vulnerability to climate change. These should be based on credible climate change data and ensure that this forms the basis for effective local policies and strategies. The development of local strategies should be co-produced by stakeholders and be supported by social learning and synergistic relationships (Pahl-Wostl, 2007; Pelling, High, Dearing and Smith, 2008; Lemos and Morehouse, 2005). Institutions concerned with climate change risk and how this should be addressed should also be involved with the development of disaster management plans which deal with post-impact activities such as relief and reconstruction (Clack, Keim and Macintyre, 2009; Keim, 2009; UNISDR, 2002). Schipper and Pelling (2006) show that disaster management plans are increasingly taking a more proactive approach and aim to reduce risks and increase local preparedness prior to the occurrence of hazards.

In addition to strong institutional structures, suitable public infrastructure can help deal with hazards. Infrastructure, such as flood defences, can avoid climate change hazards causing human impacts (Handmer, Dovers, and Downing, 1999). It can also provide a ‘lifeline’ which enables the continued movement of people goods and services during and after a hazard (Platt, 1995). Information and communications infrastructure is identified by Blaike et al (1994) as being of particular value in reducing vulnerability.

Berrang-Ford, Ford, and Paterson (2011) argue that adaption responses to climate change by developing and developed countries have distinct differences. In developed countries responses are characterised by short term stimuli such as market conditions. Responses tend to occur at individual, family unit or community level with limited governmental involvement. Adaption responses tend to focus on securing resources and include activities such as avoiding, retreating, coping and spreading risk. In developed countries, responses are characterised by a greater involvement of government who develop anticipatory adaptations to address climate change hazards (Stern, 2006; Costello, Abbas, Allen, Ball, Bell, Bellamy, Friel, Groce, Johnson, Kett, and Lee, 2009). Folke (2006) suggests that one

of the major challenges to humanity will be the development responsive adaptive governance which enable sustainable development pathways.

4. FOSTERING SOCIAL RESILIENCE

An analysis climate change projections, social vulnerability and adaptive capacity can be used to construction an understanding of social resilience and how this can be promoted. This analysis identifies a number of key factors which can be used to promote social resilience. These are presented and discussed below.

3.2 Access to productive resources

A productive resources are resources that can be used to sustain livelihoods and provide incomes to individuals and households. Examples of resources include agricultural land that can be used for farming and tools and workshop space which can be used to manufacture products for sale or provide repair and maintenance services. Local access to these resources improves social resilience as control over these resources is retained locally and resources can be adapted to respond to change. The increased diversity of economic activity resulting from local productive resources reduces vulnerability by generating local social networks and reducing exposure to economic downturns in one sector. Increased self-sufficiency generated by these resources can also reduce vulnerability to external shocks such as food price increases (Blaikie et al, 1994).

3.3 Provision for health and education

Health and education are important factors in improving the resilience of a population (Conway, 2004; O'Brien and Mileti, 1992; Vincent, 2004). Healthy populations are less vulnerable to disease and able to carry out activities, such as evacuation or the construction of basic flood defences, in case of climate change hazards such as flooding. Improved levels of education increase resilience by supporting a greater awareness and understanding about climate change and how it can be addressed. Increasing resilience through health and education can be supported by ensuring that basic health and education infrastructure such as clinics and schools are in place. In addition, other factors that promote health and education such as access to healthy food and clean drinking water as well as the provision of safe environments for learning should be in place.

3.4 Access to information

Social resilience to climate change can be promoted by access to clear information about climate change and its potential impacts. This information may be provided by local and national government and civil action groups and provides information such as climate change projections and their implications for the local area. It can also provide practical recommendations about what can be done to address these changes. This information should be presented in a way that people readily understand it and can act on it (Pahl-Wostl, 2007; Pelling et al, 2008; Lemos and Morehouse, 2005). Information about local climate resilience plans, disaster management plans and institutions that support resilience should be available.

3.5 Shared facilities

Shared local facilities and infrastructure such as local parks, sports facilities, recreational areas and community centres can be an important way of support social cohesion and networks and therefore enhancing social resilience. These facilities can encourage social interaction and shared community activities, such as sports and recreation which build trust and relationships. Shared facilities can also be used to support the development of institutions and provide a venue for public meetings which can be used to increase awareness of climate change and support the development of local climate resilience plans.

3.6 Instuitional and cultural arrangements

Local institutions, such as neighbourhood and civil groups can be an important way of fostering social resilience through increased social cohesion and social networks and as well as through coordination of local climate change plans (Cash et al, 2003). These groups can increase resilience in a range of ways. Firstly, they can be conduit for information about climate change and its impacts and help ensure that this reaches residents of a local area. Secondly, these groups can hold meetings and other fora which involve local community members and enable them to discuss climate change hazards and develop local plans to address this. Finally, these communities can develop organisational structure which are able to support and coordinate local actions to proactive address climate change hazards before these occur as well as dealing with impacts and recovery after an event.

3.6 Local climate resilience plans

Social resilience can be enhanced through collaborative activities involved in the development of local climate resilience plans. By working together to understand local climate change hazards and how these can be addressed, coordination structures and communication systems can be developed which enhance social resilience. Well understood and communicated plans can ensure that local actions to improve resilience in the face of climate change are coordinated and efficient.

3.6 Disaster management plans

Disaster Management Plans, structure actions which reduce the impacts of disasters and help support recovery following a disaster. If these are developed with local community, strong buy in and support of these plans can be achieved. The development of plans and their implementation can be used to coordinate and structure disaster related activities and enhance local social resilience (Clack et al, 2009; Keim, 2009; UNISDR, 2002). These plans can also be used to ensure that appropriate resources and infrastructure are available within appropriate entities such as local government to address climate change disasters such as flooding when these occur.

3. CONCLUSIONS AND RECOMMENDATIONS

An analysis and review of climate change projections, social vulnerability and adaptive capacity has been applied to propose key factors that may be used to promote social resilience in urban communities. These factors include: access to productive resources, provision for health and education, access to information, shared facilities, local climate resilience plans and disaster management plans. A review of these factors indicates that these are well aligned with the mandate of local councils. Therefore, the following recommendations are made:

- The identified social resilience factors are tested by piloting programmes that promote these in a selected urban community.
- Detailed monitoring and evaluation processes are put in place during testing to ascertain the effectiveness of the factors in promoting social resilience and to ensure that lessons are learnt.
- Where data indicates that programmes have been successful in promoting social resilience, methodologies are captured and consolidated in guidelines to be applied by other communities and councils to build social resilience as means of addressing climate change.

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The effects and practical implications of dated development planning practices on the University of KwaZulu-Natal

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ABSTRACT

Purpose of this paper
The apartheid practices in South Afica permeated the fabric of society and all of its sectors influencing all activities including development-planning processes. State organs and semi-government entities like the Universities, were practically absolved from complying with development planning processes and instruments. This study highlights the effects and practical implications of the past development planning practices on the management and administration of physical infrastructure at the University of KwaZulu-Natal (UKZN).

Methodology

The methodology is comprised of a case study that was conducted in two phases. Phase one focussed on preparation planning of the methodology and solution for the study and phase two, is the full project implementation plan of the methodology determined in phase one and its activities.

Findings
The findings indicated inconsistencies and inefficiencies in the layout of the existing cadastral, with buildings straddling property boundaries. There

were too many separate subdivisions that needed to be reduced to improve efficiencies. The municipal valuation and rating of property was not easily identifiable and values of property were not able to be recorded separately on each registered subdivision. The valuation roll was not able to reflect the correct category of property for rating purposes.

Research limitations
This study is confined to the University of KwaZulu-Natal.

Practical implications
There is a likelihood that there are other entities similar to the University of KwaZulu-Natal that are willing and prepared to comply with the modern South African laws and requirements but are unable to do so due to lack of knowledge and the retrospective view of the application of planning and spatial instruments.

Value of paper
This paper provides a practical perspective of the ill experiences and practices resulting from lack of proper planning and compliance with futuristic and modern practices in land-use planning and management

Keywords: Land-use planning and management, spatial planning, sustainable development, development planning, property management

Sub Theme: Construction Industry Transformation and Infrastructure Design and Delivery Challenges

1. INTRODUCTION

The implementation of apartheid, often called “separate development” since the 1960s, was made possible through the Population Registration Act No.30 of 1950, which classified all South Africans as either Bantu, that is all black Africans, Coloured, that is those of mixed race, Asian, that is Indian and Pakistani or White (Encyclopedia Britannica, 2017a).

Racial segregation, sanctioned by law, was widely practiced in South Africa before 1948 (Encyclopedia Britannica, 2017a), but the National Party, which gained office that year, extended the policy and gave it the name apartheid. The Group Areas Act No. 41 of 1950 established residential and business sections in urban areas for each race, and members of other races, non-whites, were barred from living, operating businesses, or owning land in them. In practice this act and two others (1954, 1955), which became known collectively as the Land Acts, completed a process that had begun with similar Land Acts adopted in 1913 and 1936; the end result was to set aside more than 80% of South Africa’s land for the white minority (Kringe, and Donalson, 1999).

Spatial planning systems refer to the methods and approaches used to influence the distribution of people and activities in spaces of various scales (Encyclopedia Britannica, 2017b). Spatial planning can be defined as the coordination of practices, laws and policies affecting spatial organisation and its settlement patterns. It can also be concluded that spatial planning systems were the primary instruments used to facilitate segregation and racial discrimination and in the process entrench the apartheid policy according to Joscelyne (2015). The instruments used to achieve land allocation and land use management objectives were spatial planning, state ownership of land, public financial mechanisms and administrative controls (Urban Land History, 2015).

Under the democratic government of South Africa, there has been a plethora of progressive legislation intended to facilitate uprooting the deeply embedded roots of apartheid particularly in the spatial planning sphere. The latest and final attempt of these, is through the passing of The Spatial Land Use Management Act 16 of 2013, (SPLUMA). The preamble of the Act acknowledges that many people in South Africa continue to live and work in places defined and influenced by past spatial planning and land use laws and practices that were based on racial inequality, segregation, and unsustainable settlement patterns. The challenge for South Africa is that the apartheid spatial planning systems are undesirable, outdated and need to be completely uprooted. The truth on the other hand is that they are deeply embedded and inculcated in the fabric of our communities; they also define the current settlement patterns and their complete removal and eradication is almost impossible and will always be a reminder of our sad past under the brutal apartheid dispensation.

In the past two decades that elapsed since 1994, the interpretation and implementation of the rights in the Bill of Rights have made significant strides away from a system which was characterised by an unequal, discriminatory division of land with attendant homelessness and in which the state ignored and trampled upon, among others, the equality, dignity, property, housing and cultural rights of its citizens (Van Wyk and Oranje, 2015). In South Africa, a shift has occurred from the utilisation of planning laws to regulating development, to facilitating it according to Joscelyne (2015).

Under its constitutional democracy, the South African government has created a vehicle to enhance transformation of the spatial planning and land use management through the passing of SPLUMA, which seek to achieve the following:-

- a uniform, recognisable and comprehensive system of spatial planning and land use management be established throughout the Republic to maintain economic unity, equal opportunity and equal access to government services;
- the system of spatial planning and land use management promotes social and economic inclusion;

- principles, policies, directives and national norms and standards required to achieve important urban, rural, municipal, provincial, regional and national development goals and objectives through spatial planning and land use management be established; and
- procedures and institutions to facilitate and promote cooperative government and intergovernmental relations in respect of spatial development planning and land use management systems be developed.

SPLUMA, serves to provide a framework for spatial planning and land use management in the Republic; to specify the relationship between the spatial planning and the land use management system and other kinds of planning; to provide for the inclusive, developmental, equitable and efficient spatial planning at the different spheres of government; to provide a framework for the monitoring, coordination and review of the spatial planning and land use management system; to provide a framework for policies, principles, norms and standards for spatial development planning and land use management; to address past spatial and regulatory imbalances; to promote greater consistency and uniformity in the application procedures and decision-making by authorities responsible for land use decisions and development applications; to provide for the establishment, functions and operations of Municipal Planning Tribunals; to provide for the facilitation and enforcement of land use and development measures; and to provide for matters connected therewith. Joscelyn (2015) states that the commencement of SPLUMA has triggered wholesale reform which aims to provide a more coherent legal regime governing spatial planning including the uniform approach which is applicable throughout South Africa that SPLUMA adopts.

2. BACKGROUND TO THE STUDY

The University of KwaZulu-Natal was first founded in 1910 but it can also be easily classified as young modern entity. The university is the product of a merger of the University of Durban-Westville, University of Natal, Edgewood College and the Medical School in 1994 and it has five campuses. An initial study and investigation was conducted in the Westville Campus of the University of KwaZulu-Natal to review its property portfolio and asset register of fixed property to ensure that it complies with financial reporting requirements. This resulted in the revaluation of all its buildings across the Campus. Thereafter a land audit was conducted to review the underlying land ownership and within this survey and investigation certain challenges were identified as follows:–

- The layout of the campus property was not structured efficiently with buildings straddling boundaries;

- As a result, the municipal valuation and rating of property was not easily identifiable and values of property were not able to be recorded separately on each registered subdivision as envisaged by the Local Governmnent: Municipal Property Rates Act No.6 of 2004;
- Because of the unstructured and inefficient cadastral layout across the campus, the valuation roll was not able to reflect the correct category of property for rating for example residential property was categorised as business and commercial.
- The large number and configuration of existing registered cadastral properties laid out over the campus makes the efficient management of property difficult from both a facilities management and a rating point of view.

A formal two phased investigation and study was conducted which investigated the option of consolidating and subdividing the existing cadastral into a more efficient layout. It further identified potential rates savings and a significant reduction of properties where there are indications that this should lead to a more efficient management of UKZN property.

3. RESEARCH METHODOLOGY

This study involved the case study methodology. A case study is utilised to produce facts and information in an organised and comprehensive way (Yin, 2013). The methodology is comprised of a case study that was conducted in two phases. Phase one focussed on preparation planning of the methodology and solution for the study and phase two, is the full project implementation plan of the methodology determined in phase one and its activities. The initial revaluation of Westville Campus buildings for insurance and financial reporting purposes and the land audit for the campus in order to create a UKZN owned land schedule prompted the identification of this project and the study. The University being spread over five campuses, initiated this study as a pilot project in Westville Campus which was to be rolled out to other UKZN campuses at a later stage.

3.1 Activities for Phase One of the Study

Phase one focussed on preparation planning of the methodology and solution for the study, which was to be implemented in phase two. The following were the activities and actions for phase one:-

- revaluation of Westville Campus buildings
- undertook the land audit for the campus in order to create a UKZN owned land schedule for Westville Campus

- Deeds office searches were conducted in order to confirm the ownership of property.
- Surveyor General Diagram searches were also conducted and collated title deeds obtained from the deeds registry.
- GIS layers of UKZN land was also prepared.
- The investigation of building locations against land followed
- and finally investigated the rating of property and the rating categories aligned to the actual land uses.

The preliminary cadastral layout plan provided by UKZN together with the land audit was reviewed to

- identify which properties should be consolidated and/or subdivided;
- identify which properties should be subdivided, rezoned and then consolidated;
- identify which properties form a combination of the above.
- overlaying the formal cadastral layout plan over the current cadastral dataset.

The legal land report was then compiled from the formal cadastral layout plan to identify the affected properties in relation to the proposed consolidations. The outcome of this report read with the formal cadastral layout plan informed the methodology to be employed in the second phase of the project. The legal ownership and title deeds of property was used to augment the activity outcomes. A final cadastral layout plan was prepared, showing all properties that will be required to be consolidated and or subdivided in order to realise the project objectives. This also informed the study budget and timing and was interrogated against all the above activities with respect to costs and timeframes involved for the full implementation of the project. A final methodology was developed for full project implementation based on the final cadastral layout plan. A detailed bill of quantities was prepared to inform the budget. Finally a budget was prepared for the project, which included assessing the costs of the Planning & Development ACT (PDA) application papers and PDA submission costs to the Local Municipality. The Municipal costs provisions for such things as application fees, survey fees and conveyancing fees, were also budgeted.

3.2 Activities for Phase Two of the Study

Phase one investigations clearly indicated that there were inconsistencies and inefficiencies in the existing cadastral layout of the erven and in order to promote improved management of UKZN property, there was a need to:

- Apply the data and information to facilitate a new cadastral layout;
- Reduce the number of erven through consolidation & subdivision;

- Initiate an application process in terms of of the KZN Planning and Development Act. No. 6 of 2008, (PDA) and conduct environmental reviews and assessments;

The following were identified activities for phase two that would lead to the archievement of the project goals and the full rectification of the inefficient layout and inconcistencies:-

- Initiate an application process in terms of of the KZN Planning and Development Act. No. 6 of 2008, (PDA) in order to consolidate and subdivide UKZN land as identified in phase one, which will include the realignment of land use and zonings where applicable;
- Undertaking land surveys of new and amended property;
- Preparing new survey diagrams and obtaining approvals from the Municipality and the Surveyor General's Office (SGO);
- Preparing a GIS cadastral layer of the final SGO approved cadastral plans;
- Providing a conveyancing service to attend to all legal aspects of the project of new and amended property, provision of title deeds updated and transfer evidence;
- Liaising with the municipality on the roll and rates assessment updates;
- Preparation and production of the project close out report.

4. FINDINGS FOR PHASE ONE INVESTIGATIONS

The findings indicated inconsistencies and inefficiencies in the existing layout of the existing cadastral layout as follows:

- Westville Campus has 153 separate subdivisions over which there are 60 buildings, with buildings straddling property boundaries;
- Two properties were identified in the roll rated as business and commercial, ERF 1009 and ERF 806 and these two properties hold the main bulk value for Westville Campus.
- As a result, the municipal valuation and rating of property was not easily identifiable and values of property were not recorded separately on each registered subdivision as envisaged by the municipal property rates act;
- The number of subdivisions need to be reduced to around 20 and thereby improve efficiency in property management and property rating.

Because of the unstructured and inefficient cadastral layout across the campus, the valuation roll was not able to reflect the correct category of property for rating for example residential property was categorised as business and commercial.

- The number and configuration of existing registered cadastral

properties laid out over the campus makes the efficient management of property difficult from both a facilities management and rating point of view.

- Westville Campus comprises of a number of uses typical of a university such as education, administration, recreation and the residences with the bulk of the rates attributed to business and commercial and vacant land. Of particular importance is the treatment of residences, which was included for rating as business and commercial and the investigation and implementation, has sought to create separate properties to allow for a separate valuation and a review of the tariffs and rebates.

5. RATING CONSIDERATIONS AND INEFFICIENCIES AFFECTING UKZN PROPERTY AND FACILITIES MANAGEMENT

The research suggests that the the valuation roll and the rates are impacted by an inefficient cadastral layout and it is virtually impossible for the municipality to value each registered property on its own due to the buildings straddling boundaries and varied uses.

The research and further investigations pointed out to the need to investigate and consider doing the realignment of the cadastral layout in order to minimise the category of property deemed “vacant land” that is rated at 4.998 cents in the rand. This rate is punitive compared to Business and Commercial where properties were rated at 2.528 cents in the rand. The Residential category properties were rated at 1.115 cents in the rand. A need was identified to revise the cadastral layout by creating fewer subdivisions over the campus and to realign the new cadastral boundaries to the usage and category of property for rating purposes.

In reviewing current rating practices, we have examined the applicable rates policy of the EThekwini Municipality for the 2015/2016 financial year, which was effective from 1 July 2015. In terms of the rates policy, student accommodation is included in the definitions under “Commercial accommodation” which means lodging or board and lodging, together with domestic goods and services, in any house, flat, apartment, room, hotel, motel, Inn, guesthouse, bed & breakfast, boarding house, residential holiday resort establishment, time share, holiday accommodation, student accommodation or similar establishment which is regularly or systematically supplied but excludes a domicile.

The rates policy provides for a rebate for “commercial accommodation” under section 7.7, of the rates policy and on application may receive a rebate as determined by Council at its annual budget. The rebate application is also regulated by criteria as follows:

- Student Accommodation: On application, property let out for accommodating registered students and or learners of higher education and above, may receive a rebate based on the criteria below.
  - The municipality may determine a rebate at its annual budget and for the 2015/2016 year, it was set at 25% rebate (deduction) off the business rate provided that owners must apply annually and failure to apply will result in a lapse of the rebate;
  - a list of students and student registration certificates must accompany the application;
  - and lease agreements with tertiary Institutions and or with the student or leaner, where applicable, must be included and provided as part of the application.

The research also found that student accommodation is recognised and placed in the category of property "business and commercial*"* and further the municipality has adopted the *"*dominant*"* use approach to categorise property used for more than one purpose (multiple purpose use). This means that under the current UKZN cadastral configuration and land use no opportunity exists to apply for the rebate of 25% in terms of the 2015 rates policy relief and criteria.

To illustrate the potential relief based on the rates rebates, subject to the implementation of the "Land Assembly and Rationalisation of UKZN Property" project (LARP) and any approval by the municipality of the 2015 rebate relief, the below table one has reference. Further, the research found that additional rates savings may be possible by reducing the category of vacant land by categorising it under education or residential land categories. The rates roll value for the student residential buildings for Westville Campus is part of the bulk value, the study has estimated and apportioned values for the student residences based on the UKZN revaluation project to determine and illustrate potential rates relief.

TABLE 1. POTENTIAL RATES SAVINGS FOR WESTVILLE CAMPUS

	RATE C/R	AMOUNT
Value (Estimated and apportioned Residential)		65,000,000.00
Current Rates as Business	2.528	1,643,200.00
Rates (Student Accommodation) with rebate of 25% by application (#)	1.896	1,232,400.00
Potential Rates savings by application (student accommodation)		410,800.00

Notes:
1. Apportioned Residential Value estimated
2. Calculations based on 2015/2016 Rates Tariffs
3. (#) The rebate of 25% is subject to application and provision of student occupancy records.

6. PHASE TWO PROJECT OVERVIEW AND UPDATE

The Westville Campus commenced on March 2015 and is scheduled to be completed in September 2017. Phase 1 has been completed with recommendations and methodology determined for Phase 2. The following provides the progress with the implementation of activities identified for phase two of the project.

Activity 1 – Project Initiation And Stakeholder Engagement
A project of this nature requires significant effort in stakeholder engagement and management as the project interacts with, the client, municipal departments, professional team which include, Town Planners, Land Surveyors and Property Valuers, government departments and is overarched by highly technical legislation covering Planning Acts (SPLUMA), Land Survey Act, Environmental Acts, Property rights and land legal, Municipal Property Rating Act, and many other related statutory regulations and bylaws.

Activity 2 – LARP Project Finalisation With Layout Plan
The consultants in the project have had numerous stakeholder engagements and in consultation with the client the PDA/SPLUMA application documents and cadastral layout plans for the Land Assembly and Rationalisation of Property (LARP) were designed, prepared and collated.

Activity 3 – Land Legal Matters
This activity was undertaken simultaneously with previous two activities above.

Activity 4 – PDA / SPLUMA Application Preparation And Submission
The final PDA / SPLUMA application documentation has been prepared and printed and was officially lodged on 2 November 2016. Following initial screening by the municipality, minor plan amendments were initiated and updated in January 2017. The application is currently being considered by the municipality.

Activity 5 – PDA / SPLUMA Application Approval Process

In progress pending the final approval. The application approval time frames are dependent on the municipality and the applicable procedures of the PDA / SPLUMA and therefore out of the control of UKZN or the project team.

Once approval is given the following activities will need to be conducted:

- consolidation of erven;
- subdivision of erven;
- conveyancing transfers and registrations;
- municipal liaison property rating;
- stakeholder engagement and reporting;
- project finalisation and close out.

5. CONCLUSION

The LARP project was identified and initiated to support the proper management of UKZN property in the areas of compliance, facilities management, and development planning and rating of property. The primary output of the LARP project is therefore to create an efficient layout of the land cadastral subdivisions for Westville Campus, to regularise any inconsistencies in land legal issues and at the same time achieve an alignment of land use to the various actual uses over the campuses to promote equitable rating of property.

The correction of the ills of the past in terms of neglected planning, spatial planning, and land-use planning that affect current and future usage of physical developments and property has no clearly defined and documented guidelines in terms of the application of the law and planning instruments. It is hoped that this paper will contribute to the knowledge sharing and create better understanding of the practical applications of the relevant legislative framework and corrective measures for other entities who may be in a similar situation as UKZN.

It is believed that this paper further gives credence to the initiatives that have been taken in the democratic South Africa and the evolution of the spatial planning legislative framework and the integration initiatives both vertically and horizontally to broaden the scope of planning and unify the posture of land-use planning and management and spatial planning nationally to scholars of construction management and spatial planning.

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The Glass is always greener on the other side: A Case Study between two residential projects

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ABSTRACT AND KEYWORDS

Purpose of this paper
This paper aims to identify and compare different fenestration systems, their prices and the effect they have on indoor climate. A case study between two different types of fenestration systems, including their prices, their impact on regulating temperature within the dwelling and possibly saving costs due to eliminating air-conditioning and heating (HVAC) expenditures. The paper will investigate whether paying more for one type of fenestration system will be more beneficial in the end in terms of life cycle cost and sustainability.

Design/methodology/approach
The case study is an observation between two houses with two different fenestration systems in Bloemfontein – Woodland Hills Wildlife Estate. Measurements were taken over an extended period at regular intervals to examine the performance of the two separate fenestration systems. This was done by installing a temperature and relative humidity meter in both houses. This study is limited to two houses over a set period in Bloemfontein, Free State.

Findings
The initial cost of uPVC double glazed windows of House 2 is 68, 63% higher per square meter than the aluminium single glazed windows of House 1. Results show there is no cost saving in terms of life-cycle costs

and no financial advantages of purchasing uPVC double glazed windows compared to aluminium single glazed windows.

Keywords: Fenestration, Sustainability, Life cycle cost

1. INTRODUCTION

With the realisation that global warming is in fact changing our environment, there has been a growing movement in the concern for the environment and energy consumption. The building industry has a substantial impact on global warming. Sustainable building and creating a zero-energy and carbon-neutral house is the way forward. The concept that one can live comfortably and off the grid is an interesting and exciting new chapter in construction.

Since 2007 the price we pay for energy has skyrocketed by over 400%. The solution is not more energy generation, but better, more efficient use of what we have (Teva, 2016)

This paper focuses on different fenestration systems, their prices and the effect they have on the indoor climate. A comparison between two different types of windows, including their prices, their impact on regulating temperature within the building and possibly saving costs due to eliminating air-conditioning and heating (HVAC) expenditures. The paper will investigate whether paying more for one type of window will be more beneficial in the end in terms of cost and sustainability. The question that always arises, every time when sustainability is brought up is, is it worth it? After all the consideration and the willingness to go green, it might still not be a feasible option, this paper aims to address this through research.

2. LITERATURE REVIEW

2.1 An overview of windows in sustainable building

Windows usually have a sheet of glass fixed in an enclosing framework that allows the window to open. This allows fresh air to enter the building and ventilate it, acting as its second most important function. Apart from the primary and supplementary functional requirements, windows will also need to provide these additional functional requirements: weather resistance, security, thermal conductivity, sound insulation and cleaning.

Windows and doors constitute a large percentage area versus floor area. It is a predominant part of any building and it is where a lot of heat transfer occurs. Windows are no longer only used to allow daylight and ventilation in a dwelling, windows now play a pivotal role in the thermal capabilities of

the dwelling. Many studies have proved that health, comfort and productivity are improved due to well ventilated indoor environments with access to natural light (Ander, 2014). We have seen progress being made in the selection of sustainable materials in South Africa, and the Government has also tried to enforce it, new legislation demands that a building with more than fifteen percent glazing coverage must have thermally efficient windows. The SANS 204 and SANS 10400 Part XA which became law at the end of 2011, requires that a building with more than 15 percent glazing coverage (Glass square meters in relation to internal floor square meters) needs to have thermally efficient windows.

Although as stated progress has been made in this particular field of selecting the correct materials: that has the least impact on the environment and human health it still remains a challenge. It's not due to a lack of information or knowledge but rather the decision of appropriate materials for a sustainable design will vary according to project budgets, regional issues and performance requirements.

To address the goal of sustainable development, the construction material production and construction industries must shift their use of resources and fuels from non-renewable to renewables, from waste production to reuse and recycling, from an emphasis on first costs to life-cycle costs and full-cost accounting, where all costs such as waste, emissions, and pollution are factored into the price of materials (Kibert, 2002)

2.2 Comparison between the window encasements of the two projects: Aluminium vs uPVC

Windows are made out of glass which is an impermeable material, but the problem for leakage happens at the frame or the subset casement where the window opens. The encasement or framework of windows is where most heat loss occurs. Thermal efficiency is affected by the, window framing material and the type of glass and whether it is single, double or performing glazing.. Windows are also a great way to improve the temperature of the house. They form part of the external fabric of the house and needs to work cooperatively to enhance the thermal insulation of the building. Unfortunately, windows are made out of glass, which has a high thermal conductivity. (Charlett, 2007) The thermal conductivity of windows can be improved by the use of multiple glazing.

Product lifestyle tests prove that our windows have less impact on the environment than aluminium and wooden alternatives. The manufacturing of uPVC uses just one seventh of the energy required to make aluminium (Teva, 2016)

Not only do uPVC windows have unique conductive properties but they are also one hundred percent recyclable. The strong system of uPVC windows makes them durable and low maintenance, which make them the cost effective product over its lifetime, compared to aluminium. Product lifestyle tests prove that uPVC windows have less impact on the environment than aluminium and wooden alternatives (Teva, 2016).

3. RESEARCH APPROACH

The case study is an observation between two houses with two different fenestration systems in Bloemfontein – Woodland Hills Wildlife Estate. The study set out to link the performance properties of the windows to the financial aspects of the respective case studies. Including the product price, installation price of the different window systems. Measurements were taken over an extended period at regular intervals to examine the performance of the two separate fenestration systems. This was done by installing a temperature and relative humidity meter in both houses. This study is limited to two houses over a set period in Bloemfontein, Free State.

3.1 Data Collection Instruments

Various tools, software and methods were used to collect data. The use of the HOBO U23 Pro v2 Temperature/Relative Humidity Data Logger and HOBOware Pro software was used to gather data. Structured interviews were also used to get the opinions of the homeowners and their personal experience and satisfaction or dissatisfaction towards their houses and their fenestration systems. Autodesk Revit software was used to create 3D models of the houses so that it could be imported into Autodesk Ecotect Analysis, which provided meaningful figures, tables and graphs adding to other components of the research. The homeowner's electricity bills, quotes and information was also gathered from the suppliers of the windows.

4. FINDINGS AND DISCUSSION

4.1 Introduction to House 1 and 2

Table 1: House 1 Introduction

Longitude and Latitude	29° 2' 52.9362" S, 26° 11' 47.8458" E
Type of Window used	Various. Casement windows were applied in house 1, to combine numerous types of windows to create a bigger, multifunctional window.

Framework	Aluminium.
Glazing	Single glazing. Toughened safety glass was required in areas according to the requirements of SANS 1263.
Envelope	L-shape designed house facing west. There are no or very little roof overhangs and not supplementary sunscreen protection, such as louvres to help with shading. There is no insulation in the ceilings.
Electricity Dependencies	The house makes use of various renewable resources to decrease electricity dependency, such as solar heating and wood fireplace.

Table 2 : House 2 Introduction

Longitude and Latitude	29° 3' 4.032" S, 26° 11' 48.6378" E
Type of Window	Various. Casement windows were applied in house 2, to combine numerous types of windows to create a bigger, multifunctional window.
Frame	All windows have uPVC framing with multi-chambered thermal break profile. Dual compression seals. Steel reinforcement in frames to add strength, rigidity and security. Fusion-welded frames and sashes to prevent leaks. Locking systems and hinges incorporated inside the windows.
Glazing	Double-glazing. Toughened safety glass was required in numerous areas according to the requirements of SANS 1263.
Envelope	H-shaped house and courtyard shades certain areas of the house. Roof overhang of 375mm, which is standard practice in domestic housing and is a shading method.. Recessed windows are shaded by the external envelope in some cases. Wooden cladding acts as an insulated barrier. The roof covering is slate tiles that retain heat better than concrete tiles. Cavity walls are used.
Electricity Dependencies	Solar geysers reduce the need for electricity to heat water. Central heating and air-conditioning was installed.

4.2 Cost of initial fenestration installation

The total square metres of windows and doors are calculated in relation to net floor area to get the cost per square metre of both fenestration systems. The cost includes the price for the product itself. It does not incorporate transportation costs, installation costs or any other costs associated with installing the windows and doors. In House 1 (290 m²) there is 88,65m² of aluminium single glazed windows and doors that total R 172 888, 50. The price per metre square is R 1 950, 23. In House 2 (388m²) there is 144,87m² of uPVC double glazed windows and doors that total R 411 652, 86. The price per metre square is R 2 841, 48. Therefore, uPVC double glazed windows are 68, 63% more expensive initially per square metre. House 1 is 98m² smaller than House 2 in respect of the internal floor area. House 1 also has 6% less windows per floor area than House 2.

4.3 Electricty usage

Table 3 and 4 is the monthly electricity usage from March to August for House 1 and 2 respectively. The table uses 1, 81 kWh/m² for all six months. There was an increase in electricity prices during July and August. Therefore, the electricity bill increased from R 3, 02/m², which was consistent through month one to month four and increased to R 3, 20/m² in month five and month six. House 2 usage ranges from 1, 48 kWh/m² in April to 2, 96 kWh/m² in May. House 2's electricity usage averages out to be 2, 15 kWh/m², which is 0, 34kWh/m² more than House 1. Therefore, House 2 pays more monthly for electricity than House 1, which can be attributed to size as stated above. In the coldest months however, month five and month six, House 2 uses less electricity and this is when the uPVC windows performs best.

Table 3: House 1 Electricity Usage

Month	**1**	**2**	**3**	**4**	**5**	**6**
Electricity (kWh)	523.60	523.60	523.60	523.60	523.60	523.60
Electricity (R)	877.19	877.19	877.19	877.19	928.33	928.33
(kWh/m²)	**1.81**	**1.81**	**1.81**	**1.81**	**1.81**	**1.81**
(R/m²)	**3.02**	**3.02**	**3.02**	**3.02**	**3.20**	**3.20**

Table 4: House 2 Electricity Usage

Month	**1**	**2**	**3**	**4**	**5**	**6**

Electricity (kWh)	862.10	574.80	1149.60	862.10	785.40	785.40
Electricity (R)	1,315	877.19	1,754	1,315	1,315	1,315
(kWh/m²)	**2.22**	**1.48**	**2.96**	**2.22**	**2.02**	**2.02**
(R/m²)	**3.39**	**2.26**	**4.52**	**3.39**	**3.39**	**3.39**

4.4 Comparitive temperature analysis

Table 5: Month 1 Temperature Analysis

	House 1			House 2		
Time	9:00	12:00	18:00	9:00	12:00	18:00
2016-03-18	24.30	26.10	27.10	23.05	25.15	25.10
2016-03-19	24.10	25.65	29.45	23.35	26.80	25.20
2016-03-20	24.15	26.20	28.75	23.50	27.00	26.15
2016-03-21	23.80	27.00	28.60	24.50	27.90	26.60
2016-03-22	23.05	24.90	27.90	25.00	26.40	27.30
2016-03-23	23.20	25.65	27.00	25.05	27.95	26.80
2016-03-24	24.00	25.70	27.00	25.00	28.60	29.00
Average (°C)	**23.80**	**25.89**	**27.97**	**24.21**	**27.11**	**26.59**
Average (°C)			**25.89**			**25.97**
Range			**4.17**			**2.39**
SUM			**4**			**3**

Table 5 is a detailed temperature reading taken in March for House 1 and House 2. Bloemfontein is the baseline to accurately compare the performances of House 1 and House 2 and their corresponding fenestration systems. The highlighted cells are any temperatures ranging between 18 and 24 °C, which according to the West Midlands Public Health Observatory to be the minimum and maximum comfortable room temperatures. House 2 has three readings during the morning of comfortable room temperatures. That is one less than House 1, thus, uPVC windows performs in a manner that makes the house too hot, which is unsatisfactory. The temperature range of House 2 is less than House 1, thus entailing uPVC double glazed windows controls the indoor

temperature and creates a consistent room temperature, which is easier to control than the inconsistency of aluminium single glazed windows. Both aluminium single glazed windows and uPVC double glazed windows perform satisfactory in warm conditions. House 1 averaged 4, 42 °C higher than Bloemfontein's average temperature and House 2 averaged 4, 5 °C higher.

Table 6: Month 2 Temperature Analysis

	House 1			House 2		
	9:00	12:00	18:00	9:00	12:00	18:00
2016-05-01	16.85	19.00	21.50	18.50	21.35	21.75
2016-05-02	16.60	20.00	22.80	18.15	22.00	22.65
2016-05-03	17.70	21.00	23.00	19.30	23.10	23.80
2016-05-04	18.10	21.30	23.00	19.90	22.50	22.55
2016-05-05	17.70	22.20	25.05	19.05	23.80	24.00
2016-05-06	18.60	22.60	25.00	20.60	25.00	24.80
2016-05-07	18.90	19.95	18.95	21.20	21.05	21.25
2016-05-08	17.75	19.00	20.50	19.00	18.75	19.10
2016-05-09	17.70	19.60	19.20	18.05	20.10	19.80
2016-05-10	17.40	18.00	19.00	18.70	18.50	19.65
2016-05-11	17.00	19.30	20.60	17.30	21.40	21.00
2016-05-12	16.85	19.40	20.10	18.60	20.50	21.75
2016-05-13	18.10	18.80	18.40	19.30	19.40	18.90
2016-05-14	16.85	16.35	17.40	17.20	18.00	17.60
2016-05-15	15.50	17.80	19.20	16.25	20.10	19.35
2016-05-16	16.30	18.90	21.30	17.05	19.70	20.80
2016-05-17	17.20	20.20	22.00	18.50	21.30	22.60
2016-05-18	18.00	20.55	21.00	19.60	22.90	23.80
2016-05-19	19.10	21.00	22.95	20.40	21.80	22.90
2016-05-20	18.80	21.80	23.50	20.10	23.90	23.70
2016-05-21	18.80	21.10	22.55	20.85	23.65	23.80
2016-05-22	18.20	21.10	22.70	20.80	24.20	24.10
2016-05-23	18.00	19.50	20.50	20.90	24.40	24.40
2016-05-24	17.50	20.55	21.50	20.55	23.30	23.10
2016-05-25	18.00	21.00	22.00	19.95	23.60	23.00
2016-05-26	18.15	19.00	19.70	20.00	22.95	22.20

2016-05-27	17.00	19.00	21.00	18.75	22.60	22.50
2016-05-28	16.70	18.80	21.40	18.90	22.20	23.10
2016-05-29	16.30	18.10	21.00	18.95	22.45	22.80
2016-05-30	16.30	19.40	21.30	19.50	22.65	23.60
2016-05-31	16.50	19.60	21.15	18.70	22.50	23.00
Average (°C)	**17.50**	**19.80**	**21.27**	**19.18**	**21.92**	**22.17**
Average (°C)			**19.52**			**21.09**
Range			**3.77**			**2.99**
SUM			**71**			**82**

House 2 has a total of eighty-two readings throughout the day of comfortable room temperatures, eleven more than House 1. Thus, uPVC windows makes the house more comfortable at room temperature than the house with aluminium single glazed windows. The temperature range of House 2 is 0, 78 °C less than House 1. Both aluminium single glazed windows and uPVC double glazed windows perform satisfactory in colder conditions. House 1 averaged 19, 52 °C and House 2 averaged 21, 09 °C where the outside average temperature was 14, 86 °C.

Table 7: Month 3 Temperature Analysis

	House 1			House 2		
	9:00	12:00	18:00	9:00	12:00	18:00
2016-06-01	17.00	19.80	21.30	19.65	22.65	22.90
2016-06-02	16.50	19.75	21.05	19.00	22.60	22.95
2016-06-03	16.20	18.70	21.00	19.00	22.95	23.10
2016-06-04	16.50	19.00	21.00	18.90	22.15	22.70
2016-06-05	16.80	18.50	21.50	19.40	21.25	21.50
2016-06-06	17.00	18.00	20.90	18.10	22.10	22.85
2016-06-07	16.30	18.00	19.70	18.90	22.10	21.75
2016-06-08	16.20	18.20	20.00	18.10	22.10	22.00
2016-06-09	16.50	18.80	21.00	19.00	22.50	22.10
2016-06-10	17.10	18.00	19.20	19.70	21.00	20.80
2016-06-11	16.80	18.30	19.70	18.65	19.85	18.70
2016-06-12	15.20	15.95	17.90	15.00	15.65	17.00
2016-06-13	15.30	14.50	16.10	14.85	15.15	15.40
2016-06-14	15.30	14.85	16.20	14.55	15.25	15.00
2016-06-16	15.60	18.00	19.45	16.75	18.30	20.00

2016-06-17	14.85	17.05	18.70	15.60	19.40	20.15
2016-06-18	14.80	18.25	20.15	16.10	19.50	20.25
2016-06-19	15.45	16.80	19.20	16.90	21.00	21.35
2016-06-21	14.40	17.85	18.70	17.20	20.75	21.05
2016-06-22	13.95	18.00	18.90	16.05	20.20	19.30
2016-06-23	14.10	18.60	20.00	16.45	19.90	20.50
2016-06-24	15.25	18.40	19.90	16.90	21.20	21.70
2016-06-25	14.90	17.90	19.50	17.50	21.10	21.20
2016-06-26	14.70	18.00	19.55	18.00	21.60	22.00
2016-06-27	14.75	16.80	19.20	17.85	22.15	21.50
2016-06-28	14.50	17.10	18.80	17.40	21.25	20.95
2016-06-29	14.30	16.95	19.80	17.30	21.00	21.90
2016-06-30	14.60	16.60	19.40	17.55	21.35	21.55
Average (°C)	**15.53**	**17.74**	**19.56**	**17.51**	**20.57**	**20.79**
Average (°C)			**17.61**			**19.63**
Range			**4.03**			**3.28**
SUM			**42**			**62**

Looking at the above tables, uPVC windows outperform house 1 with aluminium single glazed windows as the temperatures drop. At an average outside temperature of 12, 58 °C and average morning temperature taken at 09h00 of 6, 38 °C House 2 with uPVC windows has an average room temperature of 19, 63 °C. This falls in the range of comfortable room temperatures, whereas House 1 with aluminium single glazed windows has an average room temperature of 17, 61 °C, which is not in the range of comfortable room temperatures. Refer to Table 8 and House 1's column, not one reading taken at 09h00 is in the range of comfortable room temperatures. This is because the aluminium single glazed allows for heat loss and all the warm air escapes overnight, which is the opposite with uPVC windows in House 2.

Table 8: Month 4 Temperature Analysis

	House 1			House 2		
	9:00	12:00	18:00	9:00	12:00	18:00
2016-07-01	14.85	19.00	19.35	17.90	20.90	20.45
2016-07-02	14.50	18.20	18.50	16.70	18.90	19.70
2016-07-03	14.10	16.80	19.15	14.90	18.50	19.00
2016-07-04	14.20	16.80	18.40	16.85	19.00	19.35

2016-07-05	14.80	16.00	16.65	16.40	17.90	19.00
2016-07-06	14.50	17.20	18.50	16.30	19.30	19.20
2016-07-07	13.60	17.20	18.70	15.50	18.90	19.40
2016-07-08	14.00	17.20	19.20	15.00	19.10	19.60
2016-07-09	15.00	17.00	20.30	15.25	20.20	20.60
2016-07-10	15.00	19.60	20.30	16.35	20.90	21.05
2016-07-11	15.00	19.70	20.50	17.40	21.00	21.20
2016-07-12	15.05	19.10	20.00	17.35	20.30	21.15
2016-07-13	15.70	19.40	20.15	17.65	20.95	21.15
2016-07-14	15.00	18.70	20.15	17.00	20.90	20.25
2016-07-15	14.90	18.50	19.90	17.35	21.05	21.70
2016-07-16	14.85	18.20	20.00	17.70	21.00	21.80
2016-07-17	15.60	18.00	20.20	18.00	20.75	21.25
2016-07-18	15.45	17.40	20.45	17.90	21.80	22.20
2016-07-19	15.20	17.85	21.10	17.90	22.40	23.00
2016-07-20	15.90	20.50	21.00	18.65	23.10	23.20
2016-07-21	15.85	20.75	21.05	18.90	22.90	22.10
2016-07-22	15.50	18.95	19.90	18.70	21.90	21.05
2016-07-23	15.05	16.65	19.20	17.70	20.40	20.70
2016-07-24	13.00	16.25	19.30	15.55	17.25	19.90
2016-07-25	15.75	13.70	14.00	15.75	16.60	15.30
2016-07-26	13.70	15.20	16.50	14.00	15.70	17.10
2016-07-27	12.90	14.10	17.05	14.15	16.00	17.70
2016-07-28	14.05	15.05	16.45	14.00	13.95	13.90
2016-07-29	13.10	14.65	17.10	12.50	16.15	15.50
2016-07-30	13.05	16.20	19.00	13.35	17.15	17.00
2016-07-31	14.85	16.55	16.25	14.75	15.10	15.50
Average (°C)	**14.65**	**17.43**	**18.98**	**16.37**	**19.35**	**19.68**
Average (°C)			**17.02**			**18.47**
Range			**4.33**			**3.31**
SUM			**37**			**50**

House 1 with aluminium single glazed windows does not perform to satisfaction with an average temperature of 17, 02 °C, which is lower than the minimum requirement for comfortable interior room temperature of 18

°C. House 2 with uPVC double glazed windows performs satisfactory with an average interior room temperature of 18, 47 °C. Table 8 depicts red cells, which illustrates that in that period there was a cold front. On the 27th July at 09h00 readings showed a low of 1 °C and a high of 11 °C that particular day. During that day, House 2 with uPVC outperformed House 1 with aluminium single glazed windows. July is the coldest month of the year in Bloemfontein, thus referring to this month and the other data one can conclude that uPVC double-glazed windows perform better than aluminium single glazed windows in cold weather.

5. CONCLUSION AND RECOMMENDATIONS

uPVC double glazed windows used in House 2 perform better than aluminium single glazed windows used in House 1 , the readings over six months indicated that the range between the lowest and highest temperatures in House 2 were less than the range of House 1. The conclusion can be made that the uPVC double glazed windows of House 2 performed increasingly better than the single glazed windows of House 1 as the outside temperature declined. This proves that the heat retaining properties of uPVC double glazed windows perform better than the aluminium single glazed windows. The initial cost of uPVC double glazed windows of House 2 are 68, 63% higher per square meter than the aluminium single glazed windows of House 1. Results show that House 2 pays more monthly on electricity than House 1, therefore the conclusion can be made that there is no cost saving initially and no financial advantages of purchasing uPVC double glazed windows compared to aluminium single glazed windows. In addition, according to the acquired data there are no savings in running costs like savings on electricity bills, therefore no compensation for the 68, 63% escalation in price of purchasing uPVC double glazed windows. Further research can be done in a similar type of case study that you control the variables as accurately as possible.

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Towards sustainable human settlements in South Africa: emerging approaches through a case study analysis

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ABSTRACT AND KEYWORDS

Purpose of this paper
The purpose of this paper is to analyse the emerging discourses around low-cost housing strategies in the South Africa context and to investigate two exemplary case studies reflecting the two divergent models.

Design/methodology/approach
The methodology is based on the critical review of the current challenges and new emerging formal low-cost housing strategies and models, and on the empirical investigation of two exemplary case studies through focus group interviews with inhabitants and the manager of local government's Department of Human Settlements.

Findings
The desired target of creating integrated human settlements in South Africa has not been reached through the housing policies and delivery models implemented so far. Two new discourses are currently advancing: intensive urban consolidation linked to overarching strategies of urban regeneration, and extensive development through mega-projects of mixed-income housing. The interviews highlighted that low-income inhabitants of the intensive redevelopment in an urban environment highly benefitted from the proximity to social and economic centres and this is to them a more important factor than a better quality of physical housing environment that new green-field projects can provide.

Research limitations/implications (if applicable)
The study focus on two exemplary case studies in the area of Durban. The findings open the research to further studies oriented to investigate how to manage effectively in the construction process the transition towards principles of sustainability for South African human settlements, also through new housing policies and delivery models.

Practical implications (if applicable)
The findings of the study can stimulate further development of policy initiatives towards integrated, sustainable and resilient human settlements in South Africa.

What is original/value of paper. The paper compares and contrasts possible benefits and barriers associated to the two opposite emerging discourses around the current low-cost housing paradigm in the South African context, through the analysis of two exemplary case studies.

Keywords: Sustainable Human Settlements, Urban Regeneration, Intensive Urban Consolidation; Extensive Development; Mega-Projects.

1. INTRODUCTION

The 2030 Agenda for Sustainable Development highlights the importance of making cities and human settlements inclusive, safe, resilient and sustainable as one of the Sustainable Development Goals (UN, 2015). In particular, the access to adequate housing is considered critical to improve the living conditions of low-income groups and allow them to advance socially and economically. This issue also brings to attention the need for accessing basic services and appropriate energy infrastructure to fulfil the requirements of adequate living conditions.

In developing countries, such as South Africa, these challenges affect a large part of the population. In 2015, 14.4 percent (%) of the South African households were living in state-subsidised dwellings, whereas 14.1% lived in informal houses and 6.9% in traditional dwellings. With an unemployment rate of almost 27%, poverty and fragility of low-income groups remain among the most serious concerns for the country (Stats SA, 2016).

Since 1994 the South African Government has acknowledged the importance of ensuring the access to adequate housing as a basic human right. Section 26 of chapter two of the Constitution of South Africa states in fact that "everyone has the right to have access to adequate housing" (Gov SA, 1996), in line with the article 25(1) of the United Nation Universal Declaration of Human Rights of 1948. Consequently, in the last two decades several policies have been issued by the South African Government to promote the achievement of this target. However, obsolete planning and design schemes, location far from economic opportunities, inadequate quality of subsidised houses and lack of amenities and community services have often prevented low-income households and human settlements from achieving targets of inclusion, safety and sustainability (Sutherland *et al*., 2014; Turok, 2016).

The process of urbanisation has increased the challenge, resulting in the housing backlog continuing to grow (Ibid.) and incrementing the pressure on the urban environment and low-income groups. Alternative land and housing planning and design schemes, different financing mechanisms represent some of the topics which are at the centre of the

debate to provide sustainable solutions to the growing population in urban areas and relevant housing needs (Ibid.; Western Cape DHS, 2013). Green and sustainable principles, looking holistically at environmental, social, cultural and economic impacts, should become the drivers for addressing the challenge of developing sustainable human settlements.

This paper provides a contribution to the debate by reviewing the current challenges in the South African context, and by analysing the emerging approaches around formal low-cost housing strategies, particularly through the lens of the preliminary findings from the empirical investigation of two exemplary case studies in the Durban area.

The following section provides a critical review of the current challenges faced in the South African context and of the new emerging approaches to the housing problem. Then, the methodology adopted for the study is explained in detail, followed by the assessment and discussion on selected case studies. Finally, conclusions and recommendations are proposed.

2. FROM HOUSING PROVISION TO SUSTAINABLE HUMAN SETTLEMENTS

The urbanisation level in Africa is projected to rise from 40% in 2010 to 50% around 2035 and 58% in 2050 (African Development Bank, 2011). Urbanisation has the potential to offer better economic opportunities to low-income groups migrating from rural areas. On the contrary, unmanaged growth of cities is currently having negative environmental, health and social impacts, increasing the pressure on African cities, which need to develop new urban paradigms.

In South Africa, urban population is growing and is expected to exceed 70% of the entire population of the country by 2030 (UN, 2014). The increasing concentration of population in cities, particularly low-income groups, and consequent economic, social and environmental impacts pose massive challenges in terms of housing, infrastructure and basic services, but also food, education, health and resource conservation. The consequent risk is the persistence of poverty, inequality, social exclusion and spatial segregation while cities grow due to the migration of low-income groups (UN, 2016). The New Urban Agenda, released through the Habitat III Conference in 2016, is oriented to face these challenges globally by readdressing “the way cities and human settlements are planned, financed, developed, governed and managed” (ibid.: 1) in a coordinated and integrated manner. The implementation of the New Urban Agenda will contribute to the implementation of the 2030 Agenda for Sustainable Development and its specific goal aimed at making cities and human settlements inclusive, safe, resilient and sustainable.

According to recent figures, South Africa’s housing backlog still stands at 2.1 million of units, decisively more than the estimated deficit of 1.5 million houses in 1994 when the Government started formal subsidised housing programmes (Tomlinson, 2015). This occurs although the Government has provided since 1994 2.5 million subsidised houses and 1.2 million serviced sites, with a significant increase of the housing subsidy

over this period and an escalation of state spending on housing and community amenities from 1% to 3.7% of GDP (Ibid.). These numbers indicate that South African cities cannot keep up with the current demand for housing, at least not using traditional housing models and delivery methods.

The urban population living in informal settlements decreased from 17% in 2002 to 11% in 2014. Nevertheless, the percentage of households living in informal dwellings has only decreased slightly from 13.6% to 13.1% (Stats SA, 2016). This mismatch is likely to depend on increases in households living in informal dwellings in the backyards of other dwelling types. Also, the number of informal settlements has increased significantly in the same time period (from 300 to 2225) (Tomlinson, 2015), growing faster than the rate of low-income housing delivery. This makes new approaches to the relationship and integration between formal and informal city necessary, in order to accept the informal sector as an important component of urban planning in South African contemporary cities.

Informal settlements, despite unsanitary and insecure living conditions, are generally formed in areas that offer a strategic location for low-income groups to access better economic opportunities and favoured community networks (Turok, 2015a). Extreme measures of forced eviction and demolition of shacks in urban areas, adopted in the past as “legitimate” to address the goal of eradicating poverty and the housing backlog, were mostly unsuccessful and, on the contrary, a proliferation of informal settlements in peri-urban areas has occurred (Sutherland *et al*., 2014). More recent policies have generally rejected top-down approaches of eviction and relocation of inhabitants of informal settlements far from their location, unless under exceptional circumstances. Resettlement, if necessary (e.g. in case of hazardous site conditions), should on the contrary be a last resort and follow a bottom-up approach planned and implemented in agreement with the community (DHS, 2009a). Since as early as 2004, therefore, the South African government recognised the importance of in-situ upgrading of informal settlements as an overt target of the “Breaking New Ground” (BNG) policy (DHS, 2004). The government launched therefore the Upgrading Informal Settlements Programme and associated grant money to assist municipalities with upgrades. In order to better support the implementation of the programme, the Department of Human Settlements designed the National Upgrading Support Programme in 2010, which is oriented to provide guidance, practical tools and assistance to municipalities in the process which should be based on a participatory approach. However, given the growth in the number of informal settlements, the inherent complexity of upgrades and the commitment required by all the stakeholders involved, some communities have had to fight for much time before getting upgrades (Bosworth, 2016).

The increasing number of informal settlements also relates to the inefficiency of the policy and model for formal low-cost housing delivery in sustaining the growing urbanisation. The Reconstruction and Development Programme (RDP) for housing was initiated in 1994 as a strong state-driven large-scale formal housing delivery programme through the provision of state subsidised housing to address inequality and housing

backlogs, following the principles set out in the White Paper on Housing (Sutherland *et al*., 2014). Typical RDP settlements are low-density developments with detached single-storey units, built generally on peripheral, cheap and available land, with the subsidy allocated for the construction of the top-structure of the unit. However, the houses have often been found of sub-standard quality, not complying with the building regulations and serviced by poor infrastructure making inefficient use of water, energy and other resources (Ibid.; Lodge, 2003; NPC, 2012). Settlements were generally located on the urban outskirts and isolated from social services and livelihood opportunities, therefore not producing sustainable neighbourhoods, but creating mono-functional settlements (Turok, 2014) and increasing the exclusion and spatial marginalisation of low-income communities (Sutherland *et al*., 2014; Turok, 2016). In 2000, in a judicial challenge known as "Grootboom ruling" the Constitutional Court contended that post-1994 South African housing policy was not meeting the right to housing as protected in the Bill of Rights, and then a review of the policy was claimed as necessary (Huchzemeyer, 2011). However, shifts in policy do not always correspond to meaningful implementation in practice, which requires a greater commitment at all levels from the actors involved in the process to effectively implement demanding measures (Ibid.).

The review of the national housing programme in 2004 led to the already mentioned "Breaking New Ground" policy, which adopted a more holistic approach to housing and should have shifted the focus towards integrated communities, providing social and economic facilities (Sutherland *et al*., 2014). However, despite the more integrated and holistic underpinning philosophy, housing has continued to be provided mostly as poor-quality construction and "physical shelter rather than part of an integrated human settlement with access to jobs, amenities and community services" (Turok, 2016: 14). Moreover, the new National Housing Code of 2009 highlighted the lack of any environmental criteria in the common low-cost housing practice and stated that energy consumption patterns of low income households have emerged as one of the most influencing factors to the national electricity demand (DHS, 2009b). Houses and settlements have generally been designed without consideration of basic passive design criteria and energy efficient principles, which have the potential to offer significant benefits to low-income households in terms of energy savings and better indoor comfort. The new National Housing Code however includes only a few qualitative energy saving criteria, in the form of suggestions and not specific requirements. Also, the new South African regulation on energy usage in buildings (SANS 10400-XA) does not provide specific requirements for low-cost houses, which, on the contrary, should be addressed through a specific approach due to the critical socio-economic implications.

A new more articulated housing policy has been promised since 2010, but it has taken longer than expected (Turok, 2014). Current discourses revolve around two opposite approaches to accommodate the population growth: extensive development or intensive urban development (Turok, 2016). The extensive approach focuses on planned urban extensions, new satellite cities (Ibid.) and mega-projects, incorporating mixed use and mixed

income housing, such as Cosmocity in Johannesburg and Cornubia in Durban (Sutherland *et al.*, 2015). However, some critics mentioned the risk for mega-projects, being built on cheap peripheral land, of reinforcing urban fragmentation and exclusion (Turok, 2015b).

Intensive urban development, which includes upgrading informal settlements, can be achieved through infill projects on vacant, better located land, which may also incorporate incremental housing schemes, and higher density redevelopment of existing buildings aligned to an overarching plan of urban regeneration. Higher density and participatory processes in decision making, planning and design are important aspects (Sutherland *et al.*, 2014; Turok, 2016; Tomlinson, 2015; Boyco and Cooper, 2011) which can play a key role in both intensive and extensive approaches. The new target of the government seems therefore to shift from the provision of housing to a more in-depth scope of ensuring that low-income households have easy access to economic centres (Turok, 2014). This seems to reflect an increased interest in the socio-economic sustainability of the human settlements.

The following sections describe in detail the methodology followed for the study and analyse two exemplary case studies in the area of Durban (KwaZulu-Natal province) which represent two initiatives reflecting the two contrasting approaches. The analysis is oriented to investigate in more depth possible benefits achieved by inhabitants in terms of sustainability in order to face the challenges highlighted through the literature review.

3. RESEARCH APPROACH AND METHODS

The methodology combines a theoretical approach with a case study method, which includes an empirical investigation based on a qualitative approach through observation and focus group interviews.

The in-depth review of the literature has provided an overview of the main challenges faced in South Africa in relation to the need for shifting from the concept of housing provision for low-income groups to the creation of integrated, sustainable, inclusive, safe and resilient human settlements. The review has also argued the main discourses emerging from the current debate around the topic.

In light of these findings, the analysis of two case studies in the Durban area, representative of the two opposite discourses emerging from the literature, has been utilised to highlight possible benefits and challenges related to the two different models in respect to sustainability implications, particularly from an inhabitant perspective. The case study approach has been adopted being an empirical inquiry able to investigate a phenomenon within its real life context, providing multiple sources of evidence (Yin, 1994). The case study paradigm assisted in providing a more in-depth and contextualised understanding of some of the issues emerged through the literature review.

The case studies were carried out and analysed through primarily a social sustainability lens, which also has significant implications in terms of

economic impact on communities and households. According to Berardi (2013), the most overlooked dimension of the concept of sustainability is the social aspect. The sustainability of buildings is often measured by ecological factors, however this evaluation is limited to the physical boundaries of the building, and it is mainly interpreted from the environmental perspective. As a result, sustainability assessment methods have been accused of reducing the sustainability of a building to the functioning of individual environmental criteria (Conte and Monno, 2012). Perhaps the main challenge to social sustainability assessment is that people perceive buildings and their impact in various ways. A number of stakeholders are part and parcel of the development process of a settlement, which implies different points of view in sustainability priorities and the request for more intense participatory processes.

The social sustainability aspect of human settlements development is largely enforced and entrenched by the Habitat III New Urban Agenda, Common African Position for Habitat III and UN-Habitat Sustainable Development Goals. While analysing the case studies, this research looked primarily at the following aspects of social sustainability: end user satisfaction with physical structure of houses and settlement; proximity to economic opportunities and amenities; safety; transportation-related issues for inhabitants; end-user involvement in the development of the settlement; comfort and quality of life with the possibility of expansion from those aspects expressed by participants.

The case study analysis was conducted through an empirical field investigation involving observation on site and semi-structured interviews with focus groups of fifteen participants on each of the two selected sites. The provincial Human Settlements Manager was involved in the discussions and interviews. The approach of focus groups was utilised to attain a deeper understanding of the qualitative aspect of what is happening on the ground.

From the findings from the literature review and the case study analysis, possible suggestions have been derived to contribute to the debate.

4. CASE STUDY ANALYSIS AND DISCUSSION

The preliminary findings of the analysis of case studies, which is part of a broader research, are reported. This preliminary study serves to scratch the surface of intensive and extensive development and their impact on sustainability as per the perception of the end users, particularly from a social perspective and relevant economic implications.

The case studies reflect two different approaches that the South African government seems to be exploring in terms of human settlement planning and delivery. The case studies are firstly presented in the following sections, then the results of the empirical investigation are discussed.

4.1 Cornubia project

The first case study is the Cornubia megaproject development, which is a public-private partnership between the eThekwini Municipality and Tongat Hullet Group and is located in the northern development corridor of eThekwini Municipality, 15 km south of King Shaka International Airport and Dube TradePort megaproject. The project consists of a large housing component, commercial and light industrial development, and social facilities (Department of Human Settlement, 2014). In its original proposal the development aimed to provide 50,000 homes of which 20,000 were to be subsidised housing, 90 ha of industrial platform, over 1 million m^2 of commercial space and 400 ha dedicated to a rehabilitated open space system (Tongaat Hulett, n.a.).

The Cornubia project constitutes a representation of extensive development in the form of large-scale, mixed-use and mixed-income green-field human settlement projects which mirror a 'megaproject' approach to addressing the housing crisis in South African cities. This approach emerged from the BNG Policy with the specific intention of addressing housing backlogs and persistent urban segregation. These mega-projects are promoted as having the potential to drive economic growth, create employment opportunities, restructure the pre-1994 space economy and ensure that benefits trickle down to the poor and disadvantaged (Sutherland et al., 2014). Instead of mere low cost settlements, these projects aim to also establish industrial and commercial hubs and various options in housing typologies and income groups that are targeted. Essentially, the focus seems to be to create what is often envisaged by private and public partnerships as 'better living conditions', which however consider secondarily the already established economic and social centres for low-income groups.

4.2 The redevelopment of an existing building in Durban inner city

The second case study is related to the approach of intensive urban development, based on the reuse of an existing building block located in the Durban city centre. The overarching philosophy in this case is that more intensive growth and human settlement enhancement can be realized through infill projects on vacant land or higher density redevelopment of existing inner city buildings (Turok, 2016). The arguments for intensive development vary from the efficient use of land and infrastructure to its potential to consolidate existing cities while also revitalising and regenerating older urban districts (UN-Habitat, 2014).

4.3 Research Findings

The dilemma between intensive and extensive approach to urban settlement development is essentially related to a challenging quid pro quo between preparing for new urban growth on green-field sites, versus revitalising older urban areas, including the upgrading of informal settlements.

In regards to end-user satisfaction with the physical environment of houses and settlements, the participants in Cornubia were seemingly pleased with the physical structure and housing typologies afforded to them. A majority of the participants felt their houses afforded them flexibility and space which contributed to their general comfort.

The participants in the inner city however expressed their dissatisfaction with the high density levels, which negatively contributed to their perception of safety and general comfort. What was flagged as the biggest issue in this regard was the limited space and close proximity of neighbours and restrictions such as the lack of playgrounds and access to public spaces. However all the participants stressed that the opportunities and benefits of being located within the inner city far outweighed any reservations they had about the physical environment of their house and building block. This factor supports the evidence found in a study conducted by the Centre on Housing Rights and Evictions, which also indicated that the greater majority of residents residing in the inner city would rather tolerate poor living conditions than moving to the urban edge (Housing Development Agency, 2013).

What can be gathered from this is that the upgrade of the quality of houses has provided benefits to the Cornubia settlement's beneficiaries. This is a positive turn from the past which saw RDP settlements experience deficits in building quality and other deficiencies which often provoked growing community unrest (Turok, 2016).

In terms of transportation-related issues and proximity to economic centres, the study found that inhabitants within the inner city redeveloped building had constant and considerable access to economic opportunities and amenities, with 80% of the participants having found permanent employment and small business opportunities since moving into their flat. Amenities such as schools, shops, public health care facilities as well as cultural and religious sites were all walking distance away. This meant drastic savings on cost and time spent on daily travelling.

Participants in Cornubia were all highly vocal on being subjected to burdensome (time and cost) commutes on unreliable transport networks on a daily basis. Majority of the participants stated that keeping the previous employment they had before moving to Cornubia became financially unviable, therefore they strung on the hope of attaining employment opportunities from the development of commercial and industrial spheres in Cornubia in the future. An astounding 60% of participants considered forfeiting their houses for the opportunities and conveniences that accompanied the location of their former informal settlements, as some of their previous counterparts had done. The participants also expressed their dissatisfaction with the break in social ties (supporting structures, cultural and religious aspects) as well as the additional financial and administrative expenses that came with being forced to change school for their children due distance and cost implications.

What can be gathered from the above is that location of settlements and relevant economic and social implications are critical to beneficiaries. Therefore it is important to consider that, according to Turok and Borel-

Saladin (2015), less than a third of RDP homeowners have a job. Also, the average commuting times for black households have increased from 88 to 102 minutes a day over the last decade because of where new housing developments have been constructed and the slow progress with public transport reforms (Kerr, 2015).

End-user engagement and participation in the development of both projects was limited to the final stages according to those participants who were engaged with the initial handover process. Therefore, possible input in terms of requirements and needs coming from the final users and beneficiaries, which could positively affect planning and design choices, was not considered at all.

In response to the interviews and observations on site, the provincial Manager of the Department of Human Settlements addressed the difficulties of developing inner city human settlements at scale. The Manager mentioned that there were at least sixty dilapidated buildings in Durban, twenty-six of which are located within the inner city. However he mentioned redevelopment is restricted by the following factors:

- Some of these buildings were either occupied by vagrants or partitioned into cubicles by slumlords for cheap accommodation housing criminals and illegal immigrants. They had achieved this by having taken advantage of loopholes in land legislation to invade land owned by absentee landowners. After residing on the land for some years, the land invaders claimed the right to reside on the land arguing that the Interim Protection of Informal Land Rights Act No. 31 of 1996 protects people with insecure tenure from losing their rights to, and interest in, land pending long-term land tenure reform. Sadly, failure by land legislation to resolve these land disputes have created a deadlock situation where neither the landowner nor the land invaders can win outright unless they both compromise.
- The financial model used by the government in attempt to purchase buildings within the inner city was at times not viable. They found it difficult to compete with the private sector in bids and were often outbid. In some cases the refurbishment requirements of buildings made it financially unfeasible to purchase buildings.
- Silo approach which makes cross-sector and cross-departmental collaborations difficult in the quest to achieve inner city human settlement development. The process of purchasing buildings is challenging, lengthy and requires the collaborative effort of a number of state institutions.
- Land availability and financial restrictions were unveiled as the biggest barrier to the development of human settlements within the inner city. A considerable amount of well-located vacant land is also subject to land claims. In the Durban context, plans for urban restructuring and many projects on well-located land were designed prior to the announcement of the land restitution process. As a result of this land originally identified for the development of housing within the inner city had to be returned to its owners. In some cases the process of dealing with land claims has slowed development.

5. CONCLUSIONS AND RECOMMENDATIONS

The growing urbanisation in South Africa and the migration from rural areas to cities pose challenges for the development of sustainable communities in urban environments, increasing the pressure on low-income groups. This paper has reviewed the main challenges currently related to the necessary shift from housing provision to the creation of sustainable human settlements. The analysis of two case studies in the Durban area expanded on it and discussed possible benefits and barriers related to contrasting emerging formal housing delivery models based either on intensive urban consolidation or extensive development.

The findings suggest that intensive urban development through the reuse of an inner city building has highly benefitted low-income inhabitants in terms of the proximity of economic and social centres. However, there are structural, financial and procedural barriers related to the redevelopment of existing buildings in the inner city that local governments are currently encountering. The better physical housing environment provided by a new mega-project such as Cornubia is apparent, however inhabitants complained the additional financial pressure due to the distance from economic opportunities and transportation issues, employment loss due to relocation, and the dissatisfaction with the break in social ties.

The tension between formal housing delivery and the incorporation into the urban fabric of informal development is one of the core aspects of the debate around urban growth and relevant housing needs in South African cities. In addition to informal settlement upgrading, medium-to-high density intensive urban redevelopment solutions based on infill housing, incremental housing schemes and participatory approaches offer interesting sparks for future studies.

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Water Resilience in Urban Areas

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ABSTRACT AND KEYWORDS

Purpose of this paper
A simple water resilience assessment framework for urban areas is proposed. This framework is described and critically evaluated to ascertain its potential value in relation to water resilience planning.

Design/methodology/approach
The design of the research consists of the following steps. Firstly, a literature review is carried out to identify the key mechanisms that can be used to improve water resilience in urban areas in South Africa. Secondly, a simple framework based on the mechanisms is derived. Thirdly, this framework is evaluated in terms of its potential value as a means of improving urban water resilience. Fourthly, conclusions are drawn and recommendations made for further research.

Findings
The paper indicates that a framework to assess water resilience in South African urban contexts can be derived. It also finds that while this framework shows potential as a means to improving urban water resilience, further research, and development, can be undertaken to improve this.

Research limitations/implications
The research is limited to the development of a framework. Findings are limited to this field of investigation and do not purport to make claims beyond this.

Practical implications
The practical implications of the study are that methodologies for assessing urban water resilience can be derived and may be a valuable input for planning, and developing, more resilient urban infrastructure.

What is original/value of paper
The paper is carried out in a field where there has been limited research to date. It proposes a simple framework that can be used to support the assessment of water resilience in an urban area. It will be of interest to researchers of urban resilience, water systems and urban climate adaptation and mitigation strategies. It will also be of interest to municipal officials working on water systems within urban areas.

Key words
Water resilience, urban resilience, climate change, WRAF

1. INTRODUCTION

Climate change is predicted to have significant impacts on water systems in urban areas and cities in South Africa (Muller, 2007; Department of Environmental Affairs, 2011). Higher temperatures will intensify demands made on already stretched water systems. Longer dry spells and droughts will increase the possibility of water shortages and outages. Storms and associated flooding are likely to affect water supply systems and affect water quality (Englebrecht, 2017; UNEP, 2014).

At the same time, rapid urban growth is placing increasing demands on existing water systems (South African Cities Network, 2014). Informal settlements and new townships developing on the periphery of cities and rapidly growing small towns all have to be supplied with water *(*Brikké and Vairavamoorthy, 2016). Increasing densities, demographic transformation and changing lifestyles in existing urban areas are also leading to increased consumption of water (WHO, 2009; South African Cities Network, 2014). New land uses and the proliferation of impervious landscapes are resulting in amplified runoff and storm water flows and flooding (Roberts,2010).

Ageing water delivery infrastructure has not always been maintained adequately leading to significant losses of water through leakage (Wensley and Mackintosh, 2015; South African Cities Network, 2014; SAICE 2011; Brikké and Vairavamoorthy, 2016). Limited resources and capacity have meant that municipalities struggle to keep up with these demands and water service backlogs exist and are growing in many urban areas (Wensley and Mackintosh, 2015; Fatti and Patel, 2013; Muller, 2007).

However, the development of new water systems in unserved areas and the upgrading of existing systems offers the opportunity to develop systems that are more resilient to current and future issues such as climate change *(*Brikké and Vairavamoorthy, 2016; Muller, 2007). As water and sanitation infrastructure may last over 100 years before being upgraded it is important that future variations, such as climate change, that may occur during its lifetime are taken into account (Muller, 2007).

Therefore, there is a requirement to understand the relationship between urban water systems and climate change (South African Cities Network, 2014; Folke et al, 2011). The potential impacts of climate change on urban water systems need to be ascertained and their vulnerabilities identified (WHO, 2009). To ensure water services are maintained, vulnerabilities must be addressed and systems strengthened to manage climate change impacts. Hazards, such a flooding resulting from extreme weather events, need to be mitigated against through physical interventions and effective planning and management. The ability of urban water systems to weather climate change impacts and maintain water services can be referred to as the water resilience (NIAC, 2009; Resilience Alliance, 2010).

This paper investigates the water resilience within South African urban areas. It proposes an outline Water Resilience Assessment Framework (WRAF) that can be used as a basis for assessing the resilience of water

systems within an urban area. The WRAF has been developed to explore vulnerabilities and resilience of urban water systems in relation to climate change. The paper will be structured in the following way. Firstly, climate change predictions for South Africa are outlined. Secondly, urban water systems are introduced. Thirdly, the Water Resilience Assessment Framework is presented. Fourthly, the WRAF is discussed and critically reviewed and proposals for further development made. Finally, conclusions and recommendations for further research are provided.

2.CLIMATE CHANGE PROJECTIONS

Climate change projections have been calculated for South Africa to support the development of urban climate change adaptation and mitigation strategies. Projections are provided at an 8 x 8km grid resolution for the years 2030, 2050 and 2100 (Englebrecht, 2017). This creates a basis for understanding how climate change will affect urban areas. Impacts across South Africa will vary depending on location but broad trends can be summarised as follows:

- **Hotter temperatures**: Temperature increases of 1 to 2.5°C in the southern coastal areas and 3°C in the northern areas of South Africa are expected for the period 2021 to 2050, relative to temperatures in the period 1961 – 1990.
- **Colder temperatures**: Minimum temperatures are projected to decrease by 2 to 3 °C for the period 2021 – 2050, relative to the period 1961 -1990
- **Very hot days**: An increase in very hot days is projected for the period 2021 – 20150, relative to 1961 – 1990.
- **Changes in rainfall**: Increases in rainfall are projected in the central interior and east coast, while reductions are expected in the western interior and the north-eastern parts of South Africa in the period 2021-2050, relative to the period 1971 – 2000.
- **Extreme rainfall events**: Extreme rainfall events are projected over most of eastern South Africa with reductions in these events projected for Lesotho and Kwa-Zula Natal Midlands for the period 2021- 2050, relative to the period 1961 – 2000.
- **Increased wind speeds:** Increased wind speeds are projected for the northern interior region of South Africa for the period 2021-2050, relative to the period 1961 – 2000.

Applying these climate change projections to cities and urban areas can be used to ascertain the impact of these changes on city systems, such as urban water systems.

3.URBAN WATER SYSTEMS

An urban water system can be described as the facilities and equipment comprising the physical infrastructure, the water services provided to a community by the infrastructure, the people using the water services, and the organisations that manage the infrastructure (EPA, 2015). It can be divided into the following components: water resources, water distribution, water uses, water reuse and runoff and storm water. These are briefly outlined below and are illustrated in figure 1.

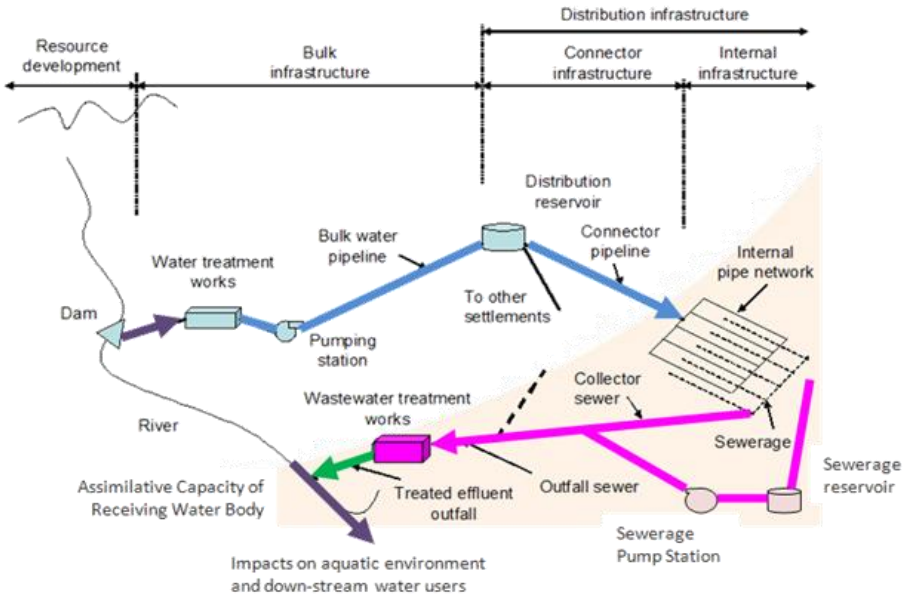

Figure 1 An urban water system (Wensley and Mackintosh, 2015).

- **Water Resources:** Water Resources refers to the sources of water used within an urban area. This may include dams, rivers and boreholes.
- **Water Distribution:** Water Distribution refers to systems which transfer water from the source to where it is used and includes bulk, connector and internal pipe networks. It also includes distribution reservoirs.
- **Water Use:** This refers to how water is used within urban areas and includes drinking, irrigation, cleaning and waterborne sanitation.
- **Water Reuse:** This refers to water that has been used and has been captured for reuse or treatment. It includes greywater and blackwater (sewage) systems.
- **Runoff and Stormwater:** This refers to water flows resulting from precipitation such as rainfall within the urban area as well within

catchment areas of rivers and streams that flow through an urban area.

The Water Resilience Assessment Framework is structured around these components and provides a basis for assessing resilience within each of these.

4.WATER RESILIENCE ASSESSMENT FRAMEWORK

Assessing resilience is a highly complex task. It is particularly complex when it includes a large multifaceted entity such as an urban area or city, and multi-layered system such as an urban water system (EPA, 2015; WHO, 2009; Piketh, Vogel, Dunsmore, Culwick, Engelbrecht and Akoon, 2014). There are also a wide range of approaches and perspectives that can be applied to assessing water resilience (EPA, 2015). The WRAF approach does not attempt to replicate, or develop these approaches, but instead aims to provide an overview of the water system in relation to climate change in order to identify key issues which should be investigated through more detailed studies and analysis. Therefore, the framework provides a means of identifying key climate change hazards and vulnerabilities within the system enabling these to be studied in more detail.

The WRAF is presented in Table 1. The first column refers to the component of the system such as water resources, water distribution, water use and water reuse. The second column provides a set of questions for each component. These assist in understanding key issues that relate to the resilience of systems within the component. The third column provides water resilience indicators that can be used to measure resilience within the water component. These can be used in more detailed assessments and can be compared to benchmarks and to other cities and urban areas. The fourth column lists potential measures that can be used to increase water resilience within the component.

More resilient urban water systems will require many changes in the way systems are designed and operated. This includes shifts in how systems are identified and described. For instance, instead of referring to ‘sewage’, the WRAF refers to ‘grey water and black water reuse’. Grey water is water produced after water is used for cleaning, such as water from showers or baths. Blackwater is what is commonly referred to as sewage. Grey water is still relatively clean and can be easily reused for other purposes, such as irrigating plants or for flushing WCs. The WRAF, therefore, refer to grey water as this can be used to reduce mains potable water use and may be an important way of increasing the resilience of urban water systems to climate change in some areas. The third column within the WRAF provides potential measures to include resilience on the water component, in order to illustrate potential alternative approaches that may be used. Potential shifts in the way water systems are described and

understood are addressed in more detail in the Discussion that follows the presentation of the framework in Table 1.

Table 1 The Water Resilience Assessment Framework

1	2	3	4
Water system component	**Questions**	**Water resilience indicators**	**Potential measures to increase resilience**
Water Resources	1. What are the water sources for the urban area? Is there a diversity of sources? Are there unexploited alternative sources of water that can be used near existing water sources? 2. What are the capacities of current water sources? How do these compare to the rate of water use in urban areas? 3. How does the capacity of these sources vary over a year? What are the patterns of water use and replenishment of water in these sources over a year? Is there a particular period when water capacity is low? 4. What is the quality of water from sources? Is, or can, water quality be affected, by, for instance, flood erosion or discharges from factories? 5. How is water treated and filtered before being distributed? How reliable are these systems? 6. How secure are water sources? Are they prone to damage, by floods, or other means? 7. Which climate change predictions will affect local water resources?	Diversity in water sources (number of sources and capacities of sources) Days of water supply without replenishment (days-worth of supply available) Years without water restrictions not having to be imposed (years / set rolling period ie 20 years) Quality of water from the resource Loss of water from resource through leakage / evaporation (% of water lost) Number of incidents requiring repairs per year Expenditure on maintenances (% expenditure on maintenance relative to replacement value of infrastructure)	Increase capacity of existing water resources (WHO, 2009) Identify additional water sources such as additional dams, desalination plants and boreholes (WHO, 2009; Kiker, 2000) Installation of early warning systems (WHO, 2009) Rainwater harvesting (Lee et al, 2016) Water catchment areas conservation and enhancement (Muller, 2007) Alien plant removal programmes. Improved technical capacity and systems to plan and manage resources (WHO 2009; SAICE, 2011)

	8. How will climate change predictions affect water sources?		
Water Distribution	1. What systems are used to distribute water? 2. What is the condition of water distribution systems? Is the system prone to breakages and leaks? 3. What powers the water distribution system? Where are pumping stations how are these powered? How reliable are these systems? 4. Where is the water distribution system located? Is it located where it may be vulnerable to damage from flooding and other issues? 5. Is there redundancy within the water distribution system? How easy is it to maintain water supply if there is a failure in one, or more, parts of the system? 6. Which climate change predictions will affect the water distribution system? 7. How will climate change predictions affect water distribution systems?	Leakage rates in water distribution system (% of water lost) Days of supply outage/year (EPA 2015) Number of incidents requiring repairs per year Expenditure on maintenance (% expenditure on maintenance relative to replace value of distribution)	Leakage management programme (WHO, 2009) Pressure management systems to reduce leakage and water use (WHO, 2009) Maintenance and infrastructure replacement programmes (WHO, 2009) Water network loops (EPA, 2015) Integrated piping systems (WHO, 2009) Water monitoring systems to pick up water leaks Improved technical capacity and systems to plan and manage distribution systems (South African Cities Network, 2014. SAICE, 2011). WHO, 2009)
Water Use	1. Does all of the water used in the urban area come from the water sources (A), or are there local sources of water that are used to supplement, or as an alternative to this, such as boreholes and rainwater harvesting systems? What is the capacity of these alternative sources? Are there other	Residential water consumption rates (L /person / day) Commercial water consumption rates for (L/value of products /	Water demand management programmes(WHO, 2009; Kiker, 2000) Water efficient fitting incentive programme (WHO, 2009) Water efficient

	local unexploited water sources that can be used? What are the capacities of these sources? 2. How accessible is the water supply in the urban area? Is the water supplied within properties or through standpipes, tankers, or in other ways? 3. How is water used in the urban area? What are the quantities and proportions of water used in the respective segments, such as residential households, or commercial offices, that make up the urban area? 4. How reliable is the water supply in the urban area? How often is water not available in the urban area? Does the water pressure vary? 5. What are the patterns of water use in the urban area? What are the water-use flows for a typical 24 hour, through a typical week and through a typical year? 6. What are the rates of water use in installed equipment with the urban area? For instance, within residential dwellings, what are flow rates for showers and taps and the flush rates for WCs? 7. Are there local measures to increase the resilience of the water systems? For instance, is the provision for water storage on site? Are there water emergency plans for the local area? 8. Which climate change predictions will affect water use in the urban area? 9. How will climate change predictions affect water use	services produced) Households / properties with wasteful water uses ie irrigation of ornamental plants and swimming pools Reduction of potable water use through grey water and rainwater harvesting. Loss of water on usage sites through leakage (% of water lost) Number of incidents requiring repairs per year Expenditure on maintenances (% expenditure on maintenance relative to replace value of infrastructure) Water storage on site (l/person) Water emergency plans in place	fittings bylaw Water metering and sub-metering Rainwater harvesting (Kiker, 2000) Sustainable urban drainage systems (WHO, 2009) Grey water systems (WHO, 2009) Penalties/high tariffs for high water usage Banning inefficient water devices Banning wasteful water uses such as ornamental water pools and irrigation of ornamental plants. Non-waterborne / dry sanitation system Increased onsite storage of water Water emergency plans

	in the urban area?		
Water Reuse	1. Where is grey and black water produced in the urban area and in what quantities? Are these produced separately, on in one stream? 2. What are the patterns of grey and black water production in the urban area? What are the flows for a typical 24 hour, through a typical week and through a typical year? 3. What is the condition of grey and black water systems? Is the system prone to breakages and leaks? 4. What powers grey and black water distribution systems? Where are pumping stations how are these powered? How reliable are these systems? 5. Where are the grey and black water distribution systems located? Is it located where it may be vulnerable to damage from flooding and other issues? 6. Is there redundancy within the grey and black water distribution system? How easy is it to maintain flows if there is a failure in one, or more, parts of the system? 7. Which climate change predictions will affect the grey and black water distribution system? 8. How will climate change predictions affect grey and black water distribution systems?	Amount of water reused within the (% of grey water used as percentage of total water used) Reduction of potable mains water use through reuse of water (% reduction of waters potable water consumption) Number of incidents requiring repairs per year Expenditure on maintenances (% expenditure on maintenance relative to replace value of infrastructure)	Incentives to introduce grey water systems Precinct grey water systems Onsite ecological sanitation (WHO 2009) Improved technical capacity and systems to plan and manage water reuse systems (WHO, 2009)

Runoff and storm water	1. Where are the current rivers, streams and stormwater flows within the urban area? Do these currently overflow and cause flooding after heavy rain? Does detritus or other obstacles exacerbate this? What are the flow patterns after heavy rain fall event in the catchment area and within the urban area, what the flow patterns over a typical day, what are the typical flow patterns over a year? How can peak flows be reduced? Are there ways of reducing runoff in the catchment area and contributing urban areas? Are there safe areas along water courses that can be flooded or where water can be stored to reduce peak flows? 2. Where is the stormwater distribution system? Does this overflow and cause flooding currently after heavy rain? Does detritus or other obstacles exacerbate this? What are the flow patterns after heavy rain fall event within the urban area, what are the patterns over flows over a year? How can peak flows be reduced? Are there ways of reducing runoff in the contributing urban areas? Are there safe areas along stormwater distribution systems that can be flooded, or where water can be stored to reduce peak flows? 3. Which locations within the urban area are responsible for large flows of runoff? What are the patterns of flows of this runoff after heavy rain? What can be done to reduce this runoff? Can the extent of absorptive surfaces within these areas be increased to increase onsite retention of runoff?	Percentage of rainwater retained onsite (%) Percentage of site area that has impervious surfaces Reduction in volume of flows through sustainable urban drainage systems Reduction in peak flow through sustainable urban drainage systems. Number of flooding incidents per year Expenditure on maintenance (% expenditure on maintenance relative to replace value of infrastructure)	Rainwater harvesting systems (Lee, Mokhtar, Hanafiah, Halim, and Badusah, 2016) Increase area of pervious surfaces and soft landscaping Detention Systems (Woods-Ballard et al, 2007) Stormwater wetlands (Woods-Ballard et al, 2007) Infiltration basins (Woods-Ballard et al, 2007) Check dams (Woods-Ballard, Kellagher, Martin, Jefferies, Bray, and Shaffer, 2007) Swales(Woods-Ballard et al, 2007) Green roofs (Woods-Ballard et al, 2007) Soakaways (Woods-Ballard et al, 2007) Filter strips (Woods-Ballard et al, 2007) Infiltration trenchs(Woods-Ballard et al, 2007) Bioretention(Woods-Ballard et al, 2007) Pervious

	Can rainwater harvesting systems and retention and detention ponds be used to reduce runoff? Can sustainable urban drainage systems, including swales, be used to reduced runoff? 4. Which climate change projections will affect runoff and stormwater systems? 5. How will climate change projectionss affect affect runoof and stormwater systems?		pavements(Woods-Ballard et al, 2007) Geocellular / modular systems(Woods-Ballard et al, 2007) Sand filters (Woods-Ballard et al, 2007)

5.DISCUSSION

The Water Resilience Assessment Framework provides a way of beginning to understand and address, the resilience of urban water systems in relation to climate change. The framework appears to be very simple and is easy to understand. It consists of a structure that reflects the form of urban water systems and includes components on water resources, water distribution, water use and water reuse. Within each of these components, there are a series of questions that can be worked through to understand key parameters within the respective component of the water system in relation to climate change. Within each component, there are also a set of indicators. These indicators provide a more detailed and quantified view of the resilience of the system. An initial review of the WRAF suggests that it provides a flexible and structured way of considering water resilience in relation to climate change within an urban area. However, while the simplicity of the approach and framework is attractive, it also raises a number of issues that need to be addressed in more detail. In particular, these relate to the approach and its value as means of assessing and improving water resilience in urban areas, and are as follows:

- Are the objectives set out for the Water Resilience Assessment Framework appropriate?
- Is the structure of the Water Resilience Assessment Framework applicable?
- Can the Water Resilience Assessment Framework make a useful contribution to the assessment of water resilience in urban areas? If so, how should it be developed?

5.1 Objectives of the WRAF

A review of the WRAF indicates that it does not provide a comprehensive and detailed methodology for the assessment of water resilience of an urban area. Instead, it aims to "provide an overview of the water system in relation to climate and change and resilience, in order to identify key issues which should be considered in order to scope more detailed studies and analysis". A secondary, implicit objective, of the framework, appears to be to encourage a questioning of current conventional water systems. This indicated by comparing questions and indicators within the WRAF with conventional a water system, as represented in figure 1. For instance, the WRAF refers to 'grey and black water' instead of 'sewage', in order to emphasize the potential of using greywater within a water system as a way of improving its resilience.

The objectives of the WRAF appear to be appropriate to urban water systems for a number of reasons. Firstly, the resilience of the water system is related to the entirety of the system, and not just one component. For instance, even if water resources are resilient, if water distribution is not, the system will fail. It is, therefore, important to have a holistic approach. Secondly, given the scale and complexity of urban water systems, it is useful to have an overview, which can be used to help structure and prioritise resilience improvement interventions. A simple overview also provides a valuable means of communicating key issues related to water and climate change within a municipality or council, where key decisions related to infrastructure planning and budgeting may be made by elected counsellors and officials who do not have a technical background.

The simplicity of the WRAF and the terminology may also be valuable in encouraging increased involvement of stakeholders in decision-making about water systems and a questioning of conventional systems. Both of these are valuable in the development of resilient water systems (Tompkins and Adger, 2005; Hallegate, 2008). For example, highly efficient resilient water systems may require changes in water consumption patterns and user behaviour and it is, therefore, important to have strong local support for these changes. Resilient systems may also require innovative alternative technologies to be introduced, such as grey water systems, which local municipalities and officials will be required to understand and support (Camacho, 2009; Zimmerman, 2011).

5.2 Structure of the WRAF

The structure of the WRAF follows the basic structure of an urban water system and addresses each component including water sources, water distribution, water use, water reuse and runoff and stormwater. Each of these components has questions, indicators and potential measures to

increase resilience which can be used to develop an understanding of resilience within each of the components of the water system.

This structure appears to work well for a number of reasons. Firstly, the structure aligns well with the different responsibilities and mandates of stakeholders involved in urban water systems (Wensley and Mackintosh, 2015). Water resources are governed by national departments, such as the Department of Water Affairs, and water boards, who work with a range of stakeholders to plan and manage water resources. Water distribution within urban areas and cities is the responsibility of local municipalities. Water use depends on user behaviour and installed equipment but can be influenced through bylaws, incentives and penalties developed by municipalities. Water reuse, runoff and storm water within urban areas and cities is the responsibility currently mainly the responsibility of local municipalities. However, municipalities can introduce measures, such as guidance, bylaws, regulations and incentives to encourage property owners to implement infrastructure such as rainwater harvesting systems, retention and detention ponds and sustainable urban drainage systems to increase local water resilience. Within each of these components, the potential measures that can be taken to improve resilience (column 4) illustrate the type of interventions that may be employed and can be used to inform the identification and application of practical measures to increase resilience.

The WRAF structure which provides key questions and performance indicator per component can be used to allocate responsibility for action to the parties most able to address and achieve this. This is valuable as it can be used to ensure that collective responsibility to achieve improved water resilience in a complex large-scale system is achieved.

Secondly, by considering the water system holistically, the framework supports the possibility of increased coordination and integration. For instance, where assessments indicate that it will be difficult to make conventional water sources such as dams resilient, a greater emphasis can be placed on alternative measures within the system, such as reducing water use through increased efficiency of water equipment and the installation of rain harvesting and grey water systems.

Thirdly, the two-part structure of the WRAF offers the possibility of assessments being undertaken in a range of ways and levels. The Question part can used by stakeholders and decision-makers to understand the key water issues related to climate change and water in their areas in order to begin to develop plans to address this. The Indicators part provides insight into how resilience performance may be defined in terms of targets and monitoring and evaluation processes that can be included in strategic plans. It also provides a means of developing benchmarks and comparing performances between urban areas and towns which supports continuous improvement and learning and sharing of good practice (McAllister, 2013).

Fourthly, providing ‘potential measures to increase resilience’ is useful as illustrates, in a practical way, some of the measures that may be taken to improve resilience. While some of these measures may not be applied in all situations, it is valuable to include them as a way of illustrating the need for alternative approaches. It also helps to show that approaches can be very simple and cost-effective.

5.3 Value of the WRAF

The review indicates that Water Resilience Assessment Framework could make a valuable contribution to the assessment of water resilience of urban water systems. It appears to offer an approach that supports the effective integration of water resilience and climate change into current water infrastructure development and planning processes.

The simplicity and the non-technical language in the WRAF can be used to develop awareness about climate change and water systems in decision-makers and stakeholders. In particular, it may play a valuable role in helping identify, and communicate, climate change risk and vulnerabilities to urban stakeholders such as mayors, councillors, urban planners and water engineers to ensure that this is addressed in infrastructure projects (Government Office for Science, 2012; Howe, 2012). This would help ensure that long-term urban planning, budgeting and legislative processes such as development of Integrated Development Plans (IDPs) and Spatial Development Frameworks (SDFs) plan for improved water resilience (Kiker, 2000). Similarly, it could be used to promote municipal bylaws which required new infrastructure and buildings to be more water efficient and resilient.

It is interesting to note however that the WRAF does not have a strong emphasis on social aspects of resilience. For instance, it has been argued that communities should be actively engaged in developing and implementing climate change strategies (Tompkins and Adger, 2005; Hallegate, 2008, Fatti and Patel, 2013 Brikké, and Vairavamoorth, 2016). In addition, Environmental Protection Agency (2015) suggests that communities need to be prepared for water emergencies and that this should be formalised in local plans. This aspect should, therefore, be researched further and developed in practical measures and indicators in the development of the WRAF.

Similarly, while the WRAF makes reference to the resilience of water distribution systems, this is not addressed in much detail. This is a complex area and while it is not recommended that the WRAF include measures of resilience in relation to water network resilience, it may be valuable to make references to these approaches and how they can be used to improve resilience of a system (EPA, 2015).

The WRAF includes a list of potential measures that may be used to increase water resilience. This illustrates that measures may be simple,

easy-to-implement and low cost. It, therefore, encourages municipalities and other stakeholders to consider these, and where appropriate, pilot, and implement these. The incorporation of water resilience indicators enables monitoring and evaluation of water systems and encourages improved performance. Thus, pilot programmes can be evaluated using indicators, to identify optimal approaches which may be implemented at a larger scale. In addition, indicators are valuable as the support ongoing monitoring and provide a means of comparing performance between urban areas.

5.4 Further Development of WRAF

The initial version of the WRAF provides a promising basis for further development. It is recommended that further development focusses on two aspects of the framework. The first aspects should develop the high-level rapid appraisal aspect to ensure that this supported more effectively. This could include more detailed sub-questions and criteria that be used to provide a simple 'water resilience rating' of the urban system. The simplicity of the current WRAF, however, should be retained and technical complex language should be avoided.

The second aspect of the WRAF that should be developed is the decision making and implementation support aspect. Instead of just including a list of potential measure to improve resilience and water resilience indicators, the framework should provide more structured and detailed guidance. This could include a manual with step-by-step guidance on carrying out resilience assessments and then using these to develop implementation plans.

6.CONCLUSIONS AND RECOMMENDATIONS

The Water Resilience Assessment Framework provides useful insight into the resilience of urban water systems to climate change. In particular, it provides a simple framework that could be used to support awareness and improved decision making about climate change and water resilience in non-technical decision makers such as municipal officials. Further research and development of the framework is recommended. Further development should include the development of a more detailed rapid-appraisal tools and manual which can be used to assess urban water systems. It is also recommended that the framework is developed to support implementation through the provision of step-by-step guidance.

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