



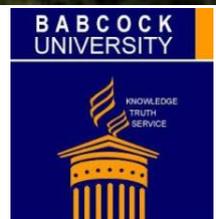
**Abstracts for the Proceedings of the**  
*10th International Conference on*  
*Construction in the 21st Century*  
**Colombo, Sri Lanka**  
**July 2-4, 2018**

**CITC-10**  
*10th Anniversary*

**Editors:**

**Syed M. Ahmed, Attaullah Shah, Salman Azhar,  
 Norma A. Smith, Shaunna Campbell, Kelly Mahaffy,  
 and Amelia Saul**

Ceylon Institute of Builders



**Abstracts for the Proceedings of the**  
**Construction in the 21<sup>st</sup> Century**  
**10<sup>th</sup> International Conference**

*July 2<sup>nd</sup>-4<sup>th</sup>, 2018 – Colombo, Sri Lanka*

**Editors**

Syed M. Ahmed

*East Carolina University, Greenville, North Carolina, USA*

Attaullah Shah

*City University of Science and Information Technology*

Salman Azhar

*Auburn University, Auburn, Alabama, USA*

Norma A. Smith

*East Carolina University, Greenville, North Carolina, USA*

Shaunna C. Campbell

*East Carolina University, Greenville, North Carolina, USA*

Kelly Mahaffy

*East Carolina University, Greenville, North Carolina, USA*

Amelia Saul

*East Carolina University, Greenville, North Carolina, USA*

**Organized and Supported by**

East Carolina University  
Greenville, North Carolina, USA

University of Moratuwa  
Moratuwa, Sri Lanka

Ceylon Institute of Builders  
Colombo, Sri Lanka

University of Wolverhampton  
Wolverhampton, England

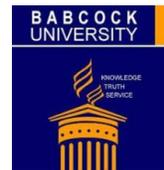
City University of Science and Information Technology  
Peshawar, Pakistan

Florida International University  
Miami, Florida, USA

Auburn University  
Auburn, Alabama, USA

Western Carolina University  
Cullowhee, North Carolina, USA

Babcock University  
Ilishan-Remo, Nigeria



## Foreword

While technology and innovation are shrinking the distance between countries and industries, leadership and collaboration are actively shaping the construction industry and guiding it to success. Construction in the 21st Century (CITC) is an organization backed by East Carolina University in collaboration with Auburn University, Florida International University, City University of Science and Technology, Ceylon Institute of Builders, University of Moratuwa, University of Wolverhampton, Western Carolina University, and Babcock University. CITC executes international conferences to bring together like-minded construction management professionals. The CITC-10 conference seeks to bring together an international group of practitioners, researchers, and educators to promote a novel exchange of ideas in a multidisciplinary fashion.

CITC-10 is a peer-reviewed conference that acts as a dynamic conduit for the exchange of knowledge. New methods and techniques must be carefully scrutinized and rigorously tested before implementation, and CITC-10 plays an integral role in this process. As the industry moves forward in an ever-complex global economy, multi-national collaboration is crucial. Future growth in the industry will undoubtedly hinge on international teamwork and alliance.

This July marks the tenth CITC conference. Previous conferences include CITC-I in Miami of 2002, CITC-II in Hong Kong of 2003, CITC-III in Athens of 2005, CITC-IV in Gold Coast, Australia of 2007, CITC-V in Istanbul of 2009, CITC-VI in Kuala Lumpur of 2011, CITC-VII in Bangkok of 2013, CITC-8 in Thessaloniki, Greece of 2015, and CITC-9 in Dubai of 2017. All conferences were tremendously successful. As with previous conferences, this effort has been greatly supported by our friends and colleagues across the globe. It is our pleasure to now present to you the Tenth International Conference on Construction in the 21<sup>st</sup> Century (CITC-10, Sri Lanka). This two-and-a-half-day conference is being held in Sri Lanka at Hilton Colombo. CITC-10 will bring together a diverse group of academics, professionals, government agencies, and students from all over the world to contribute to the future growth of the industry.

We intend to hold the CITC series of conferences at regular intervals. We gratefully appreciate your attendance and hope that you will support the future endeavors of CITC.

Thank you and kind regards,

*The Editors*

*Syed M. Ahmed, Chair*

*Attaullah Shah*

*Salman Azhar*

*Norma A. Smith*

*Shaunna Campbell*

*Kelly Mahaffy*

*Amelia Saul*

© 2018 by CITC-10, Greenville, North Carolina, USA.

All rights reserved. No part of this book may be reproduced in any form, or by any means without written permission from the editors.

The views expressed in the papers are of the individual authors. The editors are not liable to anyone for any loss or damage caused by an error or omission in the papers, whether such error or omission is the result of negligence or any other cause. All and all such liability is disclaimed.

**ISBN: 978-1-7324416-0-6**

**July 2018**

**Greenville, North Carolina, USA**

# CITC-10 Themes

- Leadership in Engineering & Construction
- Architectural Management
- Building Information Modeling
- Automation and Robotics
- Lean Construction Practices
- 3D Printing
- Augmented and/or mixed reality
- Legal issues in Construction
- Value engineering
- Procurement Management
- Project and Program Management
- Quality and Productivity Improvement
- Risk Analysis & Management
- Sustainable Design and Construction
- Concrete Technology
- Construction Contracts
- Construction Equipment Management
- Construction Safety
- Construction Scheduling
- Cost Analysis & Control
- Cultural Issues in Construction
- Design-Build Construction
- Engineering & Construction Materials
- Ethical Issues in Engineering and Construction
- Information Technology and Systems
- Infrastructure Systems and Management
- International Construction Issues
- Innovative Materials (ultra-high-performance concrete, self-healing concrete, photocatalytic "self-cleaning concrete," etc.)
- Asphalt concrete (super-pave, etc.)
- Recycled and waste materials
- Fiber reinforced polymers
- Curing compounds
- Nano-materials in infrastructure projects
- Girder bridges with superior structural performance
- Road and bridge barrier design
- Arch bridges, suspension, and cable-stayed bridges
- Bridge construction systems
- Value engineering

# CITC-10 International Scientific Review Committee

We would like to express our sincere gratitude to the members of the International Scientific Committee, who participated in the review process for the CITC-10:

*Dr. Alaa Abdou*

*Dr. Hamimah Adnan,*

*Dr. Georgios Aretoulis*

*Dr. Gokhan Arslan*

*Dr. Michael G. Behm*

*Dr. Ioannis Brilakis*

*Dr. Cenk Budayan*

*Dr. Anita Ceric*

*Dr. Albert P.C. Chan*

*Dr. Athanasios Chasiakos*

*Dr. Abdol Chini*

*Dr. Mohammed Dulaimi*

*Dr. Emilia, L.C. van Egmond*

*Dr. Mohamed El-Gafy*

*Dr. Sameh M. El Sayegh*

*Dr. Neil N. Eldin*

*Dr. Dongping Fang*

*Dr. Stuart Green*

*Dr. Murat Gunduz*

*Dr. Mamoon Hammad*

*Dr. Miklos Hajdu*

*Dr. Theodore C. Haupt*

*Dr. Zuhair El Itr*

*Dr. Ria Kalfakakou*

*Dr. Julian Kang*

*Dr. Dean Kashiwagi*

*Dr. Abdul Samed Kazi*

*Dr. Scott Kelting*

*Dr. Malik M.A. Khalfan*

*Dr. Christian Koch*

*Dr. Sergios Lambropoulos*

*Dr. Peter Love*

*Dr. Odysseus Manoliadis*

*Dr. Tayyab Maqsood*

*Dr. Innocent Musonda*

*Dr. Abid Nadeem*

*Dr. A.C. Ogbonna*

*Dr. Stephen O. Ogunlana*

*Dr. Panos Papaioannou*

*Dr. Kleopatra Petroutsatou*

*Dr. Begum Sertyesilisik*

*Dr. Mirosław J. Skibniewski*

*Dr. Wellington Didibhuku Thwala*

*Dr. Zeljko M. Torbica*

*Dr. Bambang Trigunarsyah*

*Dr. Dimitra Vagiona*

*Dr. Rizwan U. Farooqui*

*Dr. Rafiq M. Choudhry*

*Dr. Rita Li*

## Contents

Foreword .....	iii
Themes .....	v
Contents.....	vii
Keynote Speakers .....	1
Workshop .....	4
Peer Reviewed Paper Abstracts.....	6
Appreciation .....	39
Sponsors .....	40
Hotel Information .....	41
Banquet Dinner Information .....	42
Galle Fort Trip Information.....	43
Program at a Glance .....	44
Full Program.....	45

## **Keynote Speaker**

### **Chris Blythe CEO Chartered Institute of Building**

After becoming a Management Accountant, **Chris Blythe** worked in a number of financial roles which included Dunlop, Birmid Qualcast, Mitel, W Canning, Corgi Toys and GKN. In 1991 he joined the North & Mid Cheshire Training and Enterprise Council based in Warrington. He became Chief Executive in 1994. For more than 25 years he has been involved in vocational education and training, together with business development. Chris has been Chief Executive of the Chartered Institute of Building since January 2000. In the Queen's 2017 New Year's Honours list Chris received an OBE for services to the 'Construction Industry and Government.

## **Keynote Speaker**

### **Dr. Paul Hampton BSc (Hons), MSc, DProf, FRICS, FICWCI, FHEA**

**Dr. Paul Hampton** is a Global president, Director for four ERDF Research projects and Head of Built Environment within the Faculty of Science and Engineering at the University of Wolverhampton. A Chartered Surveyor and the past Chair of the West Midlands branch of the Royal Institution of Chartered Surveyors (RICS), Paul also sits on the RICS national flood forum and is part of the regional chairs forum. Paul has been the project manager on numerous European projects and is a STEM ambassador and supporter of various initiatives to promote the Built Environment to a wider audience. Supported by 30 years of expansive built environment experience, Paul is an entrepreneur, creative thinking, dedicated individual, who creates innovative team cultures, and actively supports local business regeneration within the West Midlands. Paul is extremely research active and has published and delivered over ten conference papers across the world. Paul continues to support regional APC candidates and as a Chartered building surveyor continues to host a variety of CPD events both regionally and nationally. Paul enjoys his national charity work for Crohns Colitis UK, and holds a real passion for inspiring graduates in their transition from Higher Education to the world of work. In addition, Paul has been a dedicated CITC participant and submits multiple papers each conference.

**Presenting on Tuesday, July 3<sup>rd</sup>, 2018 at 10:00**



**Dr. Paul Hampton**



**Mr. Chris Blythe**

**Abstract:**

Whilst much attention is paid to the technical aspects of construction in the 21st century, little attention is paid to the human side.

Dr. Paul Hampton and Mr. Chris Blythe examine the nature and scale of labour exploitation in the construction industry where abuse goes from low level abuse to full scale slavery. They consider the relationship between “sending” countries and “receiving” countries. They also explore some of the steps being taken in different countries. In particular they consider the work being undertaken in the United Kingdom to tackle the problem of what is now being called modern slavery.

They will explore the ethical base and whether enough attention is being paid to the moral compass in how we procure and deliver construction projects.

## Keynote Speaker

**Dr. Vasantha Abeysekera**  
**Ph. D., M.Sc., B.Sc. Eng. Hons., C. Builder, FAIB, C.Eng, MIE, MNZIQS**

**Dr. Vasantha Abeysekera** is a chartered builder and engineer holding memberships in numerous professional bodies. Traversing both public and private landscapes, he has acquired a heterogeneous portfolio with considerable experience in organizational, project management, and academic positions at the directorate and professorial level. In this path, he has been honored with awards for academic excellence, and has authored over 150 peer reviewed journal and conference papers, book chapters and reports for both governmental and non-governmental organizations. In the pursuits of these and other academic achievements, Dr. Abeysekera has secured almost half a million dollars in research funding, in addition to other support channels engaging industry stakeholders.



Dr. Abeysekera regards teaching, coaching, and mentoring a fundamental component to both his roles spanning industry and academia. From this standpoint, he has authored 8 course books for distance education programs, supervised over 75 student research projects on both undergraduate and postgraduate levels, and has been rewarded with 4 of his students going on to win industry awards for research excellence. Dr. Abeysekera has been a frequent conference participant for CITC and we look forward to hearing his keynote speech as well as reading his papers.

**Presenting on Tuesday, July 4<sup>th</sup>, 2018 at 8:00**

**Images of Construction and the Power of Simile: In search of innovative solutions to perennial problems**

### **Abstract:**

Simply, a *simile* is a comparison between two seemingly unlike things using “like” or “as” providing endless depth to our imagination. Accordingly, this study draws on the author’s experience in using similes such as *Brickwork as Chaos*, *Construction as Biological Cells*, *Monetary Retentions as Cash Cow*, *Stress, Steroid, and Safety*, *Performance as Horoscope*, and *Student as Project Manager* for generating new insights and finding innovative solutions to perennial problems. The need for intuitive and reflective inferences to forge ahead with such similes is emphasised. The value of *simile* to capture and condense knowledge, and in theory building is discussed while examining ontological and epistemological perspectives. An example of this approach is demonstrated examining the simile, *Methodology as Conic Spiral*, which illustrates challenges associated with the methodology. It is only when one spiral is traversed that the other can be seen in a misty path to the zenith. In conjunction with this novel approach of using simile, the author advocates a systematic application of logic (reasons) to generate justified beliefs for scientific practice. The study concludes that creative application of simile and figures of speech can generate new perspectives and insights on construction challenges.

## Workshop:

# *Managing Contractual Risks in Large Construction Projects*

Time: 13:30-15:00

Date: July 2<sup>nd</sup>, 2018



## **Presented by Mohamed El Agroudy**

**PhD, CCT, PMP, RMP, TRC, ACI Arb, M.ASCE**

- Dr. Mohamed El Agroudy has decades of experience in construction engineering and management. He is a Certified Corporate Trainer (CCT), a Project Management Professional (PMP), a Risk Management Professional (RMP), a Transitional Referral Certified (TRC) and an International Arbitrator.
- He has his BSc in civil/construction engineering, a Masters in contracts and a PhD in contracts and risk management.
- Dr. El Agroudy has trained many professionals around the globe and has performed a lot of workshops and keynote speeches in more than 25 countries.
- His areas of expertise include: Contracts, Risk and Facility Management.

## **Description**

This workshop highlights main risks arising from contract of the large construction projects. Impact of project risks should be covered through contingencies. Contingencies are included in the tender price to account for the various risks based on their impacts on the project objectives and profit margins. Time and cost reservers are usually used to cover delays and cost overruns due to site risks, project related risks, estimating risks, organizational risks and external risks. The workshop will also propose different strategies to mitigate risk.

## **Topics**

- Overview of large project risks
- Classification of contractual risks
- Site related risks
- Estimating risks
- Organizational risks, and external risks
- Impact of risks on project objectives
- Mitigation strategies for project risks

## **Certificate**

All participants will receive 3.0 Professional Development Hours (PHD) certificate.

## Workshop:

# *Complexity in Construction*

Time: 15:15- 16:45

Date: July 2<sup>nd</sup>, 2018

## Presented by Dr. Darshi De Saram

**PhD, M. Tech., Pg. Dip. (Const. Mgt.); B. Sc. Eng. (Mech.);  
MIM (SL); MASHRAE, Academic Director, Sawa Training  
Services**



- Dr. Darshi De Saram pursued doctoral studies focused on professional performance and coordination the focus he set after working over 12 years in our industries, often witnessing chaos.
- His background in Mechanical Engineering (University of Peradeniya) and Construction Management (Open University Sri Lanka and HK Polytechnic University). His work is to change the focus of management to natural ways we work and learn.
- To bring back attention on management aspects that intelligent beings naturally feel, recognize and synthesize, but often ignored in today's management trends.

## Description

This workshop illustrates why Construction Managers need to understand and analyze complexity in construction and other contexts. Such skills in working with complexity help bridge the gap between theory and practice. It would be illustrated how onsite Construction Managers intuitively understand and manage the complexity in the operations; all intelligent beings can understand complex contexts and respond accordingly. Can we train a person to quickly adapt to any complex context? We need to appreciate that, in real life, there are significant dynamics (other than cause and effect) such as: 'Arational' behavior, perceptual reorganization, evolutionary dynamics, spontaneous reorganization, chaos, etc. The discussion will highlight how performance would improve if we can focus attention on complex management aspects that intelligent beings naturally feel, recognize and synthesize, but often ignored in today's management trends.

## Topics

- Complexity in construction and other contexts
- How intelligent beings understand and deal with complex contexts
- Dynamics (other than cause and effect) that are significant in complex contexts
- Complex management aspects that intelligent beings naturally feel, recognize and synthesize
- How can we train to quickly adapt to any complex contexts?

## Certificate

All participants will receive 3.0 Professional Development Hours (PHD) certificate.

## Peer Reviewed Paper Abstracts

(Paper, ID 3)

### **The Potential of BIM Models as Legal Construction Documents for Sustainable Growth in the Kenyan Construction Industry**

Kimani Thomas Njuguna  
*Department of Construction Management, JKUAT,  
Nairobi, Kenya*  
[kimani.thomas.n@gmail.com](mailto:kimani.thomas.n@gmail.com)

Mugwima Njuguna  
*Center for Urban Studies, JKUAT, Nairobi, Kenya*  
[mugwima@gmail.com](mailto:mugwima@gmail.com)

Ahmad Omar Alkizim  
*Department of Construction Management, JKUAT,  
Nairobi, Kenya*  
[aalkizim@gmail.com](mailto:aalkizim@gmail.com)

Haddy Jallow  
*BIM Engineer, Carillion UK*  
[haddy.jallow@kier.co.uk](mailto:haddy.jallow@kier.co.uk)

#### **Abstract**

Building Information Modeling (BIM) has transformed the global construction industry in terms of generation, sharing and integration of design data. This has created a requirement for new protocols, activities and definitions. In Britain, the BIM overlay to the Royal Institute of British Architects (RIBA) Outline Plan of Work provides straightforward guidance on the activities needed at each RIBA work stage to successfully design and manage construction projects in a BIM environment. In the United States, two different contract addenda (E202 Building Information Modeling Exhibit and Consensus Document 301 BIM addendum) allow the contracting parties to decide whether or not BIM is to become part of the contract. The Kenyan construction industry has been using the traditional two-dimensional environments to define construction contracts. This paper suggests that as it happened with the introduction of Computer Aided Design (CAD), a tipping point will soon be reached where BIM will gain widespread local acceptance as a transformative technology and working philosophy at all scales of practice. However, with the incremental changes in projects delivery, particular concerns regarding the legal and contractual implications of BIM arise. Firstly, whether BIM will alter the traditional allocation of responsibilities for all project stakeholders. Secondly, whether standard forms of

building contracts should be altered to account for the use of BIM. To assess these concerns, a survey was conducted within Nairobi with a sample of 24 industry experts from firms that have used BIM in at least one project. The data collection methods were semi-structured face-to-face interviews. Analysis of the data was done using content analysis. The findings show that consultants are adopting the use of BIM technology for projects delivery. This paper concludes that there are strategic benefits of developing BIM expertise in Kenya and that a BIM addendum, to be attached to standard forms of contracts needs to be prepared to facilitate working at various BIM maturity levels for a sustainable growth in the Kenyan construction industry.

#### **Keywords**

BIM, Contractual Arrangements, BIM Maturity Levels, Collaboration, BIM Addendum.

(Paper, ID 4)

### **Portfolio Management in the Construction Industry – Pricing Strategies Considering the Chance/Risk Ratio for Several Projects**

Markus Kummer  
*Project Assistant, Graz University of Technology,  
Graz, Styria, Austria*

Christian Hofstadler  
*Professor, Graz University of Technology, Graz,  
Styria, Austria*

#### **Abstract**

The portfolio theory was developed by Markowitz (1952) and was originally a subfield of capital markets theory. Its starting point is a defined available investment amount distributed across several asset classes, such as equities or bonds, by its spreading or diversification. This diversification aims to reduce the associated risk relative to the variance and percentage of the return compared to an investment in only a single asset class. In relation to the capital market, this raises the question which securities to aggregate in a portfolio at which proportions. On the practical level, such an aggregation of investment opportunities happens through the establishment and marketing of funds, such as equity funds. In practice, theoretical considerations on how to establish an optimal portfolio are compromised by uncertainties of data and information on available investment alternatives

as well as by market volatility. In the construction industry, contractors are faced with a similar situation since they submit bids for various projects or requests for proposals. Contractors use the bid price as the key award criterion and thus manage both the chance/risk ratio in relation to the contract award and the economic success of the project if they are actually selected as the winning bidder. Contractors thus need not only focus on individual current or new projects; they should also integrate the interactions between these different projects and departments into their considerations. This means that the portfolio approach provides a sound basis for decision-making with respect to the pricing of future projects.

### **Keywords**

Management of Chances and Risks; Portfolio Management; Chance; Risk; Monte Carlo Simulation; Construction Contractor; Project Volume; Chance/Risk Ratio

(Paper, ID 6)

### **A Review of Hospitals Functional Resilience and Performance Indicators**

Farhad Mahmoudi, Sherif Mohamed  
(*School of Engineering and Built Environment,  
Griffith University, Queensland, Australia*)  
[farhad.mahmoudi@griffithuni.edu.au](mailto:farhad.mahmoudi@griffithuni.edu.au),  
[s.mohamed@griffith.edu.au](mailto:s.mohamed@griffith.edu.au)

### **Abstract**

In order to deliver healthcare services, hospitals' functional performance depend on their physical structure and organisational performance as well as the availability of services which are being provided by the other regional infrastructures. Therefore, any physical damage or functional disruptions can have a negative consequence on their effective response which can worsen the outcome of the emergency situation. In the seminal literature, it has been suggested that further research is needed in order to introduce a unified set of indicators and metrics through which hospitals' sustainable operational performance can be measured. For assessing the extent of vulnerability and resiliency of healthcare facilities, a number of frameworks, toolkits and checklists have been developed by scholars and institutions. Although the indicators and metrics, being used in these tools, have some similarities, they are widely different based on what they intend to measure. This paper reviews the relevant literature and presents a functional resilience index for evaluating hospitals' resilience in face of disruptive events.

### **Keywords**

Hospital, Resilience, Functional, Performance, Metrics

(Paper, ID 7)

### **A Labor Cost Analysis of the Design Review Process at the U.S. Army Corps of Engineers, Wilmington District Design**

Scott Kramer  
*Professor, Auburn University, Auburn, Alabama,  
USA*

Froilán Esclusa  
*Graduate Student, Auburn University, Auburn,  
Alabama, USA*

Junshan Liu  
*Associate Professor, Auburn University, Auburn,  
Alabama, USA*

### **Abstract**

The U.S. Army Corps of Engineers (USACE) mission is crucial to the nation's security and resilience of our infrastructure. As steward of public trust and funding, it is fundamental to design and construct with the highest standards and tradition of quality. The Wilmington District adheres closely and invests significant man-power to comply with a clearly defined guidance for design products quality reviews. Historical project data was analyzed on this research paper with the primary objective of measuring the level of effort invested on design reviews and create a numeric relationship or proportion to the cost increase during construction. This proportion is defined as the Efficiency Ratio (ER); the ratio between the costs of Change Orders per every hour of labor invested in review. The ER is expressed as a decimal number that gives us a graphical representation and attempts to illustrate the level of effectiveness from one perspective. In times of funding challenges and limitations, it is imperative that the distribution of human resources is capitalized and not challenged by it. The conclusions of this analysis provide project teams and management with a tool to prioritize or reallocate resources where the cost benefits and construction cost savings are maximized. Conclusions suggest that resources currently invested in reviewing a certain type of project may be shifted to provide additional review for other type of projects that are resulting in higher changes during construction.

### **Keywords**

Design Review, Construction Labor, USACE.

(Paper, ID 8)

### **Impact of Lean Principles on Timely Project Completion**

Helena O'Connor,  
*CAU-RJ, LEED AP, and Khalid Siddiqi, PhD*  
*Kennesaw State University*  
*Marietta, GA 30060*

#### **Abstract**

Lean ideas have been used in the business world for some time. Lean advocates have been adapting these principles to different industries, including construction. The main Lean principles are value added to the customer and elimination of waste. It is very important for the owner to get the project completed on time, but that is a contractual requirement. Minimizing time waste and delivering projects “ahead of schedule” would be an added value to the customer. Some construction companies have successfully adopted Lean principles to manage their projects while others have not. The objective of this study is to determine the impact of Lean principles on timely completion of construction projects. In this study, projects with Lean strategies versus Non-Lean strategies were compared to analyze the impact on their completion schedule. A survey was conducted with project managers of construction companies to collect data on project completion and which Lean tools have been used. Results indicated that Lean principles application assisted contractors to complete projects ahead of schedule or helped them catch up to finish on time when delays were encountered. This study is intended for those general contractors who are still skeptical about Lean practices and would like to see examples that Lean can help them deliver projects faster and more efficiently.

#### **Keywords**

Lean Principles, Lean Construction, Lean Tools, Lean Project Delivery, Project Completion.

(Paper, ID 9)

### **An exploratory study of mentoring in infrastructure development of new entry graduates in the South African construction industry**

Morena William Nkomo  
*PhD Candidate, University of Johannesburg,*  
*Department of Construction Management and*  
*Quantity Surveying, Beit Street.,*  
*2094 Doornfontein, South Africa*

Wellington Didibhuku Thwala  
*Full Professor, University of Johannesburg,*  
*Department of Construction Management and*  
*Quantity Surveying, Beit Street.,*  
*2094 Doornfontein, South Africa*

Clinton Ohis Aigbavboa  
*Associate Professor, University of Johannesburg,*  
*Department of Construction Management and*  
*Quantity Surveying, Beit Street.,*  
*2094 Doornfontein, South Africa*

#### **Abstract**

South Africa is once again on the brink of a massive growth and development opportunity with the Government’s planned 20 year National Infrastructure Development Plan (NIDP) and the 18 Strategic Integrated Project (SIPS) groups that go with this. Mentoring is important for all new entry employees entering the workplace. In spite of the growing research on both sets of individuals, mentors and protégés, mentoring from the perception of the organizational remains comparatively under described. The purpose of this paper is to investigate the impact of mentoring, on graduates employees in the construction industry. Furthermore it will classify the drawbacks, benefits and look at imminent prospects of formal mentoring in medium sized and large organizations in South African construction industry. The paper emphasizes on how organizations view mentoring. The study was mainly a literature review with a distinct focus on formal mentoring programs on graduate’s employees. The data used in the report was mainly qualitative, grounded on the, case studies and historical data. The review is into formal mentoring of graduate’s employees entering the work place. The scope of this review is limited to the literature that discusses formal mentoring internal to the workplace which support on and off job learning of new entry employees. The findings revealed the organization current situation and the issues that are vital to the HR function. Mentoring is primarily used to transfer implicit knowledge from those near retirement to younger employees, substitute the personnel development and create well-being at work. Career advancement and work performance are not as important as might have been thought. Young graduates employees, in particular may petition the use of social media, alongside mentoring.

#### **Keywords**

Construction Industry, Formal Mentoring, Infrastructure Development, Human Resource Development.

(Paper, ID 11)

### **Implementing BIM for Performing Detailed Construction Estimates in the Classroom**

John E. Patterson

*Norwich University, Northfield, VT, U.S.A.*

[jpatter2@norwich.edu](mailto:jpatter2@norwich.edu)

#### **Abstract**

Building Information Modeling (BIM) is becoming an integral part of the Architecture, Engineering, and Construction (AEC) industry as a requirement for complete Construction Documents (CD's). As a generation of new practitioners are trained the understanding of BIM is an integral part of the overall educational parameters for CE/CM. The purpose of this study is to present techniques used for assembling detailed construction estimates incorporating BIM. Various estimating process are examined determining the key aspects necessary to develop a detailed estimate. In determining the capabilities of the BIM drawing, the Level of Development (LOD) is presented as a control of the accuracy of the drawings and ultimately the estimate. This study further examines the student's ability to work with BIM modeling. At the conclusion of the course a student survey instrument was provided to the students to examine their skills and confidence.

#### **Keywords**

BIM, Estimating, LOD, Schedule, 3D

(Paper, ID 12)

### **Alternative Housing Solutions in Southern California**

Scott Kelting

*Associate Professor, California Polytechnic State University, San Luis Obispo, California, USA*

Lucas Nozick

*Project Engineer, WEST Builders, Culver City, California, USA*

#### **Abstract**

The perpetually growing population and economy within the United States necessitates building construction of all types. Increased building generates environmental concerns, and rightfully so. This industry accounts for approximately 4% of the total GDP in the United States, while creating around two-thirds of the material waste annually. The green building movement is certainly gaining popularity in both application and recognition through entities such

as the United States Green Building Council (USGBC) and their LEED program; however, builders are also producing their own ideas. Alternative housing solutions that include pre-fabricated building components and shipping container homes are making great strides in the residential construction industry, and will certainly play an important role in the future. This paper will compare the cost and schedule of modular, panelized and shipping container homes to traditional stick frame home construction in the Greater Los Angeles Metropolitan Area and recommend the best application for each option.

#### **Keywords**

Stick Framed, Prefabricated, Shipping Container, Cost, Schedule

(Paper, ID 14)

### **Scientometric Analysis of Building Information Modelling (BIM) in Facility Management (FM)**

Mustafa A. Hilal <sup>a,b</sup>

<sup>a</sup> *Faculty of Engineering and Industrial Science, Swinburne University of Technology, Melbourne, Victoria, Australia*

<sup>b</sup> *Faculty of Civil Engineering, University of Baghdad, Baghdad, Iraq*  
[mhilal@swin.edu.au](mailto:mhilal@swin.edu.au)

Tayyab Maqsood <sup>c</sup>

<sup>c</sup> *School of Property, Construction and Project Management, RMIT University, Melbourne, Victoria, Australia*

[tayyab.maqsood@rmit.edu.au](mailto:tayyab.maqsood@rmit.edu.au)

Amir, A. <sup>d</sup>

[aabdekhodaee@swin.edu.au](mailto:aabdekhodaee@swin.edu.au)

<sup>d</sup> *School of Engineering, Department of Mechanical Engineering and Product Design Engineering, Swinburne University of Technology, Melbourne, Victoria, Australia*

#### **Abstract**

Over the last few years, the emergence of BIM has successfully achieved a paradigm-shift in Architectural-Engineering-Construction and Facility Management (AEC/FM) sectors. This has led to many articles and papers that have been published in those sectors. In order to statistically classify and categorize those publications, Bibliometric and Scientometric Analysis research have been conducted to extract much useful information. However, the existing research sheds a light on the use of BIM in the construction industry in general, focusing on the

design and construction phases. Literature review has shown no Bibliometric and Scientometric Analysis of BIM in FM in particular. This research addresses this lack and establishes the first Scientometric Analysis study of BIM in FM. This study employed a quantitative approach using science mapping techniques to examine BIM-FM articles using the Web of Science (WOS) database for the period between (Jun 2003- Oct 2017). The findings guide researchers who are interested in BIM-FM topics by providing visual maps analysis of that area in a simple, easy, and readable way. Finally, knowledge gaps in this domain can be identified more easily with those findings of Scientometric Analysis.

### **Keywords**

Scientometric Analysis, FM, BIM, Construction Industry, Web of Science.

(Paper, ID 19)

### **BIM for collaboration and coordination**

Haddy Jallow

*BIM Coordinator, Kier, Temsford, London , United Kingdom*

Suresh Renukappa and Subashini Suresh

*Faculty of Science and Engineering, University of Wolverhampton, Wolverhampton, United Kingdom*

Ahmed Alneyadi

*Abu Dhabi Police GHQ, Abu Dhabi, United Arab Emirates*

### **Abstract**

Collaboration and coordination are massive factors when it comes to the construction industry. The construction industries have various parties within an organisation which have to work together to complete a project. As there are many teams within the organisations, communication is key as it could determine whether the project is productive.

Collaboration practices have not been the best in the industry as the industry has been massively paper based and with that, one team having data does not mean everyone has access to the data which may be vital for the project.

The Building Information Model has been mandated in the UK and all projects are to use a minimum of level 2 BIM. With BIM being previously aimed at building, the infrastructure sector has a lot to catch up on, BIM helps enhancing collaboration and coordination for an organisation, from visual aids to having a common data environment where everyone in the organisation can see all updated information

and all data uploaded. Using the Building Information Model can help performance of an organisation as it does not only help collaboration for the organisation, but also assists with communication with the client and stakeholders. The purpose of this research is to investigate the issues the construction industry face when it comes to collaboration and how the use of a Building Information Model assists in provide better collaboration and coordination for an organisation.

### **Keywords**

Building Information Model (BIM); Common Data Environment (CDE); Construction; BIM Implementation; 3D; 4D; 5D; 6D; 7D.

(Paper, ID 20)

### **Awareness and Adoption of Light Gauge Steel (LGS) Technique in the Construction Industry**

DOSUMU, Oluwaseun

*Sustainable Human Settlement and Construction Research Centre  
Faculty of Engineering and the Built Environment,  
University of Johannesburg, South Africa  
[Oluwaseundosumu97@gmail.com](mailto:Oluwaseundosumu97@gmail.com)*

AIGBAVBOA, Clinton

*Sustainable Human Settlement and Construction Research Centre  
Faculty of Engineering and the Built Environment,  
University of Johannesburg, South Africa  
[caigbavboa@uj.ac.za](mailto:caigbavboa@uj.ac.za)*

THWALA, Wellington

*Sustainable Human Settlement and Construction Research Centre  
Faculty of Engineering and the Built Environment,  
University of Johannesburg, South Africa  
[didibhukut@uj.ac.za](mailto:didibhukut@uj.ac.za)*

MBOYA, Unathi

*Sustainable Human Settlement and Construction Research Centre  
Faculty of Engineering and the Built Environment,  
University of Johannesburg, South Africa  
[unathi.mboya@gmail.com](mailto:unathi.mboya@gmail.com)*

### **Abstract**

Light Gauge Steel (LGS) construction has been a well embraced building technique in the developed countries for many years. However, it is an unpopular method of construction in the developing countries, including South Africa. The aim of this study is to gain insight into the level of awareness and adoption

of LGS technique in the construction industry. The survey research design was adopted for this study. Questionnaire was administered on large contracting and consulting firms in South Africa using the random sampling technique. The data for the study was analysed with frequencies, percentages, mean item scores and t test statistics. The results of the study indicate the perceived percentage level of awareness and adoption of LGS technique in the construction industry. The mean ratings of variables according to consultants and contractors were also indicated in the study. It was also concluded that light gauge steel is adopted for construction in South Africa, but it is mostly used as wall elements. The study recommends that, there is need for more awareness on the usefulness and need to adopt LGS for construction industry.

#### **Keywords**

Conventional Construction, Construction Professionals, Green Building Technique, Light Gauge Steel.

(Paper, ID 21)

#### **Challenges Associated with Nominated Suppliers Procurement (NSP) Method in the South African Construction Industry**

Oluwaseun Dosumu  
*Sustainable Human Settlement and Construction  
Research Centre  
University of Johannesburg, South Africa*  
[oluwaseundosumu97@gmail.com](mailto:oluwaseundosumu97@gmail.com)

Clinton Aigbavboa  
*Sustainable Human Settlement and Construction  
Research Centre  
University of Johannesburg, South Africa*  
[calgbavboa@uj.ac.za](mailto:calgbavboa@uj.ac.za)

Wellington Thwala  
*Sustainable Human Settlement and Construction  
Research Centre  
University of Johannesburg, South Africa*  
[didibhukur@uj.ac.za](mailto:didibhukur@uj.ac.za)

Nxumalo Thandokhule  
*Sustainable Human Settlement and Construction  
Research Centre  
University of Johannesburg, South Africa*  
[cedriclungelo@gmail.com](mailto:cedriclungelo@gmail.com)

#### **Abstract**

Nominated Suppliers procurement is a method that is being currently embraced in South Africa. However,

it is unclear how the method is being administered in the construction industry. The aim of the study is to gain a reputable knowledge into the challenges associated with Nominated supplier's procurement method in the South Africa construction industry. Out of the 90 questionnaires that were distributed, 67 (giving a response rate of 73%) were retrieved and used for the study. Data collection was based on random sampling technique from construction professionals and merchants such as project managers, clients, manufactures, suppliers, engineers and quantity surveyors. The findings reveal that inadequate planning and scheduling by the supplier, fluctuation of prices associated with the prevailing supply-demand cycle and lack of commitment by material supplier are some of the challenges of nominated supplier's procurement method in South Africa.

#### **Keywords**

Nominated Suppliers, Procurement Challenges, Construction Industry, South Africa

(Paper, ID 23)

#### **Preparing Construction Contractors for Post-Disaster Recovery Operations**

Bassam Baroudi  
*The University of Adelaide, South Australia,  
Australia*  
[sam.baroudi@adelaide.edu.au](mailto:sam.baroudi@adelaide.edu.au)

Randy Rapp  
*Purdue University, West Lafayette, Indiana, USA*  
[rrapp@purdue.edu](mailto:rrapp@purdue.edu)

#### **Abstract**

In the aftermath of a disaster there is a need for conventional and specialist contractors to perform immediate mitigation and rectification of hazardous situations followed by expeditious restoration and reconstruction of the built environment. The question is what can they do to prepare their companies for service both to themselves and to the affected community? This area of disaster reconstruction project management is quite complex and presents unique challenges in respect to the availability of skilled personnel, materials, equipment and supporting infrastructure. Hence, a special type of planning is required for contractors to be appropriately prepared so that they can serve the disaster affected community. This paper presents a review on disaster management and reconstruction research and literature. It follows on to provide a commentary on the subject and how contractors can

better prepare their organisations for disaster events. The study is important as disaster preparedness is quite often taken from that of a first responder, community or government perspective but rarely from that of the contractor. Hence, further thinking is required to offer a more strategic view in respect to disaster preparedness and gearing contractor operations to be agile enough to cope with the influx of such projects. The benefit to disaster affected people, the built environment and indeed the contractors themselves could be measurably significant.

### **Keywords**

Disaster Preparedness, Reconstruction, Contractor Planning

(Paper, ID 24)

### **Overview of Accelerated Bridge Construction Techniques in Highway Bridge Construction in the United States**

Amin K. Akhnoukh

*Associate Professor, East Carolina University,  
Greenville, North Carolina, USA*  
[Akhnoukha17@ecu.edu](mailto:Akhnoukha17@ecu.edu)

Tarik A. Youssef

*Assistant Professor, French University in Egypt,  
Shorouk City, Cairo, Egypt*  
[Tarik.youssef@ufe.edu.eg](mailto:Tarik.youssef@ufe.edu.eg)

Chao “Luna” Xiao

*Associate Professor, East Carolina University,  
Greenville, North Carolina, USA*  
[Xiaoch17@ecu.edu](mailto:Xiaoch17@ecu.edu)

### **Abstract**

The National Bridge Inventory (NBI) of the United States includes more than 600,000 highway bridges with spans exceeding 20 ft. Approximately one-fourth of the nation’s inventory are structurally deficient or functionally obsolete, thus, repair, rehabilitation, or total replacement is required to maintain the highway bridges from collapse. The total cost of required bridge maintenance activities requires a total annual budget of \$15 billion compared to a \$1 billion available budget at the Federal Highway Administration. The budget deficiency requires innovative techniques in bridge rehabilitation and replacement that provides the construction industry with sufficient savings in the direct and indirect cost of bridge maintenance activities. Accelerated Bridge Construction (ABC) techniques are introduced as a new-approach that

uses innovative planning, design, and construction techniques in a cost-effective manner to reduce the onsite activities, utilize site-available topography and materials to reduce construction time and consumed materials, and minimize the use of heavy equipment. Recent studies by the Federal Highway Administration proved that ABC techniques has resulted in minimized detour time, and significantly reduced the overall bridge construction projects by months to years.

### **Keywords**

Accelerated Bridge Construction (ABC), Structurally Deficient, Maintenance Activities, Detours

(Paper, ID 25)

### **Global Construction 2030 Market at Top Three Nations**

Roberto Soares, PhD, DSc, MBA,AIC,DBIA, PE  
*Teaching Assistant Professor, East Carolina  
University, Greenville, NC, USA*

Amin K. Akhnoukh

*Associate Professor, East Carolina University,  
Greenville, North Carolina, USA*  
[Akhnoukha17@ecu.edu](mailto:Akhnoukha17@ecu.edu)

### **Abstract**

The Global construction market is showing an increase in the needs of construction services over the years, it is forecasted that by 2030 the global construction market will be worth \$ 17.5 Trillion. Data from the Global Construction Report 2030 indicates that China, US, India will account for 57% of the total market worth value. The aim of this paper is to analyses the environment, the business opportunities and the objectives of these three countries using strategic management technics as: PESTLE, SWOT, and SMART to provide convincing arguments for construction enterprises interested in service these countries. Dedicated analysis and recommendations for each country listed above will be provided.

### **Keywords**

Global Construction, PESTLE. SWOT, SMART, Business Opportunities.

(Paper, ID 26)

### **Augmented Reality (AR) and Virtual Reality (VR) in construction industry: An experiential development workflow**

Dr. Poorang Piroozfar  
*School of Environment and Technology, University of  
Brighton, Brighton, East Sussex, BN2 4GJ, United  
Kingdom, [A.E.Piroozfar@brighton.ac.uk](mailto:A.E.Piroozfar@brighton.ac.uk)*

Mr. Amer Essa  
*School of Environment and Technology, University of  
Brighton, Brighton, East Sussex, BN2 4GJ, United  
Kingdom, [ameressa@outlook.com](mailto:ameressa@outlook.com)*

Mr. Simon Boseley  
*School of Environment and Technology, University of  
Brighton, Brighton, East Sussex, BN2 4GJ, United  
Kingdom, [sboseley@outlook.com](mailto:sboseley@outlook.com)*

Dr. Eric R. P. Farr  
*NONAMES Design Research Foundation, 1249 F  
Street, San Diego, CA 92101, USA  
[Eric.R.P.Farr@gmail.com](mailto:Eric.R.P.Farr@gmail.com)*

Dr. Ruoyu Jin  
*School of Environment and Technology, University of  
Brighton, Brighton, East Sussex, BN2 4GJ, United  
Kingdom, [R.Jin@brighton.ac.uk](mailto:R.Jin@brighton.ac.uk)*

#### **Abstract**

Augmented Reality (AR) and Virtual Reality (VR) in the Architecture, Engineering and Construction (AEC) industry have a sustained track record of research and development proving both technologies to be beneficial to various stakeholders throughout the lifecycle of buildings. Previous research in different areas of AR/VR in the AEC industry is not rare but rather scattered and some areas have benefitted more than others. One of the less researched areas in this field is the workflow development of the instrument in experiential research in AR/VR. With an empirical research paradigm at its core, this paper seeks to provide evidence to bridge this gap using two generic case studies, one for AR and the other for VR. A systemic procedural process is used to explain the workflow development of both experiments aiming at establishing a method which can be adopted, adapted, or customized to best suit the specifics of any similar research project in this field.

#### **Keywords**

Augmented Reality, Construction Industry, Handheld Devices, Head-Mounted Devices, ICT Application, Virtual Reality

(Paper, ID 27)

### **The application of Augmented Reality (AR) in the Architecture Engineering and Construction (AEC) industry**

Dr. Poorang Piroozfar  
*School of Environment and Technology, University of  
Brighton, Brighton, East Sussex, BN2 4GJ, United  
Kingdom, [A.E.Piroozfar@brighton.ac.uk](mailto:A.E.Piroozfar@brighton.ac.uk)*

Mr. Simon Boseley  
*School of Environment and Technology, University of  
Brighton, Brighton, East Sussex, BN2 4GJ, United  
Kingdom, [sboseley@outlook.com](mailto:sboseley@outlook.com)*

Mr. Amer Essa  
*School of Environment and Technology, University of  
Brighton, Brighton, East Sussex, BN2 4GJ, United  
Kingdom, [ameressa@outlook.com](mailto:ameressa@outlook.com)*

Dr. Eric R. P. Farr  
*NONAMES Design Research Foundation, 1249 F  
Street, San Diego, CA 92101, USA  
[Eric.R.P.Farr@gmail.com](mailto:Eric.R.P.Farr@gmail.com)*

Dr. Ruoyu Jin  
*School of Environment and Technology, University of  
Brighton, Brighton, East Sussex, BN2 4GJ, United  
Kingdom, [R.Jin@brighton.ac.uk](mailto:R.Jin@brighton.ac.uk)*

#### **Abstract**

Augmented Reality (AR) as a concept has been in use for many years and prevalence of new mobile technologies, such as smartphones and handheld devices, have facilitated the concept of AR becoming fully realized. Various fields are exploiting the increasing feasibilities the concept of AR can offer; one of these being the Architecture, Engineering and Construction (AEC) industry. This paper introduces a research project that investigates benefits and limitations of AR for use in AEC industry. It starts with a brief background to the research before presenting a critical literature review, which forms the basis for the development and design of an AR experiment and a questionnaire for participants in the study. Results are provided with an in-depth discussion on their possible significance, before a conclusion is presented. The results suggest that although the participants believed that AR can offer a wide range of benefits to different tasks and at different stages of a project, it seems more beneficial to some specific tasks or at some specific stages than the others. Using the specific findings of this study future research in this field is proposed in different areas.

**Keywords**

Augmented Reality, Construction Industry, Handheld Devices, ICT Application, Virtual Reality

(Paper, ID 29)

**Field Evaluation of Surface Characteristics of Microsurfacing Pavements**

Yi Jiang, Ph.D., P.E.

*School of Construction Management, Purdue University, West Lafayette, Indiana, USA*  
[jiang2@purdue.edu](mailto:jiang2@purdue.edu)

Shuo Li, Ph.D., P.E.

*Division of Research and Development, Indiana Department of Transportation West Lafayette, Indiana, USA*  
[sli@indot.in.gov](mailto:sli@indot.in.gov)

**Abstract**

The Indiana Department of Transportation (INDOT) started to experiment with microsurfacing in pavement surface preservation. In order to provide first-hand, original data to better utilize microsurfacing in pavement surface preservation, a study was conducted to evaluate the surface characteristics of microsurfacing, in particular the surface friction properties. A total of six microsurfacing pavements were selected for field evaluation in this study. Field tests were conducted to evaluate the performance of microsurfacing, including pavement surface friction, surface depth and surface smoothness. Friction numbers were measured on freshly placed microsurfacing and as well as over time. Mean profile depth (MPD) was measured to assess the properties of surface macrotexture. The international roughness index (IRI) was measured to evaluate the surface smoothness. Data analysis was conducted to examine the effect of possible factors on the surface characteristics. Based on the results, the friction characteristics were identified and the typical MPD was determined. The improvement in surface smoothness from microsurfacing was assessed. It is believed that the original and reliable information presented herein can be utilized to better assess the performance of microsurfacing and perform engineering analysis.

**Keywords**

Microsurfacing, Pavement Friction, Preservation, Pavement Roughness, Rutting

(Paper, ID 30)

**Remoteness, Mental Health and Safety Behaviour among Oil and Gas Workers**

Anwar S. Alroomi

*Griffith University, Gold Coast, Australia,*  
[anwar.alroomi@griffithuni.edu.au](mailto:anwar.alroomi@griffithuni.edu.au)

Sherif Mohamed

*Griffith University, Gold Coast, Australia,*  
[s.mohamed@griffith.edu.au](mailto:s.mohamed@griffith.edu.au)

**Abstract**

The literature lacks a model that combines working in remote and isolated areas, safety behaviour and the relationship between them. This paper reports on an ongoing research study investigating the influence of remoteness on workers' mental health and, in turn, on their safety behaviour. The paper presents a conceptual framework comprising a number of dependent and independent variables for remoteness identified through the literature (i.e., physical isolation and occupational stressors) and for safety behaviour (i.e., compliance and participation). The framework (and relevant hypotheses) is intended to examine the mediating role workers' mental health can have on the remoteness–safety behaviour relationship. Mental health is represented by two more variables; namely, anxiety and depression. This paper is theoretical in nature, focuses on oil and gas workers working in remote areas, but its content should be relevant to the construction industry where the use of a non-resident workforce is common practice in many parts of the world, especially in the Middle East—the geographic focus of this study.

**Keywords**

Safety Behaviour, Mental Health, Occupational Stressors, Social Isolation, Loneliness.

(Paper, ID 31)

**Quantity Uncertainties in Shuttering Works – Comparison of Public versus Private Clients**

Markus Kummer

*Project Assistant, Graz University of Technology, Graz, Styria, Austria*

**Abstract**

Uncertainties are systematically considered and dealt with by applying probabilistic calculation methods, such as Monte Carlo simulations. When selecting appropriate distribution functions for input parameters, users are constantly faced with the issue

of having to choose the “right” distribution function for the relevant parameter. Quantities of individual works play a crucial role for costing and pricing, but also for construction process and logistics planning purposes. Quantities stated by the client in its structural specifications are fraught with uncertainties owing to, for instance, incomplete plans at the time of specification, inaccurate calculations, or mere estimates. This is why actual quantities can either be greater or smaller than the specified quantities. From the point of view of the bidder/contractor, the above-mentioned quantity uncertainties constitute a risk (for instance with respect to the contribution margin), but also a chance (such as in unit-priced contracts in the case of quantity increases at a high unit price), and should be reflected by distribution functions of relevant quantities in the probabilistic costing exercise. Considering quantity uncertainties is also of interest to clients in order to investigate, during the phase of selecting the best bidder, how prices quoted by bidders would move when specified quantities change in the case of unit-priced contracts. This paper demonstrates how distribution functions can be derived from expert surveys delivering responses from actual construction practice. Specific reference is made to shuttering works whilst distinguishing between public and private clients. The outcomes of the survey presented and discussed in this paper include descriptive data analyses as well as violin plots and fitted distribution functions.

#### **Keywords**

Distribution Functions; Expert Survey; Data Fitting; Management Of Chances And Risks; Quantity Uncertainties; Monte Carlo Simulation; Uncertainty

(Paper, ID 32)

#### **Going for Waste to Energy in Developing Countries**

Dr. Shahid Mahmood  
*Director, Capital Development Authority, Islamabad,  
Pakistan*  
[cda\\_shahid@yahoo.com](mailto:cda_shahid@yahoo.com)

Mohammad Arshad Chuhan  
*Director Planning, Capital Development Authority,  
Islamabad, Pakistan*  
[mac\\_chouhan@hotmail.com](mailto:mac_chouhan@hotmail.com)

#### **Abstract**

Municipal solid waste (MSW) is a global environmental problem. Its quantity is increasing with corresponding increase in population. Safe disposal of MSW is a big challenge for municipal authorities. One way of disposal of MSW is in

landfill sites and the other is to make its beneficial use as fuel for power generation.

MSW is easily available in abundance and is a cheap source of energy for power generation. Solid waste incinerator can remove up to 99.9999 percent of all toxins from their emissions and as such are no more harmful to the environment; in comparison MSW landfills emit methane-gas, and leachates that are hazardous for environment and ground water. This research study has examined the possibility of waste to energy project for capital city of Pakistan, and has carried out its technical and financial feasibility analysis. This technically feasible and cost-effective project will not only solve the MSW disposal problem, but would improve the environment of the city along with providing electricity and saving precious foreign exchange used for import of fuel.

#### **Keywords**

Municipal Solid Waste, Waste to Energy, Power Generation, Garbage Incineration, Refuse Derived Fuel

(Paper, ID 33)

#### **Reactive Powder Concrete Application in the Construction Industry in the United States**

Amin K. Akhnoukh  
*Associate Professor, East Carolina University,  
Greenville, North Carolina, USA*  
[akhnoukha17@ecu.edu](mailto:akhnoukha17@ecu.edu)

Roberto Soares  
*Teaching Assistant Professor, East Carolina  
University, Greenville, North Carolina, USA*  
[soaresr17@ecu.edu](mailto:soaresr17@ecu.edu)

#### **Abstract**

Reactive powder concrete (RPC) is a new class of concrete developed in France in the 1990s. RPC mixes shows superior material properties as high early strength, higher compressive and tensile strength, durability and higher resistance to shrinkage, creep, and hard environmental conditions. Currently, RPC is introduced to the US market through the FHWA and is commercially known as *ultra-high-performance concrete* (UHPC).

UHPC displayed superior performance in high-rise building construction and prestressed concrete girder bridges. The high early strength results in expedited fabrication at precast yards. The RPC high strength results in smaller cross sections, lighter weight structures, reduced labor, and construction equipment

with smaller capacities. In 2010, the FHWA started using RPC in various bridge construction and repair projects using the accelerated bridge construction (ABC) innovative approach. This paper presents the history of RPC, RPC mix constituents, advantages, and its application in prefabricated bridge elements and systems construction (PBES).

#### **Keywords**

Reactive Powder Concrete (RPC), Ultra-High-Performance Concrete (UHPC), Pi-girder, Compressive Strength

(Paper, ID 34)

#### **Claim Management - Fundamentals and Utilization for Industrial Construction**

Bernhard Bauer, Clemens Gaugl, Detlef Heck  
Graz University of Technology, Graz, Styria, Austria  
[bernhard.bauer@tugraz.at](mailto:bernhard.bauer@tugraz.at), [Cgaugl@gmx.net](mailto:Cgaugl@gmx.net),  
[detlef.heck@tugraz.at](mailto:detlef.heck@tugraz.at)

#### **Abstract**

The subject of claim management is becoming more and more present in the construction industry. Taking a look at the industrial building sector, it becomes clear, that there are different boundary conditions compared to classic residential construction projects. These include very short construction periods in which significant areas have to be built. Meaning that most industrial buildings are single-storey buildings with a large floor space, that are built with precast elements as common construction method to be able to comply with short construction times.

To come up with possible further reasons for claims, in this research an interview guide was compiled and expert interviews were conducted with persons working in this specific sector. These opinion polls were deliberately conducted with non-standardized questionnaires to leave room for interviewers to provide answers and different interpretations of possible reasons for claims.

The results show, that claims in industrial construction projects mostly result from the client's sphere. Those can be cost increases due to changes in the project scope, but also decreases resulting from optional services that are not executed. Also the large base areas, which are typical for industrial structures, can increase the project budget. Poor groundwater discoveries repeatedly lead to performance problems and consequently to additional costs. In the process, the foundation risks are repeatedly passed on, which is also permissible within a reasonable scope (Kurbos, 2010).

#### **Keywords**

Claim Management, Construction Contract, Industrial Construction

(Paper, ID 35)

#### **Improving Productivity of Concreting Equipment: Failure Modeling Case Study on New Hot Strip Mill, Rourkela, India**

Arka Ghosh

*M.Tech. Student, Department of Civil Engineering, Indian Institute of Technology, New Delhi, Delhi, India*

[Arka.Ghosh.cec16@civil.iitd.ac.in](mailto:Arka.Ghosh.cec16@civil.iitd.ac.in)

Abid Hasan

*Ph.D. Candidate, University of South Australia, Adelaide, Australia*

[abid.hasan@mymail.unisa.edu.au](mailto:abid.hasan@mymail.unisa.edu.au)

Kumar Neeraj Jha

*Associate Professor, Department of Civil Engineering, Indian Institute of Technology, New Delhi, Delhi, India*

[knjha@civil.iitd.ac.in](mailto:knjha@civil.iitd.ac.in)

#### **Abstract**

There is a growing reliance on concrete batching plants and ready-mix concrete presently due to faster work, uniform quality of concrete, eco-friendly nature and reduction in wastage. Rapid changes in the type of equipment and technological advancement has restructured the dynamics of the construction industry. Hence improving the productivity of Concrete Batching Plants and their supporting equipment will ensure better quality, durable and robust infrastructure development economically and sustainably. The high variability in site concreting operations, complex problems in logistical and combinational optimization are major hindrance factors that affect effective management strategies/procedures. Overall Reliability of the System (Concrete Batching Plant and Transit Mixer) is calculated using k out of n method algorithm developed by Barlow Heidman. A regression model is then developed for each of the equipment that tries to find out the factors on which the time to failure of a concrete batching plant depends upon and establishes a mathematical relationship with an acceptable level of accuracy. The model will act as a tool for future forecasting so that effective maintenance strategies can be duly formulated, and maintenance crew allotted/kept on standby just

before the next failure to minimize loss of productivity due to equipment breakdown.

### **Keywords**

Failure Modelling, Ready Mix Concrete, Overall Equipment Efficiency, Reliability.

(Paper, ID 36)

### **The Dilemma of Pricing Against the Backdrop of the Chance/Risk Ratio**

Christian Hofstadler

*Professor, Graz University of Technology, Graz, Styria, Austria*

Markus Kummer

*Project Assistant, Graz University of Technology, Graz, Styria, Austria*

### **Abstract**

Calculating construction costs and times is one of the most important and demanding tasks in construction management and economics. Valid data and information is constantly being sought for labor consumption rates, output values, productivity levels, material consumption, quantities in stock, number of transport cycles, and cost and time parameters that must be estimated and/or calculated *ex ante*.

Ultimately, final cost and time parameters are determined on the basis of such considerations and calculations. *Ex post* and/or *inter actio* analyses are performed to check if actual values achieved in the construction phase are identical to the target values. In an ideal scenario, the productivity level would be higher and/or material consumption or equipment utilization lower than originally planned. However, the chances that calculated assumptions are exceeded in a positive sense are also associated with risks of non-compliance in a negative sense.

Accurate figures must be stated or submitted at the end of any analysis. These depend on the complexity of the building or structure and on the conditions prevailing at the actual work stages and rely on more or less uncertain input data. One possible solution to this issue is to consider ranges that can deliver final conclusions on determined values. Applying probabilistic calculation methods appears to be useful to systematically consider ranges in input parameters. Key outcomes of probabilistic calculations include histograms derived from (numerical) simulations. These histograms are used to directly capture the chance/risk ratio relative to a specific (selected) value.

This paper outlines the dilemma of pricing and deals with the issue of viable bid prices in relation to the chance/risk ratio.

### **Keywords**

Management of Chances and Risks; Chance; Risk; Monte Carlo Simulation; Chance/Risk Ratio; Costing; Histogram

(Paper, ID 37)

### **In-Depth Bid Assessment for Unit-Priced Contracts**

Christian Hofstadler

*Professor, Graz University of Technology, Graz, Styria, Austria*

### **Abstract**

Both at the design and specification stages and when assessing submitted bids, the client bears great responsibility for ensuring a high standard of workmanship, fair competition, economic efficiency, and the greatest possible benefit for management and operations. Public-sector clients use in-depth bid assessment as an effective tool to eliminate bids that are implausible or that bidders cannot sufficiently justify in related discussions. To ensure project success on all levels, it is crucial for the client to identify the chance/risk ratios associated with each of the bidders. Conversely, to ensure the continued existence and operation of its business, it is very important for the contractor to be aware of the chance/risk ratio on which the bid price is based. In either case, the selected baseline value determines the specific ratio of chances and risks. For reference purposes, the client can rely on cost estimates provided by experts, such as construction cost indicators adjusted to the specific region and project, whereas the contractor is in a position to apply full costing free of speculative elements (break-even costing).

This paper describes the models and calculations that enable a transparent breakdown of cost risks in the specification and award process. For this purpose, Monte Carlo simulations and associated histograms for the interpretation of results are used in order to systematically consider uncertainties and ranges of values in the bid assessment.

### **Keywords**

Management of chances and risks; bid assessment; unit-priced contract; Monte Carlo simulation; chance/risk ratio; costing; histogram

(Paper, ID 38)

### **Factors Influencing Productivity of Concreting Equipment in Indian Construction Projects**

Abid Hasan

*Ph.D. Candidate, University of South Australia,  
Adelaide, Australia*  
[abid.hasan@mymail.unisa.edu.au](mailto:abid.hasan@mymail.unisa.edu.au)

Kumar Neeraj Jha, Nihar Ranjan Sahoo, Arka Ghosh  
*Department of Civil Engineering, Indian Institute of  
Technology, New Delhi, Delhi, India*  
[knjha@civil.iitd.ac.in](mailto:knjha@civil.iitd.ac.in), [niharrsahoo15@gmail.com](mailto:niharrsahoo15@gmail.com),  
[Arka.Ghosh.cec16@civil.iitd.ac.in](mailto:Arka.Ghosh.cec16@civil.iitd.ac.in)

#### **Abstract**

Equipment productivity plays a significant role in the sustainability of any construction organisation in this stiff competitive market. In developing countries, one of the main concerns on construction sites is low productivity of concreting equipment. Concreting equipment form the core equipment in most of the construction projects and the costs associated with the use of these equipment are usually high. As a result, low productivity of concreting equipment affects both schedule and cost. The purpose of this paper is to identify various factors that affect productivity of concreting equipment in construction projects, especially in developing countries such as India. A questionnaire survey was conducted among experienced professionals (managers and site engineers) from across the Indian construction industry. The study identified five key factors as: (1) *improper maintenance*; (2) *unskilled operator*; (3) *poor planning*; (4) *inefficient operator*; and (5) *lack of coordination among different crews*. The major findings also indicate that engineers and managers share a general perception of the factors affecting equipment productivity; however, differences do exist. The outcome of this paper will help in addressing the issue of low productivity of concreting equipment in construction projects.

#### **Keywords**

Concreting; Productivity; Construction Equipment; Indian Construction Industry.

(Paper, ID 39)

### **Business Model Development for Modular Timber Building Systems**

Joerg Koppelhuber

*Institute of Construction Management and  
Economics, Graz University of Technology, Graz,  
Austria*  
[joerg.koppelhuber@tugraz.at](mailto:joerg.koppelhuber@tugraz.at)

Johannes Wall

*Institute of Construction Management and  
Economics, Graz University of Technology, Graz,  
Austria*  
[johannes.wall@tugraz.at](mailto:johannes.wall@tugraz.at)

Detlef Heck

*Institute of Construction Management and  
Economics, Graz University of Technology, Graz,  
Austria*  
[detlef.heck@tugraz.at](mailto:detlef.heck@tugraz.at)

#### **Abstract**

This contribution targets the current challenges in timber construction and the associated business structures of small and medium-sized enterprises in this sector. Initially, the situation of timber construction is presented based on recent developments in the Austrian corporate structures and their service portfolios as well as their future business activities. Subsequently, this paper deals especially with current challenges and the prevailing problem areas regarding current and future business models in timber construction and tries to show how promising business models as well as unconventional business concepts and trading ideas from non-construction industries can meet the prevailing market needs. These can be seen as incentives to rethink current business models focusing on long-term success within the timber construction industry.

#### **Keywords**

Business Model Development, Timber Building System, Modularity, Prototype, Strategy

(Paper, ID 40)

### **Building Information Modelling Adoption for Better Cost Estimation: Sri Lankan perspective**

Anushka Rathnayake, Sajedeh Mollasalehi, Ahmed Aboumoemen

*University of Salford, Manchester, UK*  
[A.P.Rathnayake@edu.salford.ac.uk](mailto:A.P.Rathnayake@edu.salford.ac.uk),  
[S.mollasalehi1@edu.salford.ac.uk](mailto:S.mollasalehi1@edu.salford.ac.uk),  
[A.a.aboumoemen@edu.salford.ac.uk](mailto:A.a.aboumoemen@edu.salford.ac.uk)

Udayangani Kulatunga  
The University of Moratuwa, Colombo, Sri-Lanka  
[U.kulatunga@salford.ac.uk](mailto:U.kulatunga@salford.ac.uk)

Hamed Hyab Samir  
Basra university, Basra, Iraq  
[Hamidtemeemi@yahoo.com](mailto:Hamidtemeemi@yahoo.com)

### **Abstract**

To achieve competitive productivity and performance over the past eras, the growths of innovative technological concepts are promptly increasing. The waves of Building Information Modelling (BIM) have made everyone's in the construction industry gushing about BIM in building and construction expos. BIM has potential to influence everyone's professions in different ways within the construction industry. Most importantly BIM is capable of improving the accuracy of cost estimates through various BIM related tools which can be applied in the different stages of the traditional cost estimation process. Most of the countries both developed and developing have already re-aligned their cost estimation process with BIM and experiencing the benefits of it. Although the concept of BIM is slightly practiced in Sri Lankan construction industry yet, the majority of organizations still haven't adopted BIM. Therefore, this paper aim is to investigate the level of BIM adaptation of Sri Lankan quantity surveying organizations for a better cost estimation process. The study is interesting because the new knowledge will help to develop strategies for professional development and update the education curricula to train the Quantity Surveyors to face future challenges. As a visual database of building components, BIM can provide accurate and automated quantification, and assist in significantly reducing variability in cost estimates.

### **Keywords**

BIM, Cost Estimates, Adoption, Sri Lanka, Quantity Surveyor.

(Paper, ID 41)

### **Investigating Innovative Culture Level and its Influence on Labour Turnover in Organisations**

Naseema Ebrahim<sup>1</sup>, Innocent Musonda<sup>2</sup>, Chioma Okoro<sup>3</sup>

<sup>1,2,&3</sup>School of Civil Engineering and Built Environment, Department of Construction Management and Quantity Surveying, Faculty of Engineering and the Built Environment  
University of Johannesburg  
[imusonda@uj.ac.za](mailto:imusonda@uj.ac.za); [chiomasokoro@gmail.com](mailto:chiomasokoro@gmail.com)

### **Abstract**

Innovation is ingrained in the process of building dynamic and creative capabilities in an organization. However, if employees are not encouraged to develop capabilities and positive attitude at work, a strong innovation culture may be impossible to realize. Poor innovation culture could in turn affect labour turnover and productivity. The objective of the current paper to identify the innovation culture levels in organisations and its influence on employee retention or turnover. Pilot interviews with senior management and a main field questionnaire survey were used to collect data from conveniently sampled organisations including FCMG, service, manufacturing and construction organisations in the Gauteng province of South Africa. Empirical data were analysed using the Statistical Package for Social Sciences (SPSS) to output descriptive statistics. Findings showed that across all the industries, innovation was generally high, with employees being an important source of information and encouraged to ask questions when trying to perform certain tasks. The findings of this study could assist management in organizations, including the construction industry, to identify that could encourage innovation in their respective establishments and thus guard against labour turnover.

### **Keywords**

Construction Industry, Innovation, Labour Turnover, Employee Retention, Manufacturing Industry, South Africa

(Paper, ID 42)

### **Achieving Zero Accident Vision through Management's Positive Health and Safety Culture**

J. H. F. van Heerden<sup>1</sup>, I. Musonda<sup>2</sup>, C. S. Okoro<sup>3</sup>  
<sup>1,2,&3</sup>*School of Civil Engineering and Built Environment, Department of Construction Management and Quantity Surveying, Faculty of Engineering and the Built Environment University of Johannesburg*  
<sup>2</sup>[imusonda@uj.ac.za](mailto:imusonda@uj.ac.za); <sup>1</sup>[chiomasokoro@gmail.com](mailto:chiomasokoro@gmail.com)

#### **Abstract**

The high rate of accidents in the construction industry has been a concern for ages. The current paper highlights essential factors which can help to assure zero accidents in the construction sector. A review of extant literature from various sources including journal articles, and conference proceedings was conducted from databases including Elsevier, Science Direct, Google, Google Scholar and UJooble. Extant studies, spanning over a 12-year period, were sought based on their possession of the relevant keywords. It was found that training and induction by management chiefly influences health and safety (H&S) culture and the subsequent realisation of the zero accident goal/vision. Other management factors include leadership, commitment, involvement and planning/promotion of H&S standards. These factors include leadership, commitment, communication, involvement, promotion of H&S standards and training. This study adds to the body of knowledge on H&S performance and provides evidence for assuring zero accidents on construction sites.

#### **Keywords**

Construction Industry, Health and Safety, Management, Safety Culture, Zero Accident

(Paper, ID 43)

### **Conflict Management in Construction Industry: A Review Paper**

Tauha Hussain Ali  
*Professor, Department of Civil Engineering, Mehran University of Engineering & Technology, Jamshoro*  
[sacharvi2@gmail.com](mailto:sacharvi2@gmail.com)

Shabir Hussain Khahro  
*Lecturer, Department of Engineering Management, Prince Sultan University, Saudi Arabia*  
[shkhahro@gmail.com](mailto:shkhahro@gmail.com)

Nafees Ahmed Memon  
*Professor, Department of Civil Engineering, Mehran University of Engineering & Technology, Jamshoro*  
[nafees.memon@faculty.muett.edu.pk](mailto:nafees.memon@faculty.muett.edu.pk)

Muhammad Ali Moriyani  
*Post Graduate Student, Mehran University of Engineering & Technology, Jamshoro*  
[mamoriyani@gmail.com](mailto:mamoriyani@gmail.com)

Fida Hussain Siddiqui  
*Lecturer, Department of Civil Engineering, Mehran University of Engineering & Technology, Jamshoro*  
[fida.siddiqui@faculty.muett.edu.pk](mailto:fida.siddiqui@faculty.muett.edu.pk)

Qasim Hussain Khahro  
*Post Graduate Student, Mehran University of Engineering & Technology, Jamshoro*  
[qhkahro13@gmail.com](mailto:qhkahro13@gmail.com)

#### **Abstract**

Construction industry plays a key role in any country's development. It contributes significantly in the GDP and job market of the country. It is aimed that a successful project should be carefully planned, designed and constructed in a way that it should meet the project goals and above all client's satisfaction. Various factors are involved in achieving a successful project and managing conflicts is a key one. This paper aims to investigate the existing literature available on conflict management in construction industry. A detailed literature analysis has been made for this research. In later stages, a qualitative survey followed by an SPSS analysis has also been made. The study concludes that construction projects are getting complex to meet client needs and sustainability guidelines. A total number of 93 factors are identified and ranked at the later stage of this study. Lack of proper supply chain in construction projects lead to conflicts in this industry, so this has been a topic of research interest for many researchers. This paper helps the practitioners of this industry to make necessary policies and frameworks to properly manage conflicts in construction projects.

#### **Keywords**

Conflict, Construction Industry, Dispute, Project Life Cycle

(Paper, ID 44)

### **Diffusion of innovations approach to explore sustainable development in the UAE built environment**

Dr Amna Shibeika

*Assistant Professor, UAEU, Al Ain, Aby Dhabi, UAE*

#### **Abstract**

Sustainable development is important for the UAE, not just to follow global ongoing efforts to reduce consumption of and preserve resources, but also because of the breath-taking development for the UAE economy since its formation in 1971, which is coupled with fast development in buildings and real estate sectors. This research directly addresses the UAE government policy for innovation and sustainable development by providing better understanding of the processes for innovative sustainable development of buildings. Environmental assessment methods such as Estidama and its related Pearl Building Rating System (PBRS) has the potential to play the role of market changers for the spread of sustainable development practices in the built environment, however, most of the existing research in assessment methods is focused on either comparing different methods, or adapting existing and developing new methods for specific contexts. And while a lot of research is focused on the outcomes of the assessment, very little is concerned with the assessment process itself and its effect on design and construction processes and practices. A scoping study is developed, which adopts diffusion of innovations theory as the analytical tool, and interpretive content analysis of key policy documents and guidance as the research method to explore the diffusion of sustainable development of the built environment in the UAE. Early findings indicate the role of Pearl rating system as the foundation for sustainable development in Abu Dhabi built environment, and reveal multiple two-way communication channels for diffusing sustainable development policy and practices. Next steps for the research to further explore these findings through in-depth case studies of the adoption of PBRS in projects in UAE are presented.

#### **Keywords**

Adoption, Building Assessment, Design Management, Innovation, Sustainability

(Paper, ID 46)

### **Impact of Configuration Management on Safety: A Study in A Steel Manufacturing Industry**

Themba Nkhuna and Innocent Musonda

*School of Civil Engineering and Built Environment,  
Department of Construction Management and  
Quantity Surveying, Faculty of Engineering and the  
Built Environment*

*University of Johannesburg*

[imusonda@uj.ac.za](mailto:imusonda@uj.ac.za)

#### **Abstract**

The paper reports on a study conducted to examine the impact of configuration management on safety in a steel manufacturing company. Findings from literature were used to determine the relationship between configuration management and safety. In addition to a review of literature, empirical data was collected from a steel manufacturing plant. This study adopted a qualitative research design approach in the form of case studies. These studies on specific events and interviews with professionals within the steel manufacturing organizations were carried out in order to achieve the objectives of the study. The initial stage involved identifying the problem, while the next stage entailed conducting a review of extant literature about the concept of CM, leading to a formulation of theories about its practice. Findings were that configuration management had a negative impact on safety in the steel manufacturing plant.

#### **Keywords**

Configuration Management, Safety, Steel Manufacturing Industry

(Paper, ID 47)

### **Sustainability Indicators for a Transportation Infrastructure Investor**

Chioma Okoro<sup>3</sup>, Innocent Musonda<sup>2</sup>, Justus Agumba<sup>3</sup>

<sup>1,2,&3</sup>*School of Civil Engineering and Built*

*Environment, Department of Construction  
Management and Quantity Surveying, Faculty of  
Engineering and the Built Environment*

*University of Johannesburg*

[chiomasokoro@gmail.com](mailto:chiomasokoro@gmail.com)

#### **Abstract**

Sustainability of infrastructure has been a source of concern for ages. A panoply of literature exists on sustainability. However, few studies exist which focus on the sustainable outcomes which an infrastructure investor seeks when deciding to invest

in a project. The current study reviews extant literature to identify factors which are indicative of sustainability, specifically to an investor. Transportation literature is focused on because of its economic nature and potentiality of returns to an investor. Studies in both international and South African context are included. Findings revealed that adequacy of funding, accessibility, safety and security, quality, reliability, environmental friendliness and strong institutions are desirable outcomes to an investor. These findings will assist in the development of strategies to ensure that infrastructure projects are financially and economically sustainable.

### Keywords

Infrastructure, Investment, Investor, Sustainability, Transportation

(Paper, ID 48)

### Optimum Span Length for Steel Composite Girder Expressway Bridges

Hnin Su San

*Asian Institute of Technology (AIT)  
Pathumthani, Thailand  
[hninsusanpyae@gmail.com](mailto:hninsusanpyae@gmail.com)*

Naveed Anwar

*CEO/Executive Director AIT Solutions,  
Asian Institute of Technology (AIT)  
Pathumthani, Thailand, [nanwar@ait.ac.th](mailto:nanwar@ait.ac.th)*

Fawad Ahmed Najam

*Assistant Professor, National University of Sciences and Technology (NUST)  
Islamabad, Pakistan, [fawad@nice.nust.edu.pk](mailto:fawad@nice.nust.edu.pk)*

### Abstract

This study presents the determination of optimum span length of steel composite girder bridges for expressways. Using a case study plate girder bridge, the cost curves for superstructure and substructure were developed for different span arrangements to find the most economical design case. The optimization is carried out for various parameters governing the girder design (web depth and balanced span arrangements). The case study bridge is designed for a span lengths ranging between 25 m and 50 m, and by varying the number of girders (3, 4 and 5 girders). The optimum spans in terms of economy are compared for two different shapes of girders (i.e. with constant depth of web and with tapered web). It is observed that tapering the girder web leads to 6%-10% reduction in weight of the

girder while reducing the total cost of bridge by 8%-10% compared to the case corresponding to constant-depth web. Similarly, a significant reduction in overall cost can be achieved by reducing the number of girders in a cross-section using a similar optimization scheme. For the selected case study bridge, the three-girder case resulted in approximately 20% lower girder weight compared to four-girder case. The most economical span length is observed to be within 40m and 42m for three-girder system.

### Keywords

Optimum Span Length, Steel Plate Girder, Tapered Web, Economical Span, Expressway Bridges

(Paper, ID 51)

### Construction Monitoring and Reporting using Drones and Unmanned Aerial Vehicles (UAVs)

Naveed Anwar

*CEO/Executive Director AIT Solutions, Asian Institute of Technology (AIT)  
Pathumthani, Thailand, [nanwar@ait.ac.th](mailto:nanwar@ait.ac.th)*

Muhammad Amir Izhar

*Senior Software Developer, AIT Solutions, Asian Institute of Technology (AIT)  
Pathumthani, Thailand, [amirizharkhan@gmail.com](mailto:amirizharkhan@gmail.com)*

Fawad Ahmed Najam

*Assistant professor, National University of Sciences and Technology (NUST)  
Islamabad, Pakistan, [fawad@nice.nust.edu.pk](mailto:fawad@nice.nust.edu.pk)*

### Abstract

The use of drones and Unmanned Aerial Vehicles (UAV) has been increased in recent years for surveying, facility management and other relevant fields. However, more recently, the technological progress in the design and navigation of low-weight and autonomous drones and UAVs have resulted in their more practical and cost-effective operation in the fields of architectural engineering and construction management and monitoring. This study presents a framework for the development of a fully automated smart construction monitoring and reporting system based on real-time data obtained from drones and UAVs. The data in terms of drone images from multiple locations and point clouds (from 3D scanning of construction site) can be used to construct a 3D model using the photogrammetry techniques. This so-called "drone model" can be compared to BIM model at various construction stages to monitor the construction progress. Beside

construction scheduling and costing, this comparison can be expanded to include real-time recording, reporting, billing, verification and planning. Using the example of a case study construction project, the effective use of drone data is demonstrated in terms of smart construction monitoring and comparisons between drone model and BIM model. It is shown that this fully automated system can significantly reduce the effort required in traditional construction monitoring and reporting procedures. The system not only provides convenient and smart ways of site supervision and management but also results in better operations, planning and effective on-site adjustments.

#### **Keywords**

Smart Construction Monitoring, Drones, Unmanned Aerial Vehicles, Smart Reporting, Photogrammetry

(Paper, ID 53)

#### **Occupational Stress and the Project Manager**

Ken Farnes

*RMIT University, Melbourne, Victoria, Australia*  
[kenneth.farnes@rmit.edu.au](mailto:kenneth.farnes@rmit.edu.au)

#### **Abstract**

There has been a dramatic growth in the business importance and economic contribution of project work across the economy. Despite advances in project management practices and the profession, projects continue to have an unacceptably high failure rate which is compounded by project managers being highly stressed, due to time pressures, project uncertainties, and the complex and often dynamic social structure involved in the project environment.

This study observed that when discussing the person-environment fit and competencies of a project manager, occupational stress and stress management were overlooked by the executive project sponsors as a possible contributing factor for poor project manager performance and poor project outcomes.

Despite the growing body of research evidence that has identified occupational stress across many different professions as having an adverse impact on an individual's performance and health, there has been little recognition within the project management literature of the impacts of stress or coping strategies for managing stressors within the project environment. This strongly suggests that additional research on stress focused on the project environment is warranted and that both project sponsors and

project managers need to be made aware of the antecedents to stress and the consequences of stress both in the personal and business sense.

#### **Keywords**

Occupational Stress, Workplace Stress, Project Manager, Job Performance, Decision Making

(Paper, ID 54)

#### **Broadband Telecommunication Deployment: A Supply Side Analysis of Penetration Drivers in A Developing Country Case**

Nwakanma, Ifeanyi Cosmas

*Lecturer II, Information Management Technology  
Federal University of Technology, Owerri, Imo State,  
Nigeria*

[Ifeanyi.nwakanma@futo.edu.ng](mailto:Ifeanyi.nwakanma@futo.edu.ng);  
[fraircos@yahoo.com](mailto:fraircos@yahoo.com) +2348038113290

Ogbonna, Achimba Chibueze

*Professor, Backcock University, Ilissan-Remo, Ogun  
State, Nigeria,*

[ogbonnac@babcock.edu.ng](mailto:ogbonnac@babcock.edu.ng)

Asiegbu, Baldwin Chukwunanu

*Professor, Information Management Technology  
Federal University of Technology, Owerri, Imo State,  
Nigeria*

[Baldwin.asiegbu@futo.edu.ng](mailto:Baldwin.asiegbu@futo.edu.ng);  
[cbasiegbu@yahoo.com](mailto:cbasiegbu@yahoo.com)

Udunwa, Ikenna Augustine

*Lecturer I, Information Management Technology  
Federal University of Technology, Owerri, Imo  
State, Nigeria*

[Udunwa123@gmail.com](mailto:Udunwa123@gmail.com)

Nwokonkwo, Obi C.

*Senior Lecturer, Information Management  
Technology  
Federal University of Technology Owerri, Imo State,  
Nigeria*

[engrobinwokonkwo@yahoo.com](mailto:engrobinwokonkwo@yahoo.com)

#### **Abstract**

It is common to reference technology in the built environment to infrastructure like housing, water works, roads, bridges, and etcetera whenever construction is being discussed by even some supposedly informed persons. However, 'Broadband' is not just a technology but is fast becoming an important infrastructure needed to help the economic growth of any economy. Broadband availability/penetration, like other types of

infrastructure, remains a serious development drawback in developing/least developed world regions like Nigeria which suffer a combination of 'digital' disadvantage and tight national budgets/low receipts hence providing high investment potential that has continued to attract international construction projects/ funding thus justifying the need to investigate the supply-side drivers responsible for broadband provision as an aid to private investors, and national governments policy-wise. The result of analysis reveals that ease of doing business, competitiveness and corruption index collectively significantly affect broadband penetration

#### **Keywords**

Broadband Telecommunication Technology, Infrastructure, Broadband Penetration, Penetration Drivers, Development.

(Paper, ID 55)

#### **Applications of Nanomaterials in Pavement Engineering: A Review**

Vasileios C. Papadimitropoulos, Stylianos K. Karatzas, Athanasios P. Chassiakos  
*Department of Civil Engineering, University of Patras, Patras, Greece*  
[infovpa@gmail.com](mailto:infovpa@gmail.com), [ksteliosk@hotmail.com](mailto:ksteliosk@hotmail.com),  
[a.chassiakos@upatras.gr](mailto:a.chassiakos@upatras.gr)

#### **Abstract**

Various types of bituminous mixtures are used in the construction of flexible pavements, depending on the requirements of the project. Asphalt is a body of solid dark color substance, refined from crude oil. By mixing asphalt with additives like sand, stone and gravel, asphalt binds all of them together into what is called asphalt pavement. A systematic effort has been made to develop asphalt mixtures with improved properties. Although bituminous materials are mainly used on a large scale and in bulky quantities, the macroscopic mechanical behavior of these materials continues to essentially depend on the extent of microstructure and physical properties in micro and nano-scale. Nowadays, one of the most interesting areas of asphalt research involves the use of nanomaterials. New research efforts regarding the development of nanomaterials for use in asphalt indicate the potential for improvement in durability, mechanical and physical properties resulting thus in new multidisciplinary research fields with synergy of academia and industrial retrospective partners. This paper presents several types of nanomaterials with their properties, the ways that they can be integrated in new asphalt mixture development, potential

applications in pavement engineering and pavement characteristic improvements, and finally current trends and challenges in obtaining such results.

#### **Keywords**

Nanomaterials, Asphalt, Pavement, Material Properties

(Paper, ID 56)

#### **Effective way to reduce financial loss by safety investment: Concept from Safety Management System**

Kai-Chi Thomas Ying  
*PhD candidate, RMIT, Australia*  
*Lecturer, Vocational Training Council, Hong Kong*  
[kc\\_ying@vtc.edu.hk](mailto:kc_ying@vtc.edu.hk)

Guomin (Kevin) Zhang  
*Professor, RMIT, Australia*  
[kevin.zhang@rmit.edu.au](mailto:kevin.zhang@rmit.edu.au)

Sejeeva Setunge  
*Professor, RMIT, Australia*  
[sejeeva.setunge@rmit.edu.au](mailto:sejeeva.setunge@rmit.edu.au)

#### **Abstract**

Financial loss induced by construction accident has been widely discussed by researchers. To reduce financial loss of accident, efficient safety investment is suggested. Parameters of safety investment have been reviewed and identified based on a research study in Hong Kong. Key parameters to reduce financial loss in a combined effect by quantitative analysis have been generated. Meanwhile, investment in safety equipment, training and promotion are recommended and particularly effective to reduce financial loss of accident. Supporting statement for safety equipment, training and promotion from the Safety Management System (SMS) has been reviewed and presented in this paper. This paper provides concepts how the construction stakeholders, proprietors and participants, follow the frameworks to reduce financial loss by safety investment in training, equipment and promotion.

#### **Keywords**

Safety Management System, Financial Loss, Safety Investment, Hong Kong

(Paper, ID 57)

### Concept of “Efficient Coordination Zone” relating to Truckmixer Deliveries Serving Construction Sites

Michael Anson

*Professor Emeritus, Department of Building and Real Estate, Faculty of Construction and Environment, The Hong Kong Polytechnic University, Hong Kong*  
[clanson@polyu.edu.hk](mailto:clanson@polyu.edu.hk)

Kai-Chi Thomas Ying

*Lecturer, Vocational Training Council, Hong Kong*  
*PhD Candidate, RMIT, Australia*  
[kc\\_ying@vtc.edu.hk](mailto:kc_ying@vtc.edu.hk)

Ming-Fung Francis Siu

*Assistant Professor, Department of Building and Real Estate, Faculty of Construction and Environment, The Hong Kong Polytechnic University, Hong Kong*  
[francis.siu@polyu.edu.hk](mailto:francis.siu@polyu.edu.hk)

#### Abstract

Matching the provision of concrete delivered by truckmixers to the needs of the crew placing concrete on site is difficult. In general, a placing crew spends some time idle, waiting for concrete to arrive on site, and yet, at other times, on the same pour, truckmixers form a queue waiting to be unloaded. The paper presents observations deriving from many pours of concrete in Hong Kong, of the amount of enforced waiting by the placing crew and the amount of enforced truckmixer waiting on site to be unloaded. The concept of an “efficient coordination zone” is introduced, for the industry to aspire to achieve, such that no placing crew would spend more than 10% of the duration of the pour in waiting for concrete and that truckmixer provision, in waiting on site and unloading, would not exceed 150% of the duration of the pour. A new model is introduced which estimates the performance of site and plant resources matching, in relation to the pour parameters of journey round trip time, RT, and the time needed to unload a truckmixer, UL. The model assumes a fleet of N truckmixers circulates between site and plant. The model may be of practical use in aiding truckmixer schedulers.

#### Keywords

Truckmixer, Ready Mixed Concrete, Delivery Schedule, Concrete Batching Plant, Hong Kong.

(Paper, ID 58)

### Development of Web Stiffener Arrangements for Enhanced Web Crippling Strength

Michael H. Cornell

*Department of Civil Engineering, McMaster University, Hamilton, Ontario, Canada L8S 4L7*  
[cornem1@mcmaster.ca](mailto:cornem1@mcmaster.ca)

Ken S. Sivakumaran

*Department of Civil Engineering, McMaster University, Hamilton, Ontario, Canada L8S 4L7*  
[siva@mcmaster.ca](mailto:siva@mcmaster.ca)

#### Abstract

The governing capacity of a cold-formed steel flexural member depends on the relative capacities in bending, shear, web crippling, etc. and the combinations thereof. Out of these possible failure modes, perhaps the web crippling governing mode results in an inefficient (uneconomical) design of such members, since web crippling is a localized failure. The design efficiency can be improved if this failure mode can be shifted to a favourable mode of failure by increasing the web crippling capacity through the use of stiffeners. The objective of this investigation is to establish appropriate stiffener arrangement for single web cold-formed lipped channel steel sections that would enhance the web crippling capacity of such sections. The experimental investigation considered a total of 40 tests, subjected to interior two-flange (ITF), interior one-flange (IOF), end two-flange (ETF) and end one-flange (EOF) web crippling loads. The study also considered the impact of number of stiffeners and the number of screw fasteners. The first test series focused on single web elements subjected to ITF loading, where results showed that stiffened specimens gained about 25% in web crippling strength over corresponding unstiffened specimens. The same trend was found in IOF loading. The ETF tests had 106% increase in strength because the failure mode changed from web buckling to web yielding. The EOF tests had an increase in strength of 68%, and failed due to web buckling. Based on these studies, it is concluded that the most effective and economical method to increase the web crippling strength of the CFS lipped channel sections would be to attach a single stiffener to the inside of the web using three screws.

#### Keywords

Cold Formed Steel, Web Crippling Capacity, Experimental, Stiffeners, Number of Screws, Design Efficiency

(Paper, ID 59)

### **Evaluation of Different Building Structural Systems: The Case of Turkey**

Esra Bostancioglu

*Assoc.Prof.Dr., Department of Architecture, Istanbul Kultur University, Istanbul, Turkey*  
[esrabostancioglu@hotmail.com](mailto:esrabostancioglu@hotmail.com)

#### **Abstract**

A building structural system is evaluated by using several parameters such as cost, construction time, fire resistance, lifetime, maintenance and repair frequency and environmental impacts. This study aims to evaluate buildings constructed with different structures in Turkey. Existing building stock in Turkey is assessed in terms of structures and number of stories. For the economic evaluation of the structures, a two-storied residential project is selected as an example. For the assessment of construction cost, structural cost and the other cost components for different structures, the selected project is designed with three different structures. Selected structures are; masonry, reinforced concrete framed and wood framed structures. These structures are evaluated in terms of economic features as well as other features for providing investors with tips on how to choose the structure in future. The current situation of structures in Turkey is also examined.

#### **Keywords**

Building Structures, Masonry Structure, Reinforced Concrete Framed Structure, Wood Framed Structure, Construction Cost, Structural Cost.

(Paper, ID 60)

### **Stochastic Frontier Analysis of Water Supply Utility of Urban Cities in Bosnia-Herzegovina**

Assistant Professor Ivana Domljan, PhD  
*University of Mostar, Mostar, Bosnia and Herzegovina*  
[ivana.domljan@tel.net.ba](mailto:ivana.domljan@tel.net.ba)

#### **Abstract**

Municipalities in Bosnia and Herzegovina (B-H) are responsible for both providing water supply services and maintaining and operating their infrastructure. The municipally owned companies, currently the only ones providing municipal water services, are in a perpetual crisis due to several reasons – the major

being the inherited model from the communist period.

The characteristics of the inherited model are prices not covering operating costs, maintenance and investments, low quality standards, and water facilities not protected from potential hazards.

Despite the severe scarcity of data for B-H water sector, given the available data we developed a SFA model, a useful tool in assessing the relative efficiencies of water supply companies as well as for the selection of most critical companies for introducing public-private partnership (PPP) for improving the situation regarding efficiency.

Among the first steps in the efficiency analysis of B-H water operators, this research could serve as a benchmark against which future analysis of water utilities can be measured. Additionally, it provides policy makers with evidence on the water utility efficiency with the aim of focusing on the improvements in managing companies and on rebuilding the water sector infrastructure, beginning with the most inefficient ones to minimize huge water losses.

#### **Keywords**

Water, Efficiency, Public-Private Partnership, Bosnia-Herzegovina

(Paper, ID 61)

### **Hololens – A New Teaching Tool in Construction Education**

Pavan Meadati, PhD

*Department of Construction Management, Kennesaw State University, Marietta, Georgia, USA*  
[pmeadati@kennesaw.edu](mailto:pmeadati@kennesaw.edu)

Amin Akhnoukh, PhD, PE

*Department of Construction Management, East Carolina University, Greenville, North Carolina, USA*  
[Akhnoukha17@ecu.edu](mailto:Akhnoukha17@ecu.edu)

#### **Abstract**

Students have different learning styles and the use of technological gadgets became an integral part of their life. Engaging these technology savvy students in the learning process with their preferred learning style is a challenging task. The differences in teaching and learning styles result in problems such as disengagement of students and loss of learning aptitude. This active student engagement challenge can be addressed by using hologram-learning

environment provided by Microsoft HoloLens. This learning environment engages students in active learning processes and helps them to focus on their learning. It also encourages students to take more responsibility for their own learning process. This learning environment provides a new teaching style and helps the instructor to address some of the needs of the students' learning styles. This paper discusses about the hologram-learning environment. This paper also discusses about the progress of the pilot study conducted to engage the technology savvy visual learners in a concrete formwork course.

### **Keywords**

Hologram, HoloLens, Learning Styles, Concrete Formwork, Construction Management

(Paper, ID 64)

### **A review of client loyalty to construction professional service firms.**

Nick Williams

School of Architecture and Built Environment,  
University of Wolverhampton, UK  
[N.Williams@wlv.ac.uk](mailto:N.Williams@wlv.ac.uk)

Dr. Paul Hampton

*School of Architecture and Built Environment,  
University of Wolverhampton, UK*  
[P.Hampton@wlv.ac.uk](mailto:P.Hampton@wlv.ac.uk)

Dr. Nii A Ankrah

*School of Architecture and Built Environment,  
University of Wolverhampton, UK*  
[Nii.Ankrah2@wlv.ac.uk](mailto:Nii.Ankrah2@wlv.ac.uk)

Dr. Ezekiel Chinyio

*School of Architecture and Built Environment,  
University of Wolverhampton, UK*  
[E.Chinyio@wlv.ac.uk](mailto:E.Chinyio@wlv.ac.uk)

### **Abstract**

The global demand for construction professional services is rising but many construction professionals have neither the time nor the skills to effectively market their services offerings. Therefore, retaining and developing existing client accounts is vital. Firms with a loyal client base have lower marketing expenditure, are better able to retain talented employees and have more predictable revenues. The problem addressed by this review paper is understanding the extent of current knowledge regarding client loyalty for construction professional service firms operating in the business-to-business sector. An in-depth literature review revealed that

although there is a body of research relating to customer-loyalty in wider business-to-business services, few studies were found in respect to construction professionals. The review also indicated a considerable variation in how loyalty and construction professional services have been operationalised. Furthermore, little is known regarding the extent to which client loyalty is targeted towards construction professional services firms, their employees or both. A conceptual model of client loyalty to construction professional service firms is proposed, based on the findings of the literature review. Future empirical research, accounting for the findings of this paper would be of value to both academics and construction professionals.

### **Keywords**

Construction Professional Services; Loyalty; Commitment; Professional Service Firm.

(Paper, ID 65)

### **Key Performance Indicators: Advances in Construction Projects Performance Measurement**

Hatzigeorgiou Alexandros

*Postgraduate Course in Engineering Project  
Management, School of Science and Technology,  
Hellenic Open University, Patra, Greece*  
[alexhatz1973@gmail.com](mailto:alexhatz1973@gmail.com)

Manoliadis Odysseas

*Department of Civil Engineering, Democritus  
University of Thrace, Xanthi, Greece*  
[omanoliadis@yahoo.com](mailto:omanoliadis@yahoo.com)

### **Abstract**

The last two decades, performance measurement in the construction industry has shifted towards a more holistic and integrated assessment of the overall construction project success, with the implementation of appropriate Key Performance Indicators providing essential information for project monitoring and construction management processes control. This paper attempts a critical literature review of recent trends on performance measurement systems developed for construction projects, focusing on the development and application of related Key Performance Indicators, by presenting some of the most significant published studies in construction and project management journals. The two main objectives of this review is first to examine whether the issue of sustainability is addressed in the presented studies, and in what extend, and second to

inspect if these studies are considering performance evaluation throughout the construction project Life Cycle. After a short report on the most applied modern performance measurement frameworks in construction and the creation and evolution of Key Performance Indicators, a succinct presentation of the reviewed studies is following, summarizing and reporting their basic features in an extensive table. Finally, concluding remarks and comments are given.

### **Keywords**

Key Performance Indicators, Performance Measurement, Life Cycle Assessment, Sustainability Criteria

(Paper, ID 66)

### **Effective mentorship of new entry graduates in the construction industry: A Literature Review**

Morena William Nkomo

*PhD Candidate, University of Johannesburg,  
Department of Construction Management and  
Quantity Surveying, Beit Street.,  
2094 Doornfontein, South Africa*

Wellington Didibhuku Thwala

*Full Professor, University of Johannesburg,  
Department of Construction Management and  
Quantity Surveying, Beit Street.,  
2094 Doornfontein, South Africa*

Clinton Ohis Aigbavboa

*Associate Professor, University of Johannesburg,  
Department of Construction Management and  
Quantity Surveying, Beit Street., 2094 Doornfontein,  
South Africa*

### **Abstract**

Mentoring is vital for all young employees entering the workplace. Despite the growing research on both sets of individuals, mentors and protégés, mentoring from the perspective of the organizational remain comparatively under reported. It is important to significantly analyze the concept and to emphasize the distinct elements of effective mentoring of new entry graduates, in the construction industry. The aim of this paper is to look at the experiences and problems contributing to effective mentoring of young graduate's construction employees within construction companies. This study will examine how construction graduate employees are mentored, who is supposed to mentor them and how effective and crucial mentoring can be used to enhance performance in the construction industry, which has

become very competitive and difficult. It will look at the important potential negative outcomes or problems in mentoring. The paper focuses on how organisations view mentoring. The study is mainly a literature review with a special focus on the human resource management and leadership, the data used in the report is generally qualitative, based on the content analysis, case studies and historical data that discusses formal mentoring internal to the workplace which sustain on and off job learning. The results revealed the organisation current circumstances and the issues that are important to the HR function. Mentoring is primarily used to transfer tacit knowledge from those close to retirement to younger employees, foster the personnel development and create well-being at work. The study will indicate whether or not young graduates' construction workers are they being mentored or not, are they involved in any form of mentoring, within their construction companies and that communication skills, knowledge sharing, and correcting mistakes or giving negative feedback are important for an effective mentor in the construction industry and also that mentoring is an important tool that can enhance career and personal growth when conducted effectively.

### **Keywords**

Construction industry, Graduates Employees, Youth Mentoring, Human resource development.

(Paper, ID 67)

### **Literature Review of the applications of Artificial Intelligence (AI) in Construction Project Management**

Chao Xiao

*Department of Construction Management, East  
Carolina University, Greenville, NC, USA  
[Xiaoch17@ecu.edu](mailto:Xiaoch17@ecu.edu)*

Amin K. Akhnoukh

*Department of Construction Management, East  
Carolina University, Greenville, NC, USA  
[akhoukha17@ecu.edu](mailto:akhoukha17@ecu.edu)*

Yang Liu

*i.D BIM Tech LLC, College Station, TX, USA  
[yang-liu@idbimtech.com](mailto:yang-liu@idbimtech.com)*

### **Abstract**

The application of Artificial Intelligent (AI) has increased in the field of construction project management in recent years, mostly due to the development of high-performance computer or robot

and the potential to improve construction management efficiency. To achieving a comprehensive understanding of the research work on this subject, this paper conducts a literature view and content analysis of existing literatures on AI application in construction project management field focusing on the last decade. The authors selected the articles based on different category of AI technology and published journals with an impact factor higher than 1.0. The search resulted in 68 articles, which were then categorized into five categories to systematize the research conducted over the years. They are construction productivity management, construction safety and health management, construction performance management, construction claims and litigations, and construction logistics and site planning. The authors then analyze the selected articles that are most representative and influential from each category based on their citation and pertinence to their field. This review concluded the current trends of AI application in construction project management and further identified the gaps and limitations of the existing studies which could lead the direction of future research.

#### **Keywords**

Artificial Intelligent, Construction Project Management, Neural Network, Computer Vision, Productivity Management, Safety, Construction Performance

(Paper, ID 68)

#### **A Linear Goal Programming Model for Optimizing the Usage of Safety Measures on Construction Sites**

Ming-Fung Francis Siu  
*Department of Building and Real Estate,  
Faculty of Construction and Environment,  
The Hong Kong Polytechnic University, Hong Kong,  
China.*  
[francis.siu@polyu.edu.hk](mailto:francis.siu@polyu.edu.hk)

S. L. Tang  
*Faculty of Science and Technology,  
University of Macau, Macau, China.*  
[irsltang@gmail.com](mailto:irsltang@gmail.com)

#### **Abstract**

In Hong Kong, the construction safety performance was poor but has improved in the past 15 years because the Labour Department has made remarkable progress in promoting safety and health in the workplace. Through the establishment of safety legislation, enforcement of existing and new

legislation, industry promotion, and staff training, the safety awareness of employers and employees has increased. For example, under the “Pay For Safety Scheme (PFSS)”, the contractors are required to set aside a sum of money in their bills of quantities for implementing safety measures on site. However, the method to optimally utilize such a sum of money so the overall profit is maximized remains unaddressed. This research study proposes a linear goal programming model to determine the optimal usage of safety measures (i.e., optimally utilizing the sum of money set aside) for improving construction safety. The goals of the model are to maximize the profits of both the main contractor and the sub-contractor. The constraints denote the achievements of safety measures in the provision of safety officers, safety committee meetings, safety walks, welfare facilities, safety training, and safety auditing. This paper intends to present the framework of the model. In the future, a case study will be conducted in full scale by expanding the model using the actual collected data and available statistics, thus the optimum usage of safety measures in real practice will be determined.

#### **Keywords**

Linear Goal Programming, Optimization, Safety Measures, Pay For Safety Scheme, Hong Kong.

(Paper, ID 69)

#### **Biological Cell Surveillance: Implication on Construction Cell**

Mayur Shelke  
*University of Southern Queensland, Brisbane,  
Queensland, Australia; mgshelke@hotmail.com*

Vasantha Abeysekera  
*School of Civil Engineering and Surveying, Faculty  
of Health, Engineering and Surveying, University of  
Southern Queensland, Queensland, Australia;  
vasantha.abeysekera@usq.edu.au*

#### **Abstract**

The near flawless replication of the biological cells is often attributed to the Biological Cell Cycle Control Mechanism (BCCM) to develop a complex multi-structural functional element. Central to this success is the checkpoints and the surveillance mechanism of the cell. This paper, inspired by such perfection of cellular replication investigates this mechanism to develop further insights on replication of construction cells with a special focus on the biological cell surveillance mechanism. This led to the synthesis of

three concepts, namely, *process stress*, *process memory* and *distress signaling*. Application of these concepts has been considered as a means of overcoming the quality problems encountered in a tunnel construction project. It is argued that the application of these concepts using the RGR framework during the tunnel slab construction could have mitigated the adverse quality issues by arresting the growth of defective construction cells.

#### **Keywords**

Distress Signaling, Process Memory, Process Stress, Readiness-Growth-Rest Framework, Surveillance

(Paper, ID 71)

### **Initiating Smart City Concept for Sustainable Urban Development: A Literature Review**

Nimesha Jayasena  
*Department of Building Economics, University of Moratuwa, Sri Lanka*  
[nimeshajayasena92@gmail.com](mailto:nimeshajayasena92@gmail.com)

Harshini Mallawaarachchi  
*Department of Building Economics, University of Moratuwa, Sri Lanka*  
[harshinim@uom.lk](mailto:harshinim@uom.lk)

K.G.A.S. Waidyasekara  
*Department of Building Economics, University of Moratuwa, Sri Lanka*  
[anulk15@yahoo.com](mailto:anulk15@yahoo.com)

#### **Abstract**

With the rapid urbanisation in the world, there is a requirement to achieve sustainability within urban development. Smart city concept directs urban development in to a strategic path to achieve sustainability in urban development. There are various definitions available for smart cities which represents various dimensions and characteristics of smart cities. Further, initiation of smart cities has become crucial due to the challenges faced by urban planners and developers. In recent years, many initiatives have developed under the smart city label in order to provide a response for challenges facing cities today. The understanding made up on the initiation of the concept of smart cities within any region would be fruitful to review in this nature. Therefore, as the primary step governs in this study, the fundamentals of smart city concept were reviewed to achieve the sustainable urban development as the main purpose. As the main approach adopted, a comprehensive review was conducted by using the twenty six (26) research

projects in key literature. The concept of smart cities, the need of smart cities for sustainable urban development and the initiative factors of smart cities were finally encountered. As the key findings derived, the main and sub initiating factors of smart city concept for sustainable urban development were determined and presented through a conceptual framework. In response to the increasing use of the concept, this paper proposes to use the developed framework as a basis to understand the concept of smart cities for its flourishing initiation.

#### **Keywords**

Smart Cities, Sustainable Urban Development, Initiative Factors, Conceptual Framework

(Paper, ID 72)

### **A Study on Payment Issues Faced by Construction Consultants in Sri Lankan Construction Industry**

H.M.A.K. Abeykoon, P.A.P.V.D.S. Disaratna,  
M.K.C.S. Wijewickrama  
*Department of Building Economics, University of Moratuwa, Sri Lanka*  
[achiniabeykoongs@gmail.com](mailto:achiniabeykoongs@gmail.com),  
[vijitha.disaratna@gmail.com](mailto:vijitha.disaratna@gmail.com),  
[mkcsw.mora@gmail.com](mailto:mkcsw.mora@gmail.com)

#### **Abstract**

Payment delays endure in the construction industry and prolong to be a key concern to industry practitioners. There is a social adherence that the contractors are the only suffering party from payment defaults in construction projects. However, construction consultants are also experiencing adversely from payment delays. There are different disciplines of construction consultants, categorized according to their scope of work which determines their mode of payments. The Sri Lankan construction consultants face payment issues which have not given significant consideration in research. Henceforth, this study aims to investigate different types of payment issues experienced by construction consultants and ways of minimizing them in Sri Lankan construction industry.

To accomplish the aim, initially, an extensive literature synthesis was carried out to identify construction consultants' fee payment practices and their related issues and causes. Consequently, qualitative research approach was followed steering semi-structured interviews which were conducted among practised consultants and clients in the local industry. The gathered data was analysed systematically via computer based content analysis.

The topical study manifests highly impacted causes of fee payment issues, their effects and the best solutions to mitigate payment problems of construction consultants. Accordingly, major seven ways of mitigating consultants' fee payment issues were identified and amongst, negotiation is the most reliable mode to be used. Lastly, the research is recommending best practices which can be followed by clients and consultants to mitigate the fee payment issues of consultants in Sri Lankan construction industry.

#### **Keywords**

Consultants, Fee Payments, Issues, Mitigation, Sri Lankan Construction Industry

(Paper, ID 73)

#### **Leadership Assessment Tools that can be used in Managing Health and Safety in the Apparel Manufacturing Industry in Sri Lanka**

Ekanayake B.J., Karunathilaka S.K.  
*University of Moratuwa, Moratuwa, Western Province, Sri Lanka*  
[ra-biyanka@uom.lk](mailto:ra-biyanka@uom.lk),  
[susilkumarakarunathilaka@gmail.com](mailto:susilkumarakarunathilaka@gmail.com)

Perera B.A.K.S  
*University of Moratuwa, Moratuwa, Western Province, Sri Lanka*  
[pererabaks@gmail.com](mailto:pererabaks@gmail.com)

#### **Abstract**

Developed countries have put forward specifications for assessing the commitment of their leaders to health and safety management. Other countries including Sri Lanka, unfortunately, have so far not been able to follow suit. Apparel manufacturing industry is a key industry in Sri Lanka, which demands a proper leadership assessment method to ensure better safety management in the industry. Therefore, this research was aimed to identify a leadership assessment tool to assess leadership commitment to health and safety management in the apparel manufacturing industry in Sri Lanka. Ten semi-structured interviews were conducted as a preliminary study among health and safety management experts in the apparel industry. Subsequently, a questionnaire survey conducted among seventy health and safety management professionals. The data collected were analyzed using content and statistical data analysis to develop a leadership assessment tool. Research findings revealed that the score rating assessment method will ensure quality and transparency in the work done by

leaders which in turn will result in good health and safety performance. The research recommends the use of score rating to assess the commitment of leadership to health and safety management in the apparel manufacturing sector in Sri Lanka.

#### **Keywords**

Leadership Assessment Tool, Apparel Industry, Health and Safety Management, Sri Lanka  
(Paper, ID 74)

#### **Review on Photocatalysis Applications in Construction**

Muhammad Yasir Sadiq  
*Graduate student, East Carolina University, Greenville, NC, USA*  
[sadiqm18@students.ecu.edu](mailto:sadiqm18@students.ecu.edu)

Amin K. Akhnoukh  
*Associate Professor, East Carolina University, Greenville, North Carolina, USA*  
[akhnoukha17@ecu.edu](mailto:akhnoukha17@ecu.edu)

#### **Abstract**

Many construction projects are composed of concrete or mortar. After construction of such projects, the material faces challenges which cause aesthetic as well as physical deterioration. This paper discusses the application of Heterogeneous Photocatalysis which is a versatile, cost efficient and environmentally friendly treatment technology. The natural resources that are being used for demonstrating the self-cleaning characteristics of the photocatalytic materials is laudable. The most popularly used photocatalytic material is Titanium dioxide (TiO<sub>2</sub>). Multiple reasons are discussed for TiO<sub>2</sub> being beneficial for the construction industry. The principal utilization of TiO<sub>2</sub> as a photocatalytic building material is due to its self-cleaning, self-disinfecting and sustainability properties. The basic mechanism of photocatalysis is also analyzed for actual understanding of the project. The photocatalytic application for a greener road environment is worth mentioning. The paper discusses that which type of TiO<sub>2</sub> coating is the most sustainable and best choice for an urban road environment which will efficiently eliminate the harmful nitrogen oxides (NO<sub>x</sub>) and volatile organic compounds (VOCs). The effect of particle size on the cost and productivity of the photocatalytic material is mentioned. The variability of the coating mix with the reduction of NO<sub>x</sub> and VOCs.

#### **Keyword**

Heterogeneous Photocatalysis, Titanium Dioxide,  
Pollution, Environment, Self-Cleaning Concrete

(Paper, ID 75)

**Application of Value Engineering Concept to  
MEP Works in Sri Lankan Construction  
Industry: A Case Study**

Bandara D.G.B.S., Sandanayake Y.G.  
*University of Moratuwa, Moratuwa, Western  
Province, Sri Lanka*  
[buddhinissbandara@gmail.com](mailto:buddhinissbandara@gmail.com),  
[ysandanayake@uom.lk](mailto:ysandanayake@uom.lk)

Ekanayake B.J.  
*University of Moratuwa, Moratuwa, Western  
Province, Sri Lanka*  
[ra-biyanka@uom.lk](mailto:ra-biyanka@uom.lk)

**Abstract**

Mechanical, electrical and plumbing (MEP) systems are the life-blood of a building, which enhance functionality. However, the value of MEP works constitutes a large portion of construction cost. Due to increasing complex MEP systems and high cost, clients demand value for their money, while enhancing functionality. Value engineering (VE) is renowned as an approach for improving quality and functionality, while ensuring value for money. Therefore, this research investigates the application of VE to MEP works in Sri Lankan construction industry. A qualitative approach was adopted and three building projects, which have employed VE were selected for data collection through unstructured interviews, document review and observations. Subsequently, data were analysed using content analysis. The study revealed that the application of VE to MEP works has potential saving opportunities such as improvements in capacities, locations and material in MEP works. The challenges encountered include difficulty in identifying the possible scope for VE, poor attitude of people and lack of information. Most of the difficulties can be overcome if a formal value study process and a team with a trained facilitator is employed. The study recommends the use of VE to be more systematic and the awareness of the concept should be improved.

**Keywords**

Value Engineering; Mechanical, Electrical and Plumbing Works; Sri Lankan Construction Industry

(Paper, ID 76)

**Applicability of Life Cycle Assessment (LCA) to  
Buildings: A Review**

Amarasinghe S.D.I.A.  
*University of Moratuwa, Katubedda, Moratuwa, Sri  
Lanka*

Soorige S.D.A.  
*Lecturer, University of Moratuwa, Katubedda,  
Moratuwa, Sri Lanka*

**Abstract**

Life Cycle Assessment (LCA) is globally recognized as an analytical tool that systematically and holistically investigates, compiles and evaluates potential environmental burdens attributed with products, processes or an activity by ascertaining and quantifying material usage, energy consumption and environmental releases. LCA methodology has increased in popularity in developed countries in recent years as a decision making tool, to assess the buildings' environmental impacts and energy consumption throughout its entire life cycle. Even though, building LCA is accomplished internationally, it is hard to find evidence in the Sri Lankan context. LCA has come to a standstill in the industrial sector, as relatively less attention has been paid to the implementation of LCA to the building sector. Therefore, this study is aimed with the perspective of closing this research gap by conducting an investigation on the LCA implementation process, barriers and possible strategies of applying LCA to buildings, for the better adaptation of LCA into the Sri Lankan building sector.

**Keywords**

Life Cycle Assessment, LCA for Buildings, Life Cycle Inventory Analysis, Life Cycle Impact Assessment

(Paper, ID 78)

**Overcoming Barriers for Women in the  
Construction Industry: A Review**

Kelly Mahaffy  
*East Carolina University, Greenville, North  
Carolina, United States,*  
[mahaffyke15@students.ecu.edu](mailto:mahaffyke15@students.ecu.edu)

Syed M. Ahmed  
*East Carolina University, Greenville, North  
Carolina, United States,*  
[ahmeds@ecu.edu](mailto:ahmeds@ecu.edu)

Chelsea Buckhalter  
East Carolina University, Greenville, North  
Carolina, United States,  
[buckhalterc15@ecu.edu](mailto:buckhalterc15@ecu.edu)

### **Abstract**

The U.S. construction industry has long been known to be a male dominated field. This is due to several reasons, including stereotypes that reflect deep-rooted ideas about women in the U.S. construction industry. In order for more women to enter the field, the construction industry needs to find a way to overcome the many barriers that stand in their way. The objective of this research is to provide an analysis of the Women Participation in Construction Model (WPCM) and to see if the model has been followed within recent years. The WPCM proposes a solution to obtain and retain women within the construction industry.

The methodology used in this research is to collect data from a variety of sources, including professional journals, industry publications, construction industry leaders, construction industry organizations, and government records. Through literature and records review, information was gathered to help explain the state of the industry, highlighting women's issues. The collected data and model are combined, resulting in a series of suggestions for attracting, retaining, and promoting women in the construction industry. The conclusions drawn from this paper provide an analysis of the WPCM and women in the construction industry today and gives recommendations on how the construction industry can improve up following the model to better obtain and retain skilled female workers.

### **Keywords**

Female Population, Construction Industry,  
Construction Management, Work Force.

(Paper, ID 79)

### **Green Infrastructure: The Case for Low Impact Development in Coastal North Carolina**

Amelia Saul  
Graduate Student, East Carolina University,  
Greenville, NC, USA  
[saula12@students.ecu.edu](mailto:saula12@students.ecu.edu)

Jonathan Chase  
Graduate Student, East Carolina University,  
Greenville, NC, USA  
[chasej90@ecualumni.ecu.edu](mailto:chasej90@ecualumni.ecu.edu)

Dr. Syed Ahmed  
Professor & Chair, Construction Management Dept,  
East Carolina University, Greenville, NC, USA  
[ahmeds@ecu.edu](mailto:ahmeds@ecu.edu)

### **Abstract**

For more than 40 years, North Carolina (NC) has focused on maintaining and improving the state's water quality with conventional best management practices (BMPs) to control runoff. Despite the widespread application of BMPs, the desired results for water quality have fallen well short of expectations. NC has lost more than 100,000 acres of shellfish waters to contamination in the last 20 years and continues to lose these most sensitive waters (Low Impact Development for the NC Coast, 2008). Meanwhile, Low Impact Development (LID), within the broader construct of Green Infrastructure, has been gaining traction as a more economical and environmentally friendly alternative to conventional BMPs. In addition to improved water quality and healthier aquatic habitat, the use of LID techniques offers other benefits including lower infrastructure costs through reduced maintenance demands, greater lot yields, increased property values, and reduced incidences of costly flooding events. Despite this outreach and other educational efforts, the state has seen a small voluntary shift from conventional management techniques to LID. An online survey was distributed to 78 management professionals that work in coastal NC, investigating the awareness of LID. The survey's results indicate a common knowledge of LID regardless of years' experience or profession-type. Respondents have a favorable impression of LID and, of those who used one or more LID techniques in projects, there is a preference to LID versus conventional management techniques when future use is considered. While the state wields the most influence over the future deployment of LID, more significant outreach and education are seen as critical to a deeper understanding and acceptance of LID.

### **Keywords**

Green Infrastructure, Low Impact Development,  
Coastal NC

(Paper, ID 80)

**Causes of Fall of Person from Height Accidents on Building Maintenance and Repair Elevated Works in Hong Kong**

Abid Nadeem  
Assistant Professor, School of Engineering,  
Nazarbayev University, Astana, Kazakhstan  
[abid.nadeem@nu.edu.kz](mailto:abid.nadeem@nu.edu.kz)

Y. N. Johnny Mok  
Former Lecturer, HKUSPACE, The University of  
Hong Kong  
[johnnymok.us@gmail.com](mailto:johnnymok.us@gmail.com)

**Abstract**

Fall of Person from Height (FPH) is one of the main causes of accidents on construction sites and its accident rate is at the highest rank in Hong Kong. Therefore, this paper investigates into the causes of the FPH accidents and recommends possible solutions to tackle the deficiencies on the present safety management of building maintenance and repair elevated works. The information and data of the research project were collected through literature review and the questionnaire survey. The literature reviewed hazards and safety measures of maintenance and repair elevated works. A semi-structured questionnaire searched the opinions from 103 respondents for their views on safety measures of the building maintenance and repair elevated works. The results showed that the most important causes of accidents were the lack of sufficient knowledge of workers about safety, lack of safety training, improper communication, incompetent supervision, lack of work related training and not meeting the statutory requirements regarding the working platforms, safety management system and minor works control system.

**Keywords**

Construction Safety Management, Building Maintenance Works, Repair Elevated Works, Construction Accidents, Hong Kong

(Paper, ID 82)

**An Investigation into Interpersonal Conflicts in Post-Contract Stage of Sri Lankan Construction Projects**

Aparna Samaraweera  
Lecturer, University of Moratuwa, Katubedda, Sri Lanka  
[aparnas@uom.lk](mailto:aparnas@uom.lk)

Y.G. Sandanayake  
Senior Lecturer, University of Moratuwa, Katubedda,  
Sri Lanka  
[ysandanayake@uom.lk](mailto:ysandanayake@uom.lk)

S.A.M.S. Wijerathna  
Graduate Student, University of Moratuwa,  
Katubedda, Sri Lanka  
[manojsandarawan17@gmail.com](mailto:manojsandarawan17@gmail.com)

**Abstract**

Construction project organisational context follows a temporary multi organisational approach with number of different parties involved, interacted and depended on each other. Due to such complex nature, interpersonal conflicts are inevitable in construction projects. These interpersonal conflicts affect project outcomes both positively and negatively. Hence, the aim of this research is to investigate the interpersonal conflicts in post-contract stage of Sri Lankan construction projects. This research aim was approached through a quantitative survey research design by using a structured questionnaire as the data collection technique. Questionnaire consisted of questions to analyse data using Analytic Hierarchy Process and a Likert scale to analyse data using the 'mode' value of the responses. Data were collected from a purposive sample of 30 professionals in Sri Lankan construction industry. Findings indicate that task conflicts are the most experienced type of conflicts than process and relationship conflicts in post-contract stage of Sri Lankan construction projects. 'Conflicts on resource distribution' is the most experienced sub type of interpersonal conflicts. The most experienced positive influences of interpersonal conflicts consist of: 'force to take better managerial decisions', 'introduction of creative solutions to problems' and, 'increase of the ability to give and receive constructive feedback'. The most experienced negative influence of conflicts includes its contribution to delays in projects. These findings are important for construction professionals for better management of human resources in construction projects.

**Keywords**

Construction Projects, Process Conflicts, Relationship Conflicts, Sri Lanka, Task Conflicts

(Paper, ID 83)

### **Formation of Photocatalytic, Antibacterial and Self Cleaning TiO<sub>2</sub> Film on Tiles**

T. N. S. Palitha  
*University of Moratuwa, Sri Lanka*  
[nuwansripalitha@gmail.com](mailto:nuwansripalitha@gmail.com)

Oshadi D. Palansooriya  
*University of Moratuwa, Sri Lanka*  
[oshadidushmantha342@gmail.com](mailto:oshadidushmantha342@gmail.com)  
Galhenage A. Sewvandi, PhD  
*University of Moratuwa, Sri Lanka*  
[sewvandiga@yahoo.com](mailto:sewvandiga@yahoo.com)

#### **Abstract**

To ensure healthier environments in food industries, hospitals, swimming pools, pharmacies etc., we must clean the surfaces many times per day. Therefore, introduction of self-cleaning methods will be very useful. This research focused on studying photocatalytic anti-bacterial properties of thin film of TiO<sub>2</sub> synthesized on ceramic tiles by both dip coating and spray coating methods. Antibacterial properties are influenced by a variety of factors, such as crystal structure, surface area, nanoparticle size distribution etc. The TiO<sub>2</sub> exist in three crystalline phases. Anatase is one of the most common and favorable phases used in the manufacturing industries due to its uniqueness of functional performance and favorability to humans and the environment. The anatase structure of TiO<sub>2</sub> was obtained after sintering at 450°C for 45 minutes. The microstructures were characterized by a scanning electron microscope (SEM). The study applied Energy Dispersive Spectrometry (EDS) to determine the chemical constituency of the coating. The study revealed that, dip coating the tile delivered a homogeneous and very thin film on the surface. Coated TiO<sub>2</sub> cannot destroy the bacteria but stops growth of bacteria by a considerable percentage.

#### **Keywords**

Photo-Catalysis, Dip-Coating, Anatase, Energy Dispersive Spectrometry (EDS/EDAX), SEM, E-Coli

(Paper, ID 84)

### **Life-Cycle Cost Analysis of Energy Efficient Single Family Homes in Pakistan**

Salman Azhar, Kamal Ahmed, Amna Salman  
*McWhorter School of Building Science, Auburn University, Auburn, Alabama, USA*

#### **Abstract**

This paper is a companion of our first paper titled “Development and Testing of Energy Efficient Designs for Single Family Homes in Pakistan” which is also published in this conference proceedings. It presents results of Life-Cycle Cost Analysis (LCCA) of baseline and improved designs with energy efficiency measures for single family detached homes in Pakistan. The LCCA is an important tool to determine the feasibility of any energy efficient measure in the design process. It takes into account all costs of acquiring, owning, and disposing of a building or building system. By comparing LCCA of an existing design with a proposed design we can find out if the design updates are going to be economical in the long run. It includes initial investment, operating and maintenance, and disposal costs. The efforts made to minimize the life-cycle costs are not only beneficial for building owners but also for the society and economy. In our research, the LCCA results showed that, over the lifetime of the building, four measures namely Lighting Power (LEDs usage), White Paint on Roof, Roof Insulation and Exterior Wall Insulation are economically feasible. The LCCA results further indicated that the combined initial investment for these energy efficiency measures can be recovered within 7 to 10 years of building’s service life. It is strongly recommended that various energy efficiency measures should be implemented in residential designs in Pakistan. The Implementation process will require continuous effort from government, housing authorities, designers, contractors and homeowners. The LCCA results produced as part of this research can be used as a benchmark. In addition, the LCCA for more energy efficient products should be carried out in an effort to fully understand their economic impact as well as short and long-term feasibility.

#### **Keywords**

Life-cycle, Life-Cycle Cost Analysis (LCCA), Life-Cycle Costing (LCC), Return on Investment (ROI), Energy Efficient Design, Residential Construction

(Paper, ID 85)

### **The Journey of Exploring ‘Construction as Biological Cells’ for Improving Construction Quality: Aritculating the research paradigm**

Vasantha Abeyssekera  
*School of Civil Engineering and Surveying, Faculty of Health, Engineering and Surveying University of Southern Queensland, Queensland, Australia; [figur.abeysekera@usq.edu.au](mailto:figur.abeysekera@usq.edu.au)*

Mayur Shelke  
University of Southern Queensland, Brisbane,  
Queensland, Australia  
Quality Coordinator, Tier 1 Construction Company;  
[mgshelke@hotmail.com](mailto:mgshelke@hotmail.com)

### Abstract

Quality problems in construction is commonplace including defects. This study reports the journey to date of using a novel approach to explore solutions with *construction as biological-cells* simile. Ontological and epistemological issues regarding this approach is discussed arguing for postmodernism for comprehending *reality*, creating *knowledge* by applying logic (reason) to questions constantly in order to develop justified beliefs. *Intuitive* and *reflective inferences* have been made throughout when using *simile* as when synthesising the *Readiness-Growth-Rest* model and associated concepts published earlier explaining the approach using the simile *methodology as spiral* under the umbrella of the simile cum metaphorical approach established for such studies by the authors. The study advocates the use of this method for exploring solutions to perennial problems explaining the challenges with the simile *methodology as spiral* and how it could be used for advancing the notion of *theory as scientific practice*.

### Keywords

Cell, Metaphorical Analysis, Production Management, Quality Management, Simile

(Paper, ID 86)

### Development and Testing of Energy Efficient Designs for Single Family Homes in Pakistan

Salman Azhar, Kamal Ahmed, Amna Salman  
McWhorter School of Building Science, Auburn  
University, Auburn, Alabama, USA

### Abstract

Commercial and residential sector buildings consume up to 40% of world's energy production. It is estimated that the developing countries will consume up to 65% of world's energy by 2040. Pakistan is one of the developing countries which is facing a huge gap in supply and demand of electricity. Residential sector is the largest consumer of electricity in Pakistan which currently consumes 47% of total electricity production. The process of energy consumption can be made more efficient by using an energy efficient home design. In Pakistan, the lack of basic understanding of a sustainable home and a higher upfront cost of sustainable design are two

biggest barriers hindering the implementation of green solutions. The purpose of this research study was to develop typical single family detached home designs for Pakistan and apply different Energy Efficiency Measures (EEMs) to study their impact on electricity consumption. For home modeling, data related to climatic conditions, home designs, construction materials and electricity rates was collected from Lahore, Pakistan. eQUEST® (Quick Energy Simulation Tool) was used for baseline modeling and running energy simulations. Four different home designs within size range of 75 m<sup>2</sup> to 475 m<sup>2</sup> were modeled. A baseline design was first developed in accordance with typically used construction practices in Pakistan. In energy efficiency designs, several energy efficiency measures were separately applied to baseline design to see their impact on electricity consumption. Results showed that by applying these energy efficiency measures, there is a potential of reducing electricity costs by up to 26%. It was observed that lighting-power density, roof color, roof insulation and wall insulation result in most reduction in electricity consumption. It is suggested that government, housing authorities, designers, contractors and home owners help in promoting these energy efficiency measures to achieve maximum energy savings in the residential sector.

### Keywords

Energy Efficient Design, Residential Construction, Green Home, Energy Simulations

(Paper, ID 87)

### Review on Photocatalysis Applications in Construction

Muhammad Yasir Sadiq  
Graduate student, East Carolina University,  
Greenville, NC, USA

[sadiqm18@students.ecu.edu](mailto:sadiqm18@students.ecu.edu)

Amin K. Akhnoukh

Associate Professor, East Carolina University,  
Greenville, North Carolina, USA

[akhnoukha17@ecu.edu](mailto:akhnoukha17@ecu.edu)

### Abstract

Many construction projects are composed of concrete or mortar. After construction of such projects, the material faces challenges which cause aesthetic as well as physical deterioration. This paper discusses the application of Heterogeneous Photocatalysis which is a versatile, cost efficient and environmentally friendly treatment technology. The natural resources that are being used for

demonstrating the self-cleaning characteristics of the photocatalytic materials is laudable. The most popularly used photocatalytic material is Titanium dioxide (TiO<sub>2</sub>). Multiple reasons are discussed for TiO<sub>2</sub> being beneficial for the construction industry. The principal utilization of TiO<sub>2</sub> as a photocatalytic building material is due to its self-cleaning, self-disinfecting and sustainability properties. The basic mechanism of photocatalysis is also analyzed for actual understanding of the project. The photocatalytic application for a greener road environment is worth mentioning. The paper discusses that which type of TiO<sub>2</sub> coating is the most sustainable and best choice for an urban road environment which will efficiently eliminate the harmful nitrogen oxides (NO<sub>x</sub>) and volatile organic compounds (VOCs). The effect of particle size on the cost and productivity of the photocatalytic material is mentioned. The variability of the coating mix with the reduction of NO<sub>x</sub> and VOCs.

#### **Keywords**

Heterogeneous Photocatalysis, Titanium Dioxide, Pollution, Environment, Self-Cleaning Concrete

(Paper, ID 88)

#### **A Man's World: Opening the Door for Women in Construction Management**

Shelby Akers

*Department of Construction Management, East Carolina University, Greenville, NC, USA*  
[akerss16@students.ecu.edu](mailto:akerss16@students.ecu.edu)

Amelia Saul

*Department of Construction Management, East Carolina University, Greenville, NC, USA*  
[saul12@students.ecu.edu](mailto:saul12@students.ecu.edu)

Syed M. Ahmed

*Department of Construction Management, East Carolina University, Greenville, NC, USA*  
[ahmeds@ecu.edu](mailto:ahmeds@ecu.edu)

#### **Abstract**

Women are statistically underrepresented in many project management-based industries, specifically construction management. Research on this topic often evaluates the barriers and experiences of women in the construction management field, but often does not consider roundabout ways of decreasing these barriers. Thus, the present research aimed to review the current literature regarding such barriers and experiences and considered ways to minimize such barriers as based on evidence in other

industries with increasing female presence. Results from such efforts found possibilities such as considering similar areas of study, skill sets, and other field-relevant characteristics to utilize as recruiting tactics for women in the construction management field. Moving forward, the industry as a whole should aim to capitalize and recruit women as based on these various predictors of women who would do well and would be successful in the construction management industry. Recommendations and future implications are discussed in hopes of improving recruitment strategies for future generations of women in construction management.

#### **Keywords**

Women, Construction Management, Recruiting, Organizational Culture

(Paper, ID 89)

#### **Performance Evaluation of Dynamic Facades**

Senem Bilir

*Asst. Prof., Istanbul Technical University, Istanbul, Turkey*  
[sbilir@itu.edu.tr](mailto:sbilir@itu.edu.tr)

Mehmet Emre Bayraktar

*Prof., Istanbul Technical University, Istanbul, Turkey*  
[ebayraktar@itu.edu.tr](mailto:ebayraktar@itu.edu.tr)

#### **Abstract**

Dynamic facades have a significant role in reducing building energy use while improving the comfort of the occupants. Also, dynamic facades can increase energy efficiency and the use of renewable energy while maintaining high levels of indoor environmental quality. This study explores advantages, disadvantages and future expectations considering the dynamic facades. The objective of this study is to gain an understanding of how experts currently define the major strengths, weaknesses, opportunities and treats of dynamic façades, key performance indicators they use and their vision for the future of dynamic facades. A qualitative study design was performed, using semi-structured interviews. Seven interviewees working in academia and practice were selected who represented the range of possible dynamic façade professionals, from researchers and designers considered performance in the assessment of dynamic facades. Our findings emphasize the challenges and the gaps for further development of effective facade control for high-performance operation of dynamic facades.

**Keywords**

Facade experts, semi-structured interviews, key performance indicators

(Paper, ID 90)

**Protection of urban areas during repair work, structure demolition, and construction**

Mehmet Emre Bayraktar

*Professor, Istanbul Technical University, Istanbul, Turkey*

Farrukh Arif

*Associate Professor, NED University of Engineering & Technology, Karachi, Pakistan*

**Abstract**

Focusing on recent practices, this paper introduces urban protection tools that are available in the construction industry. Over the course of the research, the current state of practice was determined based through a questionnaire and an interview survey which included nationwide general contractor companies and the project executive of a safety management company located in South Florida, respectively. The study showed that there are five tools which are most commonly used in construction practices including Hand Rails with Toe boards, Overhead/Walkway Canopy, Outrigger Debris Containment Netting System, Canopy Netting System, and Vertical Netting System (Cocoon System).

**Keywords**

Safety, Construction Site Management, Urban Protection During Construction

## Appreciation

We appreciate the hard work and assistance of the following people in the organization of this conference:

*Mrs. Brenda Battle-Simms*

*Mrs. Amy Taylor*

*Janie Poncelet*

As well as those who assisted in the paper review process:

*Dr. Amin K. Akhnoukh*

*Dr. Lincoln Forbes*

*Thank you!*



## **-A Special Thank You to Our Sponsor-**

On behalf of the CITC-10 Organization, we would like to express our gratitude to Trimble Buildings.



Trimble Buildings uses advanced positioning solutions to increase productive and safety. Although best known for GPS technology, Trimble integrates a wide range of positioning technologies including GPS, laser, optical and inertial technologies with application software, wireless communications, and services to provide complete commercial solutions. Its integrated solutions allow customers to collect, manage and analyze complex information faster and easier, making them more productive, efficient and profitable.

Trimble products are used in over 150 countries around the world. Employees in more than 35 countries, coupled with a highly capable network of dealers and distribution partners serve and support our customers.

For over 38 years, Trimble has created unique positioning products that help customers grow their business. Our portfolio includes over 1,200 patents and serves as the basis for the broadest positioning offerings in the industry. Trimble augments its organic product development with strategic acquisitions to bring the latest positioning technologies to a wider market.

*Information obtained from the Trimble website: <https://buildings.trimble.com>*

# Hotel Information

## HILTON COLOMBO

2 SIR CHITTAMPALAM A GARDINER, MAWATHA, COLOMBO, 2, SRI LANKA  
TEL: +94-11-249-2492 FAX: +94-11-254-4657

### Colombo's Premier Hotel

Awarded the title of Sri Lanka's Leading Hotel and Sri Lanka's Leading Business Hotel at the World Travel Awards, this Colombo hotel is centrally located in Colombo's business district. With a range of accommodation, from guest rooms and executive rooms to suites, this hotel in Colombo offers stunning views over the Indian Ocean. For relaxation and business alike, Guests will enjoy the endless luxurious accommodations we have to offer.



#### Good to Know

- Only hotel with a connecting bridge to The World Trade Centre
- Largest pillar-less ballroom in the city
- Signature chefs from Italy, Japan, India, China, Australia and Sri Lanka
- Located in the heart of Colombo
- Equipped with a gym, pool, karaoke bar and signature restaurants

#### Location Information

Forty-five minutes away from the Bandaranaike International Airport, this Colombo hotel offers business travelers both comfort and convenience. Directly connected to Colombo World Trade Centre, Hilton Colombo offers 25 on-site venues for business and social functions, including the city's only pillar-less ballroom.



#### Amenities You Need

Unwind with a workout in our fitness center or our swimming pool. From a range of designer amenities to internet access right at your finger tips, Hilton Colombo caters to all your leisure and business needs.

#### Delicious Eats

With seven specialty restaurants and bars - from Il Ponte, Sri Lanka's only Italian trattoria, to Curry Leaf, serving its famed Sri Lankan cuisine - the Hilton Colombo hotel is a city favorite for both visitors and locals to dine at.



Information and photos obtained from the Hilton Colombo website: [http://www3.hilton.com/en/hotels/sri-lanka/hilton-colombo-COLHITW/index.html?WT.mc\\_id=zELWAKN0APAC1HI2DMH3LocalSearch4DGGenericx6COLHITW](http://www3.hilton.com/en/hotels/sri-lanka/hilton-colombo-COLHITW/index.html?WT.mc_id=zELWAKN0APAC1HI2DMH3LocalSearch4DGGenericx6COLHITW)

*Join us for a  
Banquet Dinner  
at The Navy Club  
July 3, 2018 18:00-22:00*



*Beautiful Views*

*Great Food*

*Live Music*

*For more information: <http://www.clubhouseuswetakeiyawa.lk/>*

## Galle Fort Sightseeing Trip

July 4<sup>th</sup>, 2018

15:30-23:00



Basking on the southern coast of Sri Lanka in the bay of Galle, the Fort was first built by the Portuguese in 1588 before being extensively fortified by the Dutch in the mid 1600s. Recognized by UNESCO for its cultural heritage value, the Fort was declared a World Heritage Site in 1988 as a unique exposition of "an urban ensemble which illustrates the interaction of European architecture and South Asian traditions from the 16th to the 19th centuries." For more [history](#).

Whether on a [‘guided walk’](#) or strolling along the narrow streets, today you will see clear and well-maintained evidence of the Dutch influence. Although these days there are some notable differences to 400 years ago.

Today a Museum occupies the stables; jewelry shops abound; cafes emerge from behind restored columns; interior design shops mingle with book stores and fashion outlets; and to cap it all the Dutch Governor’s residence is now the luxurious Amangalla Hotel.

Accommodation has also changed and there is something for every budget and preference ([accommodation](#)) within these historic ramparts ([map](#)).

Galle is the cultural capital of the southern coast of this magical island and along with the seven other [UNESCO sites](#) in Sri Lanka, Galle Fort is a must see for everyone.

*Information and photos obtained from the Galle Fort Guide website:*

<http://gallefortguide.com/>

## Program at a Glance

### ***Monday, 2 July 2018***

- 13:00-17:00 Registration: Foyer
- 13:30-15:00 Workshop: Managing Contractual Risks in Large Construction Projects
- 15:15-16:45 Workshop: Complexity in Construction
- 17:00-20:00 Welcome Reception: IL Ponte (A/C Section) & Pool Side

### ***Tuesday, 3 July 2018***

- 7:30-8:00 Registration (Foyer)
- 8:00-9:35 Opening Ceremony
- 9:35-10:00 Keynote Speaker: Dr. Paul Hampton and Christopher Blythe
- 10:00-10:15 Morning Coffee/Tea break
- 10:15-11:45 *Session 1*
- 11:45-13:00 Lunch (with Trimble Presentation)
- 13:00-14:45 *Session 2*
- 14:45-15:00 Afternoon Coffee/Tea break
- 15:00-17:00 *Session 3*
- 18:00 Assemble for Banquet Bus Ride
- 18:00-22:00 Banquet Dinner

### ***Wednesday, 4 July 2018***

- 08:00-08:25 Keynote Speaker: Dr. Vasantha Abeysekera
- 08:25-09:55 *Session 4*
- 09:55-10:15 Morning Coffee/Tea break
- 10:15-12:00 *Session 5*
- 12:00-13:00 Lunch
- 13:00-15:00 *Session 6*
- 15:00-15:15 Afternoon Coffee/Tea Break
- 15:15-15:30 Closing Ceremony
- 15:30 Assemble to leave for Galle Fort
- 17:30 Arrive in Galle Fort
- 17:30-21:00 Explore Galle Fort & dinner on your own
- 21:00 Depart from Galle Fort

**Monday, 2 July 2018**

13:00-17:00	Registration (Foyer)
13:30-15:00	<b>Workshop: Managing Contractual Risks in Large Construction Projects</b>
	Workshop Presented by Dr. Mohamed El Agroudy Location: The Blue Room
15:15- 16:45	<b>Workshop: Complexity in Construction</b>
	Workshop Presented by Dr. Darshi De Saram51 Location: The Blue Room
17:00-20:00	<b>Welcome Reception</b>
	Location: IL Ponte (A/C Section) & Pool Side

**Tuesday, 3 July 2018**

07:30-08:00	<b>Registration</b> (Foyer)
08:00-08:15	<b>Opening Ceremony, Cultural Dance &amp; Light the Oil Lamp</b> (The Blue Room)
08:15-08:25	<b>Prof. Syed M. Ahmed</b> , CITC-10 Chair
08:25-08:35	<b>Prof. Mohan Kumaraswamy</b> , Honorary Professor, University of Moratuwa & The University of Hong Kong
08:35-08:40	<b>Cultural Dance</b>
08:40-08:50	<b>Eng. Ranjith Gunatilleke</b> , President, Chamber of Construction Industry: Sri Lanka
08:50-09:00	<b>Eng. M R Jeyachandran</b> , Chairman, Construction Industry Development Authority
09:00-09:05	<b>Cultural Dance</b>
09:05-09:15	<b>Dr. Yasangika Sandanayake</b> , Head of the Department of Building Economics, University of Moratuwa
09:15-09:25	<b>Dr. Rohan Karunaratne</b> , President, Ceylon Institute of Builders
09:25-09:35	<b>Eng. Kirthi Sri Senanayake</b> , President, Association of Consulting Engineers: Sri Lanka
09:35-10:00	Keynote Speakers: <b>Dr. Paul Hampton and Christopher Blythe</b> (The Blue Room)
<b>10:00-10:15</b>	<b>Morning Coffee/Tea Break (Foyer)</b>
10:15-11:45	<b>Session 1: The Blue Room</b> <b>Session Chair: Markus Kummer</b>
	(ID 56) Effective Way to Reduce Financial Loss by Safety Investment: Concept from Safety Management System Kai-Chi, 'Thomas' Ying, Guomin (Kevin) Zhang, and Sejeeva Setunge
	(ID 51) Construction Monitoring and Reporting using Drones and Unmanned Aerial Vehicles (UAVs) Naveed Anwar, Muhammad Amir Izhar, Fawad Ahmed Najam
	(ID 40) Building Information Modelling Adoption for better cost estimation: Sri Lankan perspective Anushka Rathnayake, Sajedeh Mollasalehi, Ahmed AbouMoemen, Udayangani Kulatunga, and Hamed Hyab Samir
	(ID 34) Claim Management - Fundamentals and Utilization for Industrial Construction

	Bernhard Bauer, Clemens Gaugl, and Detlef Heck
	(ID 36) The Dilemma of Pricing Against the Backdrop of the Chance/Risk Ratio Christian Hofstadler and Markus Kummer
	(ID 83) Formation of Photocatalytic, Antibacterial and Self Cleaning TiO <sub>2</sub> Film on Tiles T. N. S. Palitha , Oshadi D. Palansooriya , Galhenage A. Sewvandi
<b>11:45-13:00</b>	<b>Lunch &amp; Trimble Presentation</b>
	<b>Session 2: The Blue Room</b> <b>Session Chair: Christian Hofstadler</b>
	(ID 30) Remoteness, Mental Health and Safety Behaviour among Oil and Gas Workers Anwar S. Alroomi and Sherif Mohamed
	(ID 72) A Study on Payment Issues Faced by Construction Consultants in Sri Lankan Construction Industry H.M.A.K. Abeykoon, P.A.P.V.D.S. Disaratna, M.K.C.S. Wijewickrama
	(ID 46) Impact of Configuration Management on Safety: A Study in A Steel Manufacturing Industry Themba Nkhuna and Innocent Musonda
13:00-14:45	(ID 53) Occupational Stress and the Project Manager Ken Farnes
	(ID 31) Quantity Uncertainties in Shuttering Works – Comparison of Public versus Private Clients Markus Kummer
	(ID 85) The Journey of Exploring ‘Construction as Biological Cells’ for Improving Construction Quality: Articulating the research paradigm Vasantha Abeysekera and Mayur Shelke
	(ID 39) Business Model Development for Modular Timber Building Systems Joerg Koppelhuber, Johannes Wall, and Detlef Heck
<b>14:45-15:00</b>	<b>Afternoon Coffee/Tea Break (Foyer)</b>
	<b>Session 3: The Blue Room</b> <b>Session Chair: Naveed Amwar</b>
	(ID 37) In-Depth Bid Assessment for Unit-Priced Contracts Christian Hofstadler
	(ID 44) Diffusion of innovations approach to explore sustainable development in the UAE built environment Amna Shibeika
15:00-17:00	(ID 26) Augmented Reality (AR) and Virtual Reality (VR) in construction industry: An experiential development workflow Poorang Piroozfar, Amer Essa, Simon Boseley, Eric R. P. Farr, Ruoyu Jin
	(ID 68) A linear goal programming model for optimizing the usage of safety measures on construction sites. Ming-Fung Francis Siu and S. L. Tang
	(64) A Review of Client Loyalty to Construction Professional Service Firms Nick Williams, Dr. Paul Hampton, Dr. Nii A Ankrah, and Dr. Ezekiel Chinyio

	(ID 35) Improving Productivity of Concreting Equipment: Failure Modeling Case Study on New Hot Strip Mill, Rourkela, India Arka Ghosh, Abid Hasan, Kumar Neeraj Jha
	(ID 76) Applicability of Life Cycle Assessment (LCA) to Buildings: A Review Amarasinghe S.D.I.A & Soorige S.D.A.
18:00	Assemble for Banquet Dinner Bus Ride (Lobby)
<b>18:00-22:00</b>	<b>Banquet Dinner</b>

### Wednesday, 4 July 2018

08:00-08:25	Keynote Speaker: <b>Dr. Vasantha Abeysekera</b> (The Blue Room)
	<b>Session 4: The Blue Room</b> <b>Session Chair: Innocent Musonda</b>
	(ID 3) The Potential of BIM Models as Legal Construction Documents for Sustainable Growth in the Kenyan Construction Industry. Kimani Thomas Njuguna, Mugwima Njuguna, Ahmad Omar Alkizim, Haddy Jallow
	(ID 43) Conflict Management in Construction Industry: A Review Paper Tauha Hussain Ali, Shabir Hussain Khahro, Nafees Ahmed Memon, Muhammad Ali Moriyani, Fida Hussain Siddiqui, Qasim Hussain Khahro
08:25-9:55	(ID 88) A Man's World: Opening the Door for Women in Construction Management Shelby Akers, Amelia Saul, Syed M. Ahmed
	(ID 27) The Application of Augmented Reality (AR) in the Architecture: Engineering and Construction (AEC) Industry Simon Boseley, Poorang Piroozfar, Amer Essa, Eric R. P. Farr, and Ruoyu Jin
	(ID 23) Preparing Construction Contractors for Post-Disaster Recovery Operations Bassam Baroudi and Randy Rapp
	(ID 75) Application of Value Engineering Concept to MEP Works in Sri Lankan Construction Industry: A Case Study Bandara D.G.B.S., Sandanayake Y.G. & Ekanayake B.J.
<b>9:55-10:15</b>	<b>Morning Coffee/Tea Break (Foyer)</b>
	<b>Session 5: The Blue Room</b> <b>Session Chair: Khalid Siddiqui</b>
	(ID 67) Literature Review of the Applications of Artificial Intelligence (AI) in Construction Project Management Chao Xiao, Wellington Didibhuku Thwala, and Yang Liu
10:15- 12:00	(ID 58) Development of Web Stiffener Arrangements for Enhanced Web Crippling Strength Ken Sivakumaran and Michael H. Cornell
	(ID 47) Sustainability Indicators for a Transportation Infrastructure Investor Chioma Okoro, Innocent Musonda, Justus Agumba
	(ID 82) An Investigation into Interpersonal Conflicts in Post-Contract Stage of Sri Lankan Construction Projects Aparna Samaraweera, Y.G. Sandanayake, S.A.M.S. Wijerathna

	(ID 80) Causes of Fall of Person from Height Accidents on Building Maintenance and Repair Elevated Works in Hong Kong Abid Nadeem and Y. N. Johnny Mok
	(ID 55) Applications of Nanomaterials in Pavement Engineering: A Review Vasileios C. Papadimitropoulos, Stylianos K. Karatzas, Athanasios P. Chassiakos
<b>12:00-13:00</b>	<b>Lunch</b>
13:00-15:00	<b>Session 6: The Blue Room</b> <b>Session Chair: Tauha Hussain Ali</b>
	(ID 33) Reactive Powder Concrete Application in the Construction Industry in the United States Amin K. Akhnoukh & Roberto Soares
	(ID 8) Impact of Lean Principles on Timely Project Completion Helena O'Connor & Khalid Siddiqi
	(ID 54) Broadband Telecommunication Deployment: A Supply Side Analysis of Penetration Drivers in A Developing Country Case Cosmas Ifeanyi Nwakanma, Chibueze Achiba Ogbonna, Baldwin Chukwunanu Asiegbu, Ikenna Augustine Udunwa, and Obi C. Nwokonkwo
	(ID 19) BIM for Collaboration and Coordination Haddy Jallow and Ahmed Alneyadi
	(ID 29) Field Evaluation of Surface Characteristics of Microsurfacing Pavements Yi Jiang and Shuo Li
	(ID 69) Biological Cell Surveillance: Implication on Construction Cell Mayur Shelke & Vasantha Abeysekera
	(ID 71) Initiating Smart City Concept for Sustainable Urban Development: A Literature Review Nimesha Jayasena, Harshini Mallawaarachchi, K.G.A.S. Waidyasekara
	(ID 73) Leadership Assessment Tools that can be used in Managing Health and Safety in the Apparel Manufacturing Industry in Sri Lanka Ekanayake B.J., Karunathilaka S.K., Perera B.A.K.S
<b>15:00-15:15</b>	<b>Afternoon Coffee/Tea Break (Foyer)</b>
15:15	Closing Ceremony (The Blue Room)
15:30	Assemble to Leave for Trip to Galle Fort (Lobby)
17:30	Arrive in Galle Fort
<b>17:30-21:00</b>	<b>Explore Galle Fort and dinner on your own</b>
21:00	Depart from Galle Fort