Advances in Science, Technology & Innovation
IEREK Interdisciplinary Series for Sustainable Development

Syed M. Ahmed · Paul Hampton ·
Salman Azhar · Amelia D. Saul *Editors*

Collaboration and Integration in Construction, Engineering, Management and Technology

Proceedings of the 11th International Conference on Construction in the 21st Century, London 2019

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Foreword

With my deepest gratitude and satisfaction, I write this Foreword to the Proceedings of the 11th International Conference on Construction in the 21st Century (CITC-11) London, United Kingdom, September 9–11, 2019.

CITC is an organization based in the Department of Construction Management at East Carolina University. Established at the dawn of the twenty-first century, Construction in the 21st Century (CITC) has lived up to its name and vision by truly representing the topical construction research issues over the past two decades. One only needs to see the breadth and depth of research issues covered in a series of these conferences to understand the shift in the research landscape over time. As one of the longest running peer-reviewed construction conferences, CITC brand has become synonymous to quality and relevance.

The CITC-11 conference was organized in collaboration with the University of Wolverhampton and supported by Auburn University, RICS, QSI, CIOB, CMAA, and Babcock University. As with previous conferences which 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, CITC-9 in Dubai of 2017, and CITC-10 in Sri Lanka of 2018, CITC-11 was also a tremendous success.

The 3-day conference brought together an international group of practitioners, researchers, and educators to promote a novel exchange of ideas in a multidisciplinary fashion through the delivery of 8 high-quality keynote presentations and 139 peer-reviewed papers. Over 100 delegates attended from 30 countries. As the world continues to become further complex and uncertain, it is through dialogue and mutual collaboration that we would be able to unravel its complexities. CITC-11 provided such a platform for dynamic collaboration and exchange of knowledge whereby new methods and techniques were carefully scrutinized and rigorously tested before implementation. Part of festivities of this conference included a fabulous river cruise down the Thames, with dinner and afternoon tea at iconic House of Common Churchill Room.

A special word of thanks is due to the conference organizers and sponsors for organizing yet again another successful conference.

Associate Professor Tayyab Maqsood
Associate Dean
RMIT University
Melbourne, Australia

Preface

While technology and innovation are shrinking, the distance between countries and industries and leadership and collaboration are actively shaping the construction industry, as well as guiding it towards success. Construction in the 21st Century (CITC) is an organization based in the Department of Construction Management at East Carolina University. The CITC-11 conference is being organized in collaboration with University of Wolverhampton and supported by Auburn University, RICS, QSI, CIOB, CMAA, and Babcock University. CITC organizes international conferences to bring together like-minded construction management professionals. The CITC-11 conference seeks to bring together an international group of practitioners, researchers, and educators to promote a novel exchange of ideas in a multi-disciplinary fashion.

CITC-11 is a peer-reviewed conference that acts as a dynamic collaboration for the exchange of knowledge. New methods and techniques must be carefully scrutinized and rigorously tested before implementation, and CITC-11 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 rely on international teamwork and alliance.

This September marks the eleventh 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, CITC-9 in Dubai of 2017, and CITC-10 in Sri Lanka of 2018. 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 Eleventh International Conference on Construction in the 21st Century (CITC-11, London). This three-day conference is being held in London at the RICS Headquarters. CITC-11 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 gratefully appreciate your attendance and hope that you will support the future endeavors of CITC.

Thank you and kind regards,

Greenville, NC, USA	Syed M. Ahmed
Wolverhampton, UK	Paul Hampton
Auburn, AL, USA	Salman Azhar
Greenville, NC, USA	Amelia D. Saul

Appreciation

We appreciate the hard work and assistance of the following people in the organization of the conference:
Dr. Paul Hampton, *University of Wolverhampton*
Richard Ackroyd, *Royal Institute of Chartered Surveyors*
Aneeta Hazir, *University of Wolverhampton*
Johanna Nobel, *University of Wolverhampton*
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Caroline Gumble, *Chartered Institute of Builders*
Brenda Battle-Simms, *East Carolina University*
Taylor Wynn, *East Carolina University*
As well as those who assisted in the paper review process:
Dr. Amin K. Akhnoukh
Dr. Lincoln Forbes
Dr. Jodi Farrington
Thank you!

CITC-11 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
- Nanomaterials 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

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-11:

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Dr. Hamimah Adnan
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A Special Thank You to Our Sponsor

CITC-11 is proud to be sponsored in part by The Royal Institution of Chartered Surveyors (RICS). RICS is a professional body that accredits professionals within the land, property, construction, and infrastructure sectors worldwide. For more information, please visit www.rics.org.

RICS is the global professional body promoting and enforcing the highest international standards in the valuation, management and development of land, real estate, construction, and infrastructure.

With offices covering the major political and financial centers of the world, RICS's market presence means they are ideally placed to influence policy and embed standards at a national level.

RICS works at a cross-governmental level, delivering a single, international standard that will support a safe and vibrant marketplace in land, real estate, construction and infrastructure, for the benefit of all.

RICS accredit over 130,000 qualified and trainee professionals and any individual or firm registered with RICS is subject to their quality assurance. RICS is proud of their reputation and guards it fiercely, so clients who work with RICS's registered professionals can have confidence in the quality and ethics of the services they receive.

Information obtained from the RICS website: http://www.rics.org/.

A Special Thank You to Our Sponsor

CITC-11 is proud to be sponsored in part by The Chartered Institute of Building (CIOB). CIOB is the world's largest and most influential professional body for construction management and leadership. CIOB has a Royal Charter to promote the science and practice of building and construction for the benefit of society, and CIOB has been doing that since 1834. Their members work worldwide in the development, conservation and improvement of the built environment.

CIOB accredits university degrees, educational courses and training. Their professional and vocational qualifications are a mark of the highest levels of competence and professionalism, providing assurance to clients and other professionals procuring built assets. For more information, please visit www.ciob.org.

Information obtained from the CIOB website: https://www.ciob.org/.

Keynote Speaker

Prof. Geoff Layer Geoff Layer has been Vice-Chancellor of the University of Wolverhampton since August 2011. Before joining Wolverhampton, he was Deputy Vice-Chancellor (Academic) at the University of Bradford and prior to that, after years of teaching and researching in Sheffield Business School, he became the Professor of Lifelong Learning in 1996 and Head of Access and Guidance at Sheffield Hallam University.

Geoff has always been active regionally, nationally, and internationally. He is a Board Member of Advance HE, the Black Country Local Enterprise Partnership, and the Black Country Chamber of Commerce. He was Chair of the Department for Education's Disabled Students Sector Leadership Group and is currently Chair of the Student Loans Company Stakeholder Forum. He is also a governor for the Telford College Corporation and a Trustee of the Universities Association for Lifelong Learning.

Between 2000 and 2006, he was the Director of Action on Access, an agency established to advise HEFCE on its Widening Participation Strategy. He was also Director of the HEFCE Innovations Co-ordination Team from 2000 to 2002 and has researched and published widely on Inclusive Education.

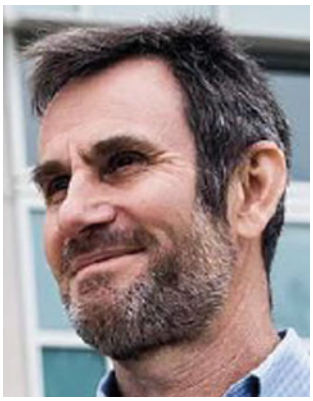
He is a Fellow of the Royal Society of Arts, a Principal Fellow of the Higher Education Academy, A Fellow of Leeds College of Music and was awarded the OBE for services to Higher Education in 2003.

Prof. Nazira Karodia Professor Nazira Karodia is Dean of the Faculty of Science & Engineering at the University of Wolverhampton and Professor of Science Education. Nazira's interests are diverse and include chemistry teaching and research in sustainable chemistry, school–HE transition, student engagement; the promotion of STEM across the education spectrum; and gender in science. She has published widely and supervises research students in chemistry, gender, and science education.

After her undergraduate studies at the University of Natal, South Africa, she moved, in 1992, to the UK to take up Ph.D. in Chemistry at the University of St Andrews, Scotland. She held postdoctoral fellowships at the Centre for Heterocyclic Chemistry, University of Florida, and with the catalysis group at the University St Andrews. Nazira was appointed as Lecturer at the University of Bradford in 1999. There her role morphed from teaching and research in Chemistry to Associate Dean, an active role in student recruitment and extending and enabling university opportunity to a

wider group of students. She was Director of STEM at Bradford and led the regional spoke of a national initiative to promote STEM education.

In 2015, Nazira moved to the University of Wolverhampton as a Professor of Science Education; she is currently Dean of Faculty of Science & Engineering. She is a member of the RSC's Science, Education, and Industry Board, the RSC's Outreach Working Group, the Institute of Physics Schools Outreach Support Advisory Group. She is a Fellow of the RSC and one of its "175 Faces of Chemistry."



Prof. Richard Burt Professor Richard Burt trained and qualified as a Chartered Building Surveyor in the UK. He holds a Masters degree in Construction Management and a Ph.D. in Architecture from Texas A&M University. He is currently the McWhorter Endowed Chair & Head of the McWhorter School of Building Science at Auburn University in Alabama. His expertise is in construction history and the survey and documentation of historic buildings. He has worked on several building documentation projects in the US and France. He has published in numerous journals and conference proceedings and was a principal investigator in a multi-year federally funded project to investigate the building remains at the historic D Day landing site at Pointe du Hoc in Normandy.

He served as the chair of an American Council for Construction Education task force to develop learning outcomes-based standards for construction education and in this capacity he conducted data gathering workshops in conjunction with the Associated General Contractors of America. He currently serves on the Board of Directors of the AGC Education and Research Foundation and the Board of Trustees of the American Council for Construction Education. Dr. Burt also serves as the co-coordinator of the International Council for Building (CIB) Working Group WG089—Education in the Built Environment in this capacity he has organized workshops and paper sessions at conferences in England, Canada, United States, Finland, and Australia.

Construction Management Education—A Historical Snapshot from both sides of the Atlantic

Prof. Richard Burt
McWhorter School of Building Science, Auburn University, Auburn, AL

Abstract: What is the future for construction education? That was the original title for this keynote address. In making predictions about the future, it is important to understand what has happened in the past and how that has shaped the current environment. The early history of construction education particularly in the education of construction managers in the United Kingdom and the United States has not been formerly documented. The Second World War and the anticipated reconstruction programs on both sides of the Atlantic led to a focus on planning for educating managers for the industry. In the United Kingdom, various government reports with industry participation led to the majority of construction managers obtaining their education while in employment through part-time education at technical colleges. Up until the mid-1960s, there are minimal opportunities for students in the UK to study for a degree in "Building". In the United States, the situation is somewhat different with degree courses in subjects such as "Building Construction" and "Architectural Engineering" being offered at several universities before the Second World War. The anticipated construction activity after cessation of hostilities led to a growth in programs with an emphasis on "Light Construction"

in anticipation of the anticipated need for housing. A significant contribution to the establishment of these programs was made by Arthur A. Hood of the Johns-Manville company, who served on a wartime government committee. An understanding of the early history of construction education should allow us to better understand the current situation and make more informed decisions about the future.

Irtishad Ahmad Irtishad Ahmad has more than 30 years of experience in teaching, research, and curricula development in civil engineering and construction management. Prior to joining AUS, he taught at Florida International University, North Dakota State University, University of Cincinnati, and Bangladesh University of Engineering and Technology.

In 2016, the American Institute of Constructors awarded Dr. Ahmad the prestigious W. A. Klinger Construction Education Award. He has co-authored the book Quantitative Techniques for Decision Making in Construction. He served as the Editor-in-Chief of the Journal of Management in Engineering, published by the American Society of Civil Engineers (ASCE) from 2002 to 2008. He is a registered professional engineer and an elected Fellow of ASCE.

Digital Technology and Integration in Construction: The UAE Context
Irtishad Ahmad1 and Sameh El-Sayegh1

1 American University of Sharjah, P.O. Box 26666, Sharjah UAE irahmad@aus.edu

Abstract. Traditionally construction is a fragmented industry too slow in adopting new technology. As a result, the construction sector productivity continues to remain stagnant. Digital technology offers a great opportunity to improve productivity by integrating many entities and functions in construction. The paper argues that integration can be achieved to a large extent with the proper adoption of digital technology. Technology's transformational role in construction needs to be recognized and harnessed by the stakeholders. The transformations and potentials are evidenced in the construction sector of UAE, where the government is taking a proactive role in facilitating the adoption of digital technologies, such as Blockchain. A conceptual model that explains the push/pull relationship between technology and integration is presented in the paper. The main conclusion of the paper is that the construction industry at all levels—firm, industry, and government—must take proactive actions to foster and facilitate integration in its processes by adopting technology.

Mohan M. Kumaraswamy Prof. Mohan Kumaraswamy is now an Honorary Professor of The University of Hong Kong, having been based there from 1992 to 2013. He is also an Honorary Professor of the University of Moratuwa; and has previously been a Visiting Professor at the National University of Singapore and at Curtin University, Australia; and an Adjunct Chair Professor at IIT Madras, India.

His Civil Engineering Degree is from Sri Lanka, while his M.Sc., Ph.D., and D.Sc. degrees are from Loughborough University, UK. Before joining academia, he worked on designs, construction, and project management, and led

consultancies funded by ILO, UNDP, and World Bank. He also served as a Consultant to the World Bank in 2014. He is also an Adjudicator and Arbitrator.

He has contributed to many professional bodies, e.g., the first Sri Lanka representative of CIOB (Chartered Institute of Building, UK) until 1992; Vice-Chairman of CIOB Hong Kong in 1996–97; Chairman of the Civil Division of Hong Kong Institution of Engineers in 1997–98. He is now a member of the Accreditation Board of the Institution of Engineers Sri Lanka.

He is the Founding Director of the 'Centre for Innovation in Construction & Infrastructure Development' (CICID), which he launched in Hong Kong in 2002. His international contributions include those as Coordinator of the international CIB Working Commission on 'Public Private Partnership'; and as the Editor-in-Chief of the 'Built Environment Project and Asset Management' journal.

UNSTABLE LINKS and UNTAPPED SYNERGIES between Academia, Construction Industry, Government & Society at large
Prof. Mohan Kumaraswamy
The University of Hong Kong & The University of Moratuwa

Much has been said about the imperative for deep collaboration between academia and industry in formulating and jointly pursuing R&D agendas, particularly in our domain of construction engineering and management. However, initiating and sustaining meaningful collaboration, yielding significant gains, has often proved difficult. Therefore, potential synergies from such latent linkages remain largely untapped. One approach to strengthen existing weak links and/or establish and nurture new linkages, has been to catalyze them with Governmental inputs, such as seed-funding and/or incentives including tax concessions. It is shown how such approaches could in turn be reinforced and sustained by engaging the end-users of construction outputs from the outset, while also factoring in the long-term net benefits and value additions to society at large. From another perspective, but along similar lines, it is shown how Government funding of academia could be more productive in helping target overall societal goals, by linking relevant representatives to develop and aim at long-term national developmental goals. From a third perspective, it is shown how Public-Private Partnerships that develop public built infrastructure need to be strengthened and stabilized by focusing on life-cycle value based on end-user needs. For this, it is suggested that relevant representatives of "People" should be embedded in Public-Private-People-Partnerships (4P), through "framework agreements" in suitable projects, albeit with necessary safeguards to minimize potential downsides. The above suggestions, with examples, are presented in the context of a quest for "breakthrough solutions" in developing operating and sustaining "smart, sustainable and best value" built infrastructure for society at large.

Peter Bolton-King Peter Bolton-King (FRICS FNAEA FIRMP) is the Global Director of Professionalism and Ethics at the Royal Institution of Chartered Surveyors (RICS), whom he joined in April 2012. Peter started to work in 1973 with a leading firm in the UK. After qualifying as a Chartered Surveyor, he became the firm's youngest ever partner.

In 2003, Peter was appointed Group Chief Executive of the National Federation of Property Professionals in the UK, a post he held for 10 years before RICS.

Peter currently holds a number of UK and Global Industry appointments on behalf of RICS. He is also a "Senior Visiting Fellow" at a UK University. He continues to influence Governments in the UK and globally for better standards in the industry and is Chair of the International Ethics Standards Coalition.

A large part of Peter's current workload involves leading a project, which is looking to understand the nontechnical risks to the reputation of RICS professionals.

What does being a professional mean in this day and age?
Peter Bolton-King
Royal Institute of Chartered Surveyors (RICS)

Abstract: The real estate profession, whether that be Land, Construction, Infrastructure, Property or related professionals is under pressure. To many, professionalism is a word that over the years has been dumbed down.
Peter will consider this issue and share some recent RICS research.

It is equally clear that our industry continues to become increasingly international. Many works in worldwide firms and we deal with large global end-users. Investors are often considering property and development schemes around the world. As our work changes and grows, so must our approach to developing and reinforcing professional ethics.

Peter will explain how global standards help to bring much needed transparency and re-assurance?

Andrea Rutledge, CAE
President & CEO
Construction Management Association of America

Association executive with 28 years' experience in association leadership, government, and higher education with a significant record of achievement as an innovative executive, strategic thinker, collaborative leader, and passionate advocate.

Before becoming President and CEO of CMAA, Andrea Rutledge spent 10 years as Executive Director of the National Architectural Accrediting Board, the sole agency authorized to accredit professional degree programs in architecture. Previously, she was Managing Director/Alliances at the American Institute of Architects.

CMAA

About CMAA

The Construction Management Association of America is an industry association dedicated to the practice of professional construction management. CMAA represents more than 16,000 members including federal/state/local government and private sector owners, construction consultants, technology suppliers, academia, and legal organizations all with a common goal: to improve our nation's infrastructure.

History of CMAA

CMAA was formed in 1982 to establish a set of professional standards for managing capital construction projects. One of CMAA's goals is to help the construction management profession further develop its own unique identity within the architecture, engineering, and construction industries. The organization's mission is to promote the profession of construction management and the use of qualified construction managers on capital projects and programs. For additional information, visit www.cmaanet.org.

Workshop
Managing Risks in Multi-Stakeholders' Projects

Description: This workshop highlights the main risks arising in managing construction contracts of multi-stakeholders. Key stakeholders in most common projects are three or four parties: Owner, Consultant/PM and Contractor. In multi-stakeholder projects, you may have around ten key stakeholders: Owner, Sponsor, Regulator, End User, Designer, Supervision Consultant, Project Manager, Main Contractor, Supplier/Vendor and other Specialized Sub-Contractor. Dealing with those stakeholders of different—and sometimes contradicting—perspectives, requirements, interests, and expectations would create high impact project risk/issues. This workshop presents analytical techniques for identifying, classifying, and engaging project stakeholders for the best outcomes in achieving project objectives. It will also identify the main risks/issues and proposes different strategies for mitigating them.

Topics: Overview of stakeholder management—Analysis, classification and engagement of stakeholders—Contradicting stakeholders' requirements—Main risks/issues related to stakeholders—mitigation strategies for project risks.

Date: Sept. 10, 2019 15:45–17:15
Session: 6
Location: Lecture Hall

Speaker: Dr. Mohamed El Agroudy, Ph.D., CCT, PMP, RMP, TRC, MCIArb, M.ASCE, PM Consultant and Visiting Professor, The American University in Cairo, Egypt.

Certificate:
All participants will receive 2.0 Professional Development Hours (PDH) certificate.

Speaker: Dr. Mohamed El Agroudy Ph.D., CCT, PMP, RMP, TRC, MCIArb, 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 Transnational Referral Certified (TRC), and an International Arbitrator. He had his B.Sc. in civil/construction engineering, a Masters in contracts, and a Ph.D. in contracts and risk management. He is teaching Contracts/Risk Management at the American University in Cairo. He is a project management consultant for mega projects in the Middle East. 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 expertize include: Contracts, Risk and Facility Management. He is an active member of Project Management Institute (PMI), International Facility Management Association (IFMA), Chartered Institute of Arbitrators (CIArb), American Society of Civil Engineers (ASCE), and board member of Green Building chapter at Saudi Council of Engineers (SCE).

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