

# CONSTRUCTION RESEARCH CONGRESS 2022

*Project Management and Delivery, Contracts, and  
Design and Materials*

---

SELECTED PAPERS FROM THE CONSTRUCTION  
RESEARCH CONGRESS 2022

---

March 9–12, 2022  
Arlington, Virginia

SPONSORED BY

Virginia Polytechnic Institute and State University  
Construction Research Council  
Construction Institute of the  
American Society of Civil Engineers

EDITED BY  
Farrokh Jazizadeh, Ph.D.  
Tripp Shealy, Ph.D.  
Michael J. Garvin, Ph.D., P.E.



Published by the American Society of Civil Engineers

Published by American Society of Civil Engineers  
1801 Alexander Bell Drive  
Reston, Virginia, 20191-4382  
[www.asce.org/publications](http://www.asce.org/publications) | [ascelibrary.org](http://ascelibrary.org)

Any statements expressed in these materials are those of the individual authors and do not necessarily represent the views of ASCE, which takes no responsibility for any statement made herein. No reference made in this publication to any specific method, product, process, or service constitutes or implies an endorsement, recommendation, or warranty thereof by ASCE. The materials are for general information only and do not represent a standard of ASCE, nor are they intended as a reference in purchase specifications, contracts, regulations, statutes, or any other legal document. ASCE makes no representation or warranty of any kind, whether express or implied, concerning the accuracy, completeness, suitability, or utility of any information, apparatus, product, or process discussed in this publication, and assumes no liability therefor. The information contained in these materials should not be used without first securing competent advice with respect to its suitability for any general or specific application. Anyone utilizing such information assumes all liability arising from such use, including but not limited to infringement of any patent or patents.

ASCE and American Society of Civil Engineers—Registered in U.S. Patent and Trademark Office.

*Photocopies and permissions.* Permission to photocopy or reproduce material from ASCE publications can be requested by sending an e-mail to [permissions@asce.org](mailto:permissions@asce.org) or by locating a title in ASCE's Civil Engineering Database (<http://cedb.asce.org>) or ASCE Library (<http://ascelibrary.org>) and using the "Permissions" link.

**Errata:** Errata, if any, can be found at <https://doi.org/10.1061/9780784483978>

Copyright © 2022 by the American Society of Civil Engineers.  
All Rights Reserved.  
ISBN 978-0-7844-8397-8 (PDF)  
Manufactured in the United States of America.

# Preface

The Construction Research Congress (CRC) 2022 Organizing Committee, Virginia Polytechnic Institute & State University (Virginia Tech), the Construction Research Council, and the Construction Institute (CI) of the American Society of Civil Engineers (ASCE) are pleased to present the CRC 2022 Proceedings. CRC is one of the leading international conferences in the area of construction engineering and management. The Congress is held every two years, which provides a university the opportunity to serve and host colleagues across the world for the interactive exchange of ideas, knowledge and research findings. CRC 2022 was hosted by Virginia Tech and its Vecellio Construction Engineering and Management Program (VCEMP) in the Department of Civil and Environmental Engineering. The conference was held in Arlington, VA on March 9-12, 2022. CRC 2022 was part of the first-ever joint conference of the Construction Research Congress and the Construction Institute Summit. This combination of academic and industry experts promoted wide-ranging discussions about finding real solutions to the most pressing societal and industry problems.

The theme of the CI & CRC Joint Conference was: "Next Generation Construction." The joint conference's technical program provided insights on the latest research and industry practices that will lead to next generation techniques, technologies, and strategies to meet the many 21st century challenges in construction and the built environment. This unique setting allowed academic and industry peers from around the world to share insights with one another to promote progress in both research and practice.

The Conference Proceedings contain 405 peer-reviewed technical papers, which were developed from over 690 abstract submissions. All submissions went through a two-step review process with a minimum of two external reviewers per paper, by a scientific community of hundreds of international construction experts. The work was exhibited at the conference in short presentations. The resulting proceedings are divided into four volumes:

- Volume I: Infrastructure Sustainability and Resilience (69 papers)
- Volume II: Computer Applications, Automation and Data Analytics (144 papers)
- Volume III: Project Management and Delivery, Controls, and Design and Materials (113 papers)
- Volume IV: Health and Safety, Workforce, and Education (79 papers)

On behalf of the Organizing Committee, Virginia Tech, the Construction Research Council and the ASCE Construction Institute, we hope that the CRC 2022 proceedings reflect the vitality of the first-ever CRC and CI Joint Conference as well as our community's research and its potential to better our industry.

Michael J. Garvin, PhD, PE, NAC  
Farrokh Jazizadeh, PhD  
Tripp Shealy, PhD

Organizing Committee  
Virginia Tech

# Acknowledgments

The editors would like to thank and recognize everyone who volunteered their time, effort, and expertise to make CRC 2022 a successful conference. CRC 2022 could not have happened without the leadership and support of the following individuals:

**Conference Chair:**

Michael J. Garvin, Virginia Tech

**Technical Committee Co-Chairs:**

Farrokh Jazizadeh, Virginia Tech

Tripp Shealy, Virginia Tech

**Track Chairs:***Infrastructure Systems, Sustainability and Resilience*

Ali Mostafavi, Texas A&M University

Soowon Chang, Purdue University

Cristina Poleacovschi, Iowa State University

Cheng Zhang, Purdue University Northwest

*Computer Applications, Information Modeling, and Simulation*

Jiansong Zhang, Purdue University

Xinghua Gao, Virginia Tech

Yilong Han, Tongji University

*Advanced Technologies and Data Analytics*

Arsalan Heydarian, University of Virginia

Kristen Cetin, Michigan State University

Javier Irizarry, Georgia Tech

*Automation in Construction*

Youngjib Ham, Texas A&M University

Kevin Han, North Carolina State University

*Engineering and Materials Design, Quality, and Value Management*

Ingrid Arocho, Oregon State University

Sharareh Kermanshachi, University of Texas, Arlington

*Project and Organizational Management and Planning*

David Jeong, Texas A&M University

Farook Hamzeh, University of Alberta

Katherine Madson, Iowa State University

*Construction Scheduling, Estimating, Economics, and Controls*

Islam El-Adaway, Missouri University S&amp;T

Diana Franco Duran, University of Virginia

*Contracting, Project Delivery, and Legal Issues*

Bryan Franz, University of Florida

Jose Guevara, University of the Andes, Columbia

*Construction Education*

Anthony Sparkling, Purdue University

Mohamed Elzomor, Florida International University

*Health, Safety, and Workforce Issues*

Alex Albert, North Carolina State University

Sogand Hasanzadeh, Purdue University

Christofer Harper, Colorado State University

**Virginia Tech Staff:**

Rachel Atwell, VCEMP Program Administrator

**ASCE's Construction Institute (CI) Staff:**

Katerina Lachinova, CI Director

Susan Long, CI Manager, Conferences &amp; Programs

Monica Bradford, CI Coordinator, Marketing &amp; Conferences

**Virginia Tech Graduate Student Volunteers:**

Brooke Baugher

Chi Nguyen Anh

Emma Coleman Todoroff

Esteban Amezcuita Radillo

Josh Trump

Kase Poling

Manik Ahmed

Mayank Khurana

Mo Hu

Mostafa Meimand

Paulo Dias Ignacio Junior

Tianzhi He

Ushma Manandhar

Wendell Grinton

Yueyan Gu

Finally, the editors would like to thank all of our colleagues who provided reviews for submitted papers. We are grateful for your contributions to the success of the conference.

# Contents

## *Contracting, Project Delivery, and Legal Issues*

<b>Precontract Negotiations in Design-Build Projects .....</b>	<b>1</b>
Elif Deniz Oguz Erkal and Keith Molenaar	
<b>Fairly Apportioning Concurrent Delay Liability: A Game Theory Approach.....</b>	<b>11</b>
Huu T. Huynh, Gunnar Lucko, and Mohamed S. Eid	
<b>Sharing Risk Contingency Costs in Construction Joint Venture Agreements: A Cooperative Game Theory Approach .....</b>	<b>20</b>
Radwa Eissa, Yasmein Shahin, and Mohamed S. Eid	
<b>Project Performance Comparison of Vertical Projects versus Horizontal Projects .....</b>	<b>30</b>
Pramen P. Shrestha and Elina Prajapati	
<b>Impacts of Alternative Contracting Methods for Utility Coordination of Transportation Projects .....</b>	<b>41</b>
Tarig Omer, Roy Sturgill, and Timothy Taylor	
<b>In the Name of the Pandemic: A Case Study of Contractual Modifications in PPP Solicited and Unsolicited Proposals in COVID-19 Times.....</b>	<b>50</b>
Gabriel Castelblanco, Jose Guevara, and Paula Mendez-Gonzalez	
<b>Identifying Contingency Liability from P3 Contracts Using Rule-Based NLP .....</b>	<b>59</b>
Yu Wang, Kunqi Zhang, Man Liang, and Qingbin Cui	
<b>Longitudinal Study of Information Management in University Construction Contracts .....</b>	<b>69</b>
Amelia Celoza, Daniel P. de Oliveira, and Fernanda Leite	
<b>Major Causes of Claims and Disputes on Transportation Public–Private Partnership Projects.....</b>	<b>79</b>
Omar Shabana and Ghada Gad	
<b>Leveraging Alternative Technical Concept for Contract Delivery of Accelerated Bridge Construction .....</b>	<b>89</b>
Piyush Pradhananga and Mohamed Elzomor	

<b>PPP Renegotiation Flight Simulator: A System Dynamics Model for Renegotiating PPPs after Pandemic Crisis.....</b>	<b>100</b>
Gabriel Castelblanco, Jose Guevara, and Paula Mendez-Gonzalez	
<b>Current State of Practice in Selection and Implementation of Airport Capital Project Delivery Methods .....</b>	<b>109</b>
Phuong Nguyen and Daniel Tran	
<b>Dimensions of Innovation in Project Delivery Method Selection for Highway Projects .....</b>	<b>119</b>
Vassiliki Demetracopoulou, William J. O'Brien, and Nabeel Khwaja	
<b>Transferral of Responsibilities of PPP European Equity Markets: Dependency Analysis .....</b>	<b>129</b>
John S. Salazar, Jose A. Guevara, and Luis A. Herrera	
<b>Investigating Financial Risks Associated with Public–Private Partnerships for Transportation Project Delivery .....</b>	<b>139</b>
Kalyani Joshi, Christofer M. Harper, John Killingsworth, and Suren Chen	
<b>The Moderating Role of Trustworthiness in the Relationship between Institutional Distance and Private Ownerships in PPPs: Evidence from Emerging Markets and Developing Countries.....</b>	<b>149</b>
Qinghua He, Yang Li, Ge Wang, and Zilun Wang	
<b>State-of-the-Art Review on the Applicability of Natural Language Processing (NLP) Methods to Address Legal Issues in Construction.....</b>	<b>159</b>
Fahad Ul Hassan and Tuyen Le	
<b>Enabling Faster Project Delivery through Use of Construction-Driven Designs .....</b>	<b>169</b>
Aleksandra Markovic Graff and Jesus M. de la Garza	
<b>Determining Contract Requirements for Quality Assurance Program in Innovative Project Delivery .....</b>	<b>179</b>
Jung Hyun Lee, Evan Mistur, Lier Liu, and Baabak Ashuri	
<b>CMAR Procurement in US Public Projects: Qualifications-Driven Processes and Criteria .....</b>	<b>189</b>
Hala Sanboskani, Mounir El Asmar, Bahaa Chammout, and Oscar Bou Maachar	
<b>Award Algorithms and Technical Scoring Trends in Design-Build Best-Value Highway Projects.....</b>	<b>200</b>
Maria Calahorra-Jimenez	



<b>Management and Contract Allocation of Geotechnical Risks on Mega Design-Build Infrastructure Projects.....</b>	<b>210</b>
Hajer W. Dawoody and Ghada M. Gad	

<b>Uncertainty Factors Affecting Bid Price from Pre-Bid Clarification Document of Transport Construction Projects.....</b>	<b>219</b>
YeEun Jang, JeongWook Son, and June-Seong Yi	

<b>A Comparison of Georgia DOT's Design-Build Legislation and Project Expenditures with Those of Bordering States.....</b>	<b>225</b>
Wesley D. Mitchell, Raed T. Jarrah, and Chang-Ray Chen	

<b>Synthesis of Challenges for Public–Private Partnerships (PPPs) in Transportation Infrastructure in Southeast Asia .....</b>	<b>235</b>
Chi A. Nguyen and Michael J. Garvin	

<b>Selection Factors for Progressive Design-Build Delivery Method .....</b>	<b>244</b>
Ruqaya Alameri and Behzad Esmaeili	

### *Construction Scheduling, Estimating, Economics, and Controls*

<b>Economic Vulnerability Assessment of the Construction Industry in the United States.....</b>	<b>254</b>
Arkaprabha Bhattacharyya and Makarand Hastak	

<b>Determination of Optimal Rolling Planning Period for the Management of BIM-Based Construction Supply Chain Processes .....</b>	<b>263</b>
Qian Chen, Borja Garcia de Soto, and Bryan T. Adey	

<b>Construction Insurance Machine-Learning Estimation Approach for Multiple Attempted Bids .....</b>	<b>274</b>
Ayman H. El Hakea and Mohamed S. Eid	

<b>Developing a Multivariate Time-Series Model to Forecast the Level of Competition in Transportation Projects.....</b>	<b>283</b>
Minsoo Baek, Baabak Ashuri, and Suma Veeravenkatappa	

<b>Machine Learning Framework to Predict Last Planner System Performance Metrics .....</b>	<b>292</b>
Lynn Shehab, Diana Salhab, Elyar Pourrahimian, Karim Noueihed, Gunnar Lucko, and Farook R. Hamzeh	

<b>A Pattern-Recognition Method for Highway Construction Project Expenditure Cash Flows Using Clustering-Based K-Means Approach .....</b>	<b>302</b>
Minsoo Baek, Yunping Liang, and Baabak Ashuri	

<b>Global and Local Risk Factors Causing Correlation between Activities in Fuzzy Linear Schedules .....</b>	<b>311</b>
Yi Su, Shabtai Isaac, and Gunnar Lucko	
<b>Framework of Automatic Cycle Schedule Management Based on BIM Technology .....</b>	<b>322</b>
Yanhui Jia and Ding Liu	
<b>Construction Procedural Information Extraction from Textual Sources to Support Scheduling .....</b>	<b>330</b>
Ran Ren and Jiansong Zhang	
<b>Predicting Ratio of Low Bid to Owner's Estimate Using Feedforward Neural Networks for Highway Construction .....</b>	<b>340</b>
Mingshu Li, Qiu Zheng, and Baabak Ashuri	
<b>Feasibility of an Integrated Heuristic and Machine Learning Approach for Schedule Health Monitoring in Construction .....</b>	<b>351</b>
Yoonhwa Jung, Fouad Amer, and Mani Golparvar-Fard	
<b>Prediction of Egypt's Construction Industry Resilience .....</b>	<b>361</b>
Ahmed Shiha and Elkhayam M. Dorra	
<b>Integrated DEMATEL and ANP-Based Framework to Model Construction Labor Productivity .....</b>	<b>370</b>
Ali Bayesteh, Elyar Pourrahimian, Ming Lu, and Simaan AbouRizk	
<b>Cost Estimate Risk Factors in US Army Corps of Engineers' Emergency Streambank Protection Projects .....</b>	<b>381</b>
Hunter Waugaman, M. Ammar Alzarrad, and James Bryce	
<b>Forecasting Architecture Billings Index Using Time Series Models .....</b>	<b>391</b>
Soojin Kim, Bahram Abediniangerabi, and Mohsen Shahandashti	
<b>Developing Assessment Criteria for State DOTs' Standard Specifications on Contractor Schedules .....</b>	<b>403</b>
Byung Gi Han, Junghye Son, Nabeel Khwaja, and William J. O'Brien	
<b>An Artificial Intelligence Based Model for Construction Activity Sequence Prediction in Highway Projects .....</b>	<b>414</b>
Hamed Alikhani and H. David Jeong	
<b>Building Optimization Model for Minimizing Operation and Maintenance Costs .....</b>	<b>422</b>
Mahdi Ghafoori and Moatassem Abdallah	

<b>Estimating Electricity Consumption of Buildings Using Information Theory and Machine Learning Methods .....</b>	<b>432</b>
Mahdi Ghafoori and Moatassem Abdallah	

<b>Improving the Efficiency of Rebar Manufacturing Works for Simultaneous Multiple Projects Using Discrete Event Simulation .....</b>	<b>441</b>
Eunbin Hong, June-Seong Yi, JeongWook Son, MinYoung Hong, and YeEun Jang	

<b>Optimization of Multi-Skilled Labor with the Application of Partial Allocation of Resources .....</b>	<b>451</b>
Amira A. Saleh, Ibrahim S. Abotaleb, and Ossama A. Hosny	

<b>Linear Optimization Model for Scheduling Repetitive Construction Projects with Multiple Crews .....</b>	<b>461</b>
Shahryar Monghasemi and Moatassem Abdallah	

<b>Benefits of Building Information Modeling in Road Projects for Cost Overrun Factors Mitigation.....</b>	<b>472</b>
Omar Sánchez, Karen Castañeda, Rodrigo F. Herrera, and Eugenio Pellicer	

<b>A Rating Score for Assessing the Risks and Challenges Associated with Modular Construction .....</b>	<b>483</b>
Mohamad Abdul Nabi and Islam H. El-Adaway	

### *Engineering and Materials Design, Quality, and Value Management*

<b>Cost Analysis of a Mass Timber Building Project: Comparison of Budgeted and Actual Construction Cost .....</b>	<b>493</b>
Shafayet Ahmed and Ingrid Arocho	

<b>Identifying the Level of Awareness and Challenges to Adopt Mass Timber by the Construction Practitioners in the United States .....</b>	<b>502</b>
Shafayet Ahmed and Ingrid Arocho	

<b>Developing a Value Dashboard for Tracking Value Alignment during Design .....</b>	<b>513</b>
Salam Khalife and Farook Hamzeh	

<b>Structural Behavior of Composite Reinforced Concrete One-Way Slabs Voided with Plastic Bubbles.....</b>	<b>524</b>
Amer M. Ibrahim, Ibrahim A. Ali, and Rouaida H. Ali	

<b>Unveiling Value Creation in Megaprojects from the Perspective of Stakeholder Value Network .....</b>	<b>535</b>
Ouyang Luxia, Zheng Xian, Li Yongkui, Pang Bo, and Gao Xinglin	

<b>Critical Constructability Review Indicators for Construction of Transportation Infrastructure.....</b>	<b>544</b>
Minerva Bonilla, William Rasdorf, Amin Akhnoukh, Nick Norboge, Daniel Findley, and Clare Fullerton	
<b>Life Cycle Cost Assessment of Green Lightweight Concrete Utilizing Recycled Plastic Based Lightweight Aggregates .....</b>	<b>553</b>
Fahad K. Alqahtani, Ibrahim S. Abotaleb, and Mohamed Elmenshawy	
<b>Examination of Contractor Quality Control Plans for Highway Construction Projects .....</b>	<b>563</b>
Mamdouh Mohamed and Daniel Tran	
<b>Performance of Engineered Cementitious Composite Material under Differing Site Conditions.....</b>	<b>574</b>
Michèle Anderson and Susan M. Bogus	
<b>Identifying and Prioritizing Criteria for Selecting Sustainable Façade Materials of High-Rise Buildings .....</b>	<b>583</b>
Pouria Mohammadi, Amir Mohammad Ramezaniapour, and Abdolmajid Erfani	
<b>Exploring Utilization of the 3D Printed Housing as Post-Disaster Temporary Shelter for Displaced People .....</b>	<b>594</b>
Karthik Subramanya and Sharareh Kermanshachi	
<b>Streamlining WELL Concepts of Office Buildings for Developing Countries: The Case of Malaysia.....</b>	<b>606</b>
Carmen Y. M. Tan, Rahimi A. Rahman, Bo Xia, and Qing Chen	
<b>Mistakeproofing Framework and Applications in Civil Engineering Operations and Products.....</b>	<b>617</b>
Iris D. Tommelein and Karilin Yiu	
<b>Modular Adaptable Hospital Design (MAHD): Proposing a Design and Construction Methodology for Flexible and Adaptable Hospitals .....</b>	<b>627</b>
Gordan Kucan, Konrad Graser, David Grossmann, and Daniel M. Hall	
<b>Upstream Digitized Materials Tracking by Vendors and Suppliers—Barriers, Drivers, and Benefits .....</b>	<b>638</b>
Verena Schneider and David Grau	
<b>Multi-Objective Optimization Model to Minimize Upgrade and Utility Costs of Large Existing Buildings .....</b>	<b>648</b>
Mahdi Ghafoori and Moatassem Abdallah	

**Literature Review of Residential Aboveground Storm Shelter.....658**  
Bi Zhang and Ajay Shanker

**A Framework for Estimating the Reuse Value of In Situ Building Materials.....666**  
Aida Mollaei, Chris Bachmann, and Carl Haas

**Strategies for Enhancing Construction Waste Recycling: A Fuzzy  
Synthetic Evaluation.....676**  
Mazen M. Omer, Rahimi A. Rahman, and Saud Almutairi

**Investigation of Relationship between Geotechnical Parameters  
and Electrical Resistivity of Sandy Soils.....686**  
Mina Zamanian and Mohsen Shahandashti

**LEED Assessment of Green Lightweight Concrete Containing Plastic  
Based Aggregates in Construction .....696**  
Fahad K. Alqahtani, Ibrahim S. Abotaleb, and Sara Harb

*Project and Organizational Management and Planning*

**Mapping the Preconstruction Project Development Process for  
Transportation Projects .....706**  
Tanin A. Haidary, Dennis C. Bausman, Ajay S. Jadhav, and Mashrur Chowdhury

**Facility Design Standardization: Six Solution Pieces and Industry  
Maximization Enablers .....715**  
Jin Ouk Choi, Binit K. Shrestha, Seung Ho Song, Jennifer S. Shane,  
and Young Hoon Kwak

**Choosing by Advantages (CBA) Method to Determine Feasibility of  
Mass Timber Building Material in the US Construction Market .....724**  
Shafayet Ahmed and Ingrid Arocho

**POP: A Data-Based Construction Project Overall Performance Model.....734**  
Hiba Jalloul, Awad S. Hanna, and Wafik Lotfallah

**Identifying Multilevel Metrics for Construction Competency  
and Performance Measures .....744**  
Yisshak T. Gebretekle and Aminah Robinson Fayek

**A Framework to Measure the Cost of Controversy Surrounding Energy  
Construction Projects .....754**  
Michaela LaPatin, Lauryn Spearing, Helena R. Tiedmann, Olga Kavvada,  
Maria Giorda, Jean Daniélou, and Kasey M. Faust

<b>Barriers and Motivators of Knowledge Sharing in a Virtual Engineering Office .....</b>	<b>764</b>
Marilyn Karam, Hala Sanboskani, Daoud Kiomjian, and Issam Srouf	
<b>Exploring Trends in Risk Statements among Design and Construction of Scientific Research Facility Projects .....</b>	<b>774</b>
Evan P. Dicks and Keith R. Molenaar	
<b>An Integrated Sustainability Performance Criteria Checklist for Sustainable Public Housing Projects .....</b>	<b>784</b>
Asma A. Sharafeddin and Ingrid Arocho	
<b>Making Project Risk Response Decisions through Stakeholders' Impact on Project Risk Interaction .....</b>	<b>794</b>
Zhixue Liu, Ronggui Ding, Lei Wang, Rui Song, and Xinyi Song	
<b>Human Values and Sustainable Construction Management: A Literature Review .....</b>	<b>805</b>
David Gutierrez and Leidy Klotz	
<b>Understanding and Comparing the Different Fund Levels in Airport Improvement Projects: A Graph Theory Approach .....</b>	<b>815</b>
Ramy Khalef and Islam H. El-Adaway	
<b>Collaborative Planning Metrics in Construction Projects: A Factor Analysis Approach .....</b>	<b>825</b>
Amr Elsayegh and Islam El-Adaway	
<b>Mitigating the Winner's Curse Dilemma in Multi-Stage Construction Bidding .....</b>	<b>835</b>
Muaz O. Ahmed, Islam H. El-Adaway, and Kalyn Coatney	
<b>Improved Project Planning Strategies for Transportation Assets: The Necessity of Early Stakeholder Involvement .....</b>	<b>845</b>
Bukola Oni and Katherine Madson	
<b>Understanding Organizational Improvisation in Construction Megaprojects .....</b>	<b>855</b>
Kaiwen Jiang, Yun Le, Xian Zheng, and Xinyue Zhang	
<b>An Integrated Framework to Quantify the Impact of Competency Factors on Project Performance .....</b>	<b>863</b>
Mina Naguib, Ebrahim S. Eldamhoury, Awad S. Hanna, and Wafik Lotfallah	
<b>Using Functional Near-Infrared Spectroscopy (fNIRS) to Evaluate the Construction Decision Making Inventory (CDMI) .....</b>	<b>874</b>
Tulio Sulbaran and Krishna P. Kisi	

<b>Front End Planning for Industrial Projects: Identifying the Reasons behind Schedule and Cost Overruns Using the New PDRI MATRS .....</b>	<b>883</b>
Namho Cho, G. Edward Gibson Jr., and Mounir El Asmar	
<b>A Pre-Demolition Planning Framework to Balance Recyclability and Productivity .....</b>	<b>892</b>
Hiba Jalloul, Ana Pinto, and Juyeong Choi	
<b>The Effect of the Economic and Social Motivations on Knowledge Sharing Behavior in Megaprojects: A Mediating Effect of Environmental Dynamism .....</b>	<b>902</b>
Hui He, Xiaoxue Liu, Qinghua He, Ge Wang, and Jun Zhu	
<b>Assessing Automation Readiness of Recurring Pavement Failure in Developing Countries: Case Studies of Nigeria and Jordan .....</b>	<b>912</b>
Olugbenro Ogunrinde, Ifeanyi Okpala, Rapheal A. Ojelabi, Opeyemi Oyeyipo, and Muhammad T. Hatamleh	
<b>Are Different Innovations More Challenging to Implement? A Comparison of Different Types of Changes in the AEC .....</b>	<b>922</b>
Omar Maali, Amirali Shalwani, Brian Lines, Kristen Hurtado, and Kenneth Sullivan	
<b>Lean Adoption for Trade Contractors: Benefits, Barriers, and Path Forward .....</b>	<b>932</b>
Elnaz Asadian, Robert M. Leicht, and John I. Messner	
<b>New Heuristic Method of Section Network Compression Process for Large-Scale Networks.....</b>	<b>943</b>
Silas Stewart and Yoojung Yoon	
<b>Development of Key Performance Indicators for Performance Assessment of Owners' Project Managers .....</b>	<b>954</b>
Shantanu Kumar and Mohammed S. Hashem M. Mehany	
<b>Comparative Analysis of Right of Way Acquisition Processes by State DOTs .....</b>	<b>964</b>
Frederick Chung and Baabak Ashuri	
<b>A Framework for Assessing Strategies to Combat Individuals' Resistance to Technological Innovation in the Construction Industry .....</b>	<b>974</b>
Yelly Kwesey Lawlavy, Fangyu Guo, and Kaiyang Wang	
<b>Digital Technology in Architecture, Engineering, and Construction (AEC) Industry: Research Trends and Practical Status toward Construction 4.0 .....</b>	<b>983</b>
Kaiyang Wang, Fangyu Guo, Cheng Zhang, Jianli Hao, and Dirk Schaefer	

<b>A Quantitative Assessment of Change Adoption Success within the Facility Management Industry .....</b>	<b>993</b>
Dipin Kasana, Justin Dodd, Jake Smithwick, Amirali Shalwani, and Brian Lines	
<b>Identification of the Barriers to Data-Centric Approach in the Construction Industry .....</b>	<b>1002</b>
Ali Karji, John Messner, Robert Leicht, and Christopher McComb	
<b>Project Team Collaborations during Time of Disruptions: Transaction Costs, Knowledge Flows, and Social Network Theory Perspective .....</b>	<b>1012</b>
Hasan Gokberk Bayhan, Sinem Mollaoglu, Hanzhe Zhang, and Kenneth A. Frank	
<b>A Comparative Analysis of Production Metrics across VDC Implementations .....</b>	<b>1024</b>
Tulika Majumdar, Steinar G. Rasmussen, Alexandre Almeida Del Savio, Katrin Johannesdottir, Eilif Hjelseth, and Martin Fischer	
<b>Identification of Management Processes That Impact Capital Efficiency on Downstream and Chemical Projects.....</b>	<b>1034</b>
Zhe Yin, Carlos Caldas, and Daniel de Oliveira	
<b>Review of Current Practices for Implementing Organization-Wide Knowledge Repositories .....</b>	<b>1045</b>
Siddharth Banerjee, Abdullah Alsharef, Edward J. Jaselskis, and Kalyan R. Piratla	
<b>Knowledge Exchanges in Complex Project Networks: Influence Model .....</b>	<b>1055</b>
Meltem Duva, Dong Zhao, Sinem Mollaoglu, and Kenneth A. Frank	
<b>Network Topologies and Team Performance: A Comparative Study of AEC Projects.....</b>	<b>1062</b>
Meltem Duva, Sinem Mollaoglu, Dong Zhao, and Kenneth A. Frank	
<b>Integration of Utility Coordination and Highway Design.....</b>	<b>1072</b>
Shani A. Montes Victorio, Roy E. Sturgill, and Timothy R. B. Taylor	
<b>Transition to Supervision: A Skill Gap Analysis between Female and Male Construction Supervisors .....</b>	<b>1083</b>
Callie Thomason French and Susan M. Bogus	
<b>Construction Business Strategies Used by General Contractors in the United States for Market Enhancement .....</b>	<b>1091</b>
Haiyan Sally Xie, Jayraj Singh Solanki, and Owen Shi	



**EVMS Maturity and Its Impact on Project Cost and Schedule  
Performance of Large and Complex Projects: A Preliminary Analysis.....1100**  
Vartenie Aramali, Hala Sanboskani, G. Edward Gibson Jr., and Mounir El Asmar

**Determinants for Operating Organization Selection in Urban Rail  
Transit Project under Public–Private Partnerships.....1110**  
Xian Zheng, Rui Li, Yilong Han, Jiaying Chen, and Xiao Hu