Construction Research Congress 2014

Construction in a Global Network

Atlanta, Georgia, USA
19-21 May 2014

Volume 1 of 3

Editors:

Daniel Castro-Lacouture       Baabak Ashuri
Javier Irizarry

# Table of Contents

**Volume 1**

**Information Technology, Modeling (BIM), and Simulation**

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enabling 3D Topological Analysis for Building Models with Boundary Representation</td>
<td>1</td>
</tr>
<tr>
<td>Xing Su and Hubo Cai</td>
<td></td>
</tr>
<tr>
<td>Robust Context Free Segmentation of Unordered 3D Point Cloud Models</td>
<td>11</td>
</tr>
<tr>
<td>Andrey Dimitrov and Mani Golparvar-Fard</td>
<td></td>
</tr>
<tr>
<td>Comparison of Experienced and Novice BIM Coordinators in Performing Mechanical, Electrical, and Plumbing (MEP) Coordination Tasks</td>
<td>21</td>
</tr>
<tr>
<td>Li Wang and Fernanda Leite</td>
<td></td>
</tr>
<tr>
<td>A Framework for Developing an As-built Virtual Environment to Advance Training of Crane Operators</td>
<td>31</td>
</tr>
<tr>
<td>Yihai Fang, Jochen Teizer, and Eric Marks</td>
<td></td>
</tr>
<tr>
<td>Client-Server Interaction Knowledge Discovery for Operations-level Construction Simulation Using Process Data</td>
<td>41</td>
</tr>
<tr>
<td>Reza Akhavian and Amir H. Behzadan</td>
<td></td>
</tr>
<tr>
<td>Similarities and Differences between Humans’ and Social Insects’ Building Processes and Building Behaviors</td>
<td>51</td>
</tr>
<tr>
<td>Lola Ben-Alon, Rafael Sacks, and Yasha Jacob Grobman</td>
<td></td>
</tr>
<tr>
<td>Differences in Skills Reported by Construction Professionals Who Use BIM/VDC</td>
<td>61</td>
</tr>
<tr>
<td>Girija Inguva, Caroline M. Clevenger, and Mehmet E. Ozbek</td>
<td></td>
</tr>
<tr>
<td>Estimating the Size of Temporary Facilities in Construction Site Layout Planning Using Simulation</td>
<td>70</td>
</tr>
<tr>
<td>Seyedreza Razavianavi, Simaan Abourizk, and Pejman Alanjari</td>
<td></td>
</tr>
<tr>
<td>Confidence Building of a System Dynamics Model on the Causation of Construction Workers’ Unsafe Behaviors</td>
<td>80</td>
</tr>
<tr>
<td>Zhongming Jiang and Dongping Fang</td>
<td></td>
</tr>
<tr>
<td>A Motion Sensor-based User Interface for Construction Drawings Navigation</td>
<td>90</td>
</tr>
<tr>
<td>Mehdi Nourbakhsh, Robert Stevenson, and Javier Irizarry</td>
<td></td>
</tr>
<tr>
<td>Issues of Translating BIM for Mobile Augmented Reality</td>
<td>100</td>
</tr>
</tbody>
</table>
(MAR) Environments
Graceline Williams, Masoud Gheisari, and Javier Irizarry

An Agent-based Model for Exploring Formation of Housing Prices: Housing Market Laboratory (HoML)
Ahmet Tolga Ozbakan

Scalable Nonparametric Parsing for Segmentation and Recognition of High-quantity, Low-cost Highway Assets from Car-mounted Video Streams
Vahid Balali and Mani Golparvar-Fard

Automatic Cave-in Safety Risk Identification in Construction Excavation
Jun Wang, Nipesh Pradhananga, and Jochen Teizer

Farzad Jalaei and Ahmad Jrade

Development of a Novel BIM-Energy Use Ontology
Aruna Muthumanickam, Rishee K. Jain, John E. Taylor, and Tanyel Bulbul

Comparing Mindfulness in Manual and 4D-Supported Coordination Practices
Léon L. Olde Scholtenhuis, Timo Hartmann, and André G. Dorée

Passive RFID and BIM for Real-time Visualization and Location Tracking
Aaron Costin, Nipesh Pradhananga, and Jochen Teizer

Exploring BIMs as Avatars: Using 3D Virtual Worlds to Improve Collaboration with Models
Anne Anderson, Carrie Sturts Dossick, Rahman Azari, John E. Taylor, Timo Hartmann, and Ashwin Mahalingham

Development of a Cell-based Simulation Model for Earthmoving Operation using Real-time Location Data
Nipesh Pradhananga and Jochen Teizer

Social Learning’s Effect on Absenteeism: The Effect of Project Turnover
Kyle Anderson, Seungjun Ahn, and SangHyun Lee

Implementation of Rapid As-built Building Information Modeling Using Mobile LiDAR
Samad M. E. Sepasgozar, Samsung Lim, and Sara Shirowzhan

Application of Photogrammetry: 3D Modeling of a Historic Building
Yang Liu and Julian Kang

Case Studies of BIM Practices within Mechanical Contractors
Fangyu Guo, Yelda Turkan, and Charles T. Jahren
Employing LiDAR Scanning for Drywall Prefabrication: A Qualitative Pilot Proof of Concept Study
Paul Holley and Shawn Mancill

Live Capture of Energy-related Knowledge into BIM Systems
Ibrahim Motawa, Srinivasan Janarthanam, and Abdulkareem Almarshad

Object-based 3D Intelligent Model for Construction Planning/Simulation in a Highway Construction
Zhenhua Shen, Kevin Orr, Wonsik Choi, Namgon Kim, and Hyunjoo Kim

A Case Study of Embedding Real-time Infrastructure Sensor Data to BIM
Jianli Chen, Tanyel Bulbul, John E. Taylor, and Guney Olgun

Potential Application of BIM in Cost-Benefit Analysis of Demolition Waste Management
Behzad Hamidi, Tanyel Bulbul, Annie Pearce, and Walid Thabet

A Road Maintenance Management Tool for Rural Roads in Kenya
Kabindra K. Shrestha, Pramen P. Shrestha, and Thomas K. Kandie

A Tool to Select Road Maintenance Contracting Methods
Kishor Shrestha and Pramen P. Shrestha

Embedded Wireless Communication Platform Addresses Crane Safety and Efficiency
Payam R. Zekavat and Leonhard Bernold

Eliciting Constructability Knowledge for BIM-enabled Automated, Rule-based Constructability Review: A Case Study of Formwork
Li Jiang, Robert M. Leicht, and Gül E. Okudan Kremer

Demystifying the Time-Effort Distribution Curves in Construction Projects: A BIM and non-BIM Comparison
Weisheng Lu, Cong Liang, Ada Fung, and Steve Rowlinson

Construction Education

Enhancement of Learning Objectives in Construction Engineering Education: A Step toward Simulation Assessment
Fadi Castronovo, Dragana Nikolic, Sarah E. Zappe, Robert M. Leicht, and John I. Messner

Teams Assessing Teams: How Assessment is Affected by Team Member Personality Traits
Steven K. Ayer, Gretchen A. Macht, Robert M. Leicht, and David A. Nembhard

Transforming Building Design through Integrated Project Delivery in Architectural and Engineering Education
José L. Perdomo and Humberto Cavallin

Evaluating the Implementation of Lean Construction into
# Construction Education

Bradley Hyatt

## Toward a Framework for Construction Ethics Education: A Meta-Framework of Construction Ethics Education Topics

Kenneth Sands and Annie Pearce

## Benefit-Cost Analysis of International Instructional Methods for Construction Management and Engineering Students

Anne Werner and Marcelo Azambuja

## A New Model for Offering Construction Education on MOOC Platforms

Ali Shafaat and Farshid Marbouti

## Parade Plus: A Simulation Game for Investigating and Teaching Strategies for Managing Production Variability and Dependence

Panagiotis “Takis” Mitropoulos, Thais Alves, and Kenneth D. Walsh

## A Collaborative Learning Community on Service-Learning in Energy Conservation and Efficiency

Yupeng Luo

## Preparing a Project Manual: A Comprehensive Project View

Ihab M. H. Saad

## Sustainable Design and Construction


A. Karatas and K. El-Rayes

### A Systems Approach for Sustainability Assessment of Civil Infrastructure Projects

Mehmet Boz, Islam El-Adaway, and Mohamed Eid


Hoda Homayouni, Carrie Sturts Dossick, and Gina Neff

### Results of a Case Study on Quantifying Fuel Use and Emissions for a Bridge Replacement Project

Elizabeth Hazzard and Phil Lewis

### Development of the Simple Estimating Tool to Assess the Energy Cost Savings of Attic Radiant Barrier System in Temperate Climate Regions

Somayeh Asadi and Marwa Hassan

### A Multi-Objective Harmony-Search Algorithm for Building Life-cycle Energy Optimization

Somayeh Asadi

### Carbon Footprint of Panelized Construction: An Empirical and
<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Comparative Study</strong></td>
<td>504</td>
</tr>
<tr>
<td>Hong Xian Li, Mehrdad Naseri Esfahani, Mustafa Gul, Haitao Yu, Don Mah, and Mohamed Al-Hussein</td>
<td></td>
</tr>
<tr>
<td><strong>Transition from Low-rise to High-rise Zero Carbon Buildings:</strong></td>
<td>514</td>
</tr>
<tr>
<td>The Potential of Socio-Technical Systems</td>
<td></td>
</tr>
<tr>
<td>Wei Pan and Yan Ning</td>
<td></td>
</tr>
<tr>
<td><strong>Mapping WASH Sustainability Frameworks to Legitimacy Theory</strong></td>
<td>524</td>
</tr>
<tr>
<td>Jessica Kaminsky</td>
<td></td>
</tr>
<tr>
<td><strong>Financial Valuation for Commercial Energy Retrofits under Private Risks</strong></td>
<td>534</td>
</tr>
<tr>
<td>Hyun Woo Lee, Kunhee Choi, John A. Gambatese, and Doyoon Kim</td>
<td></td>
</tr>
<tr>
<td><strong>Carbon Abatement and Its Cost in Construction Activities</strong></td>
<td>544</td>
</tr>
<tr>
<td>David G. Carmichael, Cassandra J. Malcolm, and Maria C. A. Balatbat</td>
<td></td>
</tr>
<tr>
<td><strong>Contractors’ Perspective on the Selection of Innovative Sustainable Technologies for Low-carbon Retail Buildings</strong></td>
<td>554</td>
</tr>
<tr>
<td>Syeda Zainab, Wei Pan, Steve Goodhew, and Alba Fuertes</td>
<td></td>
</tr>
<tr>
<td><strong>Methodology to Forecast the Emissions from Construction Equipment for a Transportation Construction Project</strong></td>
<td>564</td>
</tr>
<tr>
<td>Ingrid Arocho, William Rasdorf, and Joseph Hummer</td>
<td></td>
</tr>
<tr>
<td><strong>Challenges, Opportunities, and Solutions in Low-cost Building Envelopes: A Case Study of Low-strength Masonry Systems</strong></td>
<td>574</td>
</tr>
<tr>
<td>Esther Obonyo, Peter Donkor, Fabio Matta, and Ece Erdogmus</td>
<td></td>
</tr>
<tr>
<td><strong>Encouraging Elegant Solutions by Applying Choice Architecture to Infrastructure Project Delivery</strong></td>
<td>584</td>
</tr>
<tr>
<td>Tripp Shealy and Leidy Klotz</td>
<td></td>
</tr>
<tr>
<td><strong>Development and Validation of a Framework for Evaluation of Integrated Design Teams of Sustainable High-performance Buildings</strong></td>
<td>594</td>
</tr>
<tr>
<td>Rahman Azari and Yong-Woo Kim</td>
<td></td>
</tr>
<tr>
<td><strong>Assessing Occupants’ Energy-load Variation in Commercial and Educational Buildings: Occupancy Detecting Approach Based on Existing Wireless Network Infrastructure</strong></td>
<td>604</td>
</tr>
<tr>
<td>Jiayu Chen and Changbum Ahn</td>
<td></td>
</tr>
<tr>
<td><strong>Testing Effectiveness of Solar Photovoltaic Systems for Public Schools in Washington</strong></td>
<td>613</td>
</tr>
<tr>
<td>Charusheela Ghadge and Yong-Woo Kim</td>
<td></td>
</tr>
<tr>
<td><strong>Comparison of Predictive Modeling Methodologies for Estimating Fuel Use and Emission Rates for Wheel Loaders</strong></td>
<td>623</td>
</tr>
<tr>
<td>Heni Fitriani and Phil Lewis</td>
<td></td>
</tr>
<tr>
<td><strong>Discovering Stakeholder Values for Axiology-based Sustainability-oriented Value Analysis of Educational Building Projects</strong></td>
<td>634</td>
</tr>
<tr>
<td>Lu Zhang and Nora M. El-Gohary</td>
<td></td>
</tr>
</tbody>
</table>
A Review of Energy Efficiency Measures in Commercial Buildings: The Case of Lebanon
Antoine Abou Jaoude, Issam Srour, and Carol Menassa

New Eco-City: Incorporating Sustainability into the Concept Master Plan
Farah Mneimneh, Issam Srour, and Isam Kaysi

Dual-Use Research in Sustainable Construction on the Moon
Leonhard E. Bernold

Effect of Polypropylene Fiber Length on the Flexural and Compressive Strength of Compressed Stabilized Earth Blocks
Peter Donkor, Esther Obonyo, Fabio Matta, and Ece Erdogmus

Municipalities' Possible Use of 100% Recycled Asphalt
Shima Clarke and Jeffrey Austin

Determination of Optimum Pavement Construction Alternatives to Minimize Life-cycle Costs and Greenhouse Gas Emissions
Yuhong Wang and Dan Chong

Estimating the Energy Saving Potential for Office Buildings in Hong Kong Based on a Four-tier Framework
Simou Zhang, Wei Pan, and Mohan M. Kumaraswamy

Integration of Monte Carlo Simulation and Genetic Algorithms for Sustainable Designs Analysis
Peeraya Inyim and Yimin Zhu

Applying Lean Process Principles to Improve Labor Efficiency of Solar Photovoltaic Installations
Joseph Goodman, Kathryn Nagel, Matthew Wren, and Jesse Morris

The Need for Integrated Project Delivery in the Public Sector
Wesley Collins and Kristen Parrish

Productivity and Workforce Issues

Automated Worker Activity Analysis in Indoor Environments for Direct-Work Rate Improvement from Long Sequences of RGB-D Images
Ardalan Khosrowpour, Igor Fedorov, Aleksander Holynski, Juan Carlos Niebles, and Mani Golparvar-Fard

Feasibility of Onsite Biomechanical Analysis during Ladder Climbing
Joon Oh Seo, Sang Uk Han, Sang Hyun Lee, and Thomas J. Armstrong

Understanding the Role of Social Rules in Shaping Construction Workers’ Absence Behavior Using Agent-based Modeling and Surveying
Seungjun Ahn and Sang Hyun Lee

Estimating Optimal Labor Productivity: A Two-Pronged
Strategy
Krishna P. Kisi, Nirajan Mani, and Eddy M. Rojas

Cognitive Demands of Craft Professionals Based on Differing Engineering Information Delivery Formats
Gabriel B. Dadi, Timothy R. B. Taylor, Paul M. Goodrum, and William F. Maloney

A Critical Review of Methods Used to Determine Productivity of Mechanical, Electrical, and Plumbing Systems Coordination
Baabak Ashuri, Saman Yarmohammadi, and Mohsen Shahandashti

Testing the Application of Google Fusion Tables as a Collaborative Productivity Database and Benchmarking System for the Construction Industry
Roman Titov, Chandana Siriwardana, and Janaka Ruwanpura

Volume 2

Development of an Industry Level Productivity Metric for the Construction Industry
Stephanie Vereen, Joseph E. Hummer, and William Rasdorf

Estimating Labor Productivity Frontier: A Pilot Study
Nirajan Mani, Krishna P. Kisi, and Eddy M. Rojas

Time and Motion Study for Solar Contractors
Natalia Quintanilla, Saman Yarmohammadi, Baabak Ashuri, Matthew M. Wren, Mohsen S. Shahandashti, and Joseph Goodman

Construction Workforce Management Strategies to Reduce Absenteeism: A Survey Study
M. Ghayth Lattouf, F. Jordan Srour, and Issam M. Srour

Data-driven Approaches to Discovering Knowledge Gaps Related to Factors Affecting Construction Labor Productivity
Abraham Assefa Tsehayae and Aminah Robinson Fayek

Key Issues in Workforce Planning and Adaptation Strategies for BIM Implementation in Construction Industry
Wei Wu and Raja R. A. Issa

Effect of Decision-making Methods on Trust
Pardis Pishdad-Bozorgi and John Haymaker

Decision-making Model by Specialty Subcontractors in Construction Projects
Ali Shafaat, Tarek Mahfouz, Christine Jackson, and Amr Kandil

Shift Work and Labor Productivity in Urban Sewer Construction
Long D. Nguyen, Thang K. N. Nguyen, and Dai Q. Tran

Developing a Knowledge-based Information System (KISCCES) for Construction Cost Estimating and Scheduling
Seonghoon Kim, Marcel Maghiar, Lixin Li, Yong Bai, and Jason Scott
Automation and Data Sensing

Semantic-based Text Classification of Environmental Regulatory Documents for Supporting Automated Environmental Compliance Checking in Construction
Peng Zhou and Nora El-Gohary

Automated Reasoning for Regulatory Compliance Checking in the Construction Domain
Jiansong Zhang and Nora M. El-Gohary

Automatic As-is 3D Building Models Creation from Unorganized Point Clouds
Chao Wang and Yong K. Cho

Automatic 3D Reconstruction of As-built Pipeline Based on Curvature Computations from Laser-Scanned Data
Hyojoo Son, Changmin Kim, and Changwan Kim

Automated Detection of Near-miss Fall Incidents in Iron Workers Using Inertial Measurement Units
Kanghyeok Yang, Sepi Aria, Changbum R. Ahn, and Terry L. Stentz

Comparison of Methods Used for Detecting Unknown Structural Elements in Three-dimensional Point Clouds
Jamie Yeung, Mohammad Nahangi, Yasaman Shahtaheri, Carl Haas, Scott Walbridge, and Jeffrey West

Automated Extraction of Building Geometry from Mobile Laser Scanning Data Collected in Residential Environments
Alireza G. Kashani, Andrew J. Graettinger, and David Grau

A Comprehensive Matrix of Unmanned Aerial Systems Requirements for Potential Applications within a Department of Transportation
Ebrahim P. Karan, Claus Christmann, Masoud Gheisari, Javier Irizarry, and Eric N. Johnson

Automatic Detection of Pavement Surface Defects Using Consumer Depth Camera
Chenxi Yuan and Hubo Cai

Data Quality-oriented 3D Laser Scan Planning
Mingming Song, Zhenglai Shen, and Pingbo Tang

Analyzing Abnormal Cycles of Pilot Tube Microtunneling through Pattern Recognition in Time-series Data of Hydraulic Pressure
Zhenglai Shen, Pingbo Tang, and Samuel T. Ariaratnam

Automated Registration of 3D Point Clouds with 3D CAD Models for Remote Assessment of Staged Fabrication
Mohammad Nahangi, Mahdi Safa, Arash Shahi, and Carl T. Haas

Automatic 3D Thermal Zones Creation for Building Energy Simulation of Existing Residential Buildings
Chao Wang and Yong K. Cho

Evaluation of the State-of-the-Art Automated Construction Progress Monitoring and Control Systems 1023
Reza Maalek, Janaka Ruwanpura, and Kamal Ranaweera

Automated Monitoring of Operation-level Construction Progress Using 4D BIM and Daily Site Photologs 1033
Kevin K. Han and Mani Golparvar-Fard

Automating Construction Operations Using Discrete Event Simulation Models 1043
Joseph Louis, Phillip Dunston, and Julio Martinez

Rapid Dynamic Target Surface Modeling for Crane Operation Using Hybrid LADAR System 1053
Yong Cho, Chao Wang, Mengmeng Gai, and Jee Woong Park

Quantitative Methods

U.S Economic Indicators and Stock Prices of Construction Equipment Manufacturers: A Statistical Relationship Analysis 1063
Herbert Barber and Islam El-Adaway

A Data Envelopment Analysis Model for Building Energy Efficiency Benchmarking 1073
Jian Lu, Baabak Ashuri, and Mohsen Shahandashti

Modeling Bid/No Bid Decision Using Adaptive Neuro Fuzzy Inference System (ANFIS): A Case Study 1083
Gul Polat, Befrin Neval Bingol, and Enis Uysalol

Empirical Study of Effects of Price Adjustment Clauses (PACs) on Highway Construction Bid 1093
Mohammad Ilbeigi, Baabak Ashuri, and Soheil Shayegh

Analysis of the Temporal Relationships between Highway Construction Cost and Indicators Representing Macroeconomic and Construction and Energy Market Conditions 1103
Mohsen Shahandashti

A Stochastic Process to Model the Fluctuations of Asphalt Cement Price 1111
Mohammad Ilbeigi, Baabak Ashuri, and Yang Hui

Evaluating the Project Coordination Performance Using Information Centrality 1119
Pelin Ipek Timurcan and Sevgi Zeynep Dogan

Quantitative Analysis of Bidding Strategies: A Hybrid Agent Based-System Dynamics Approach 1129
Arash Mahdavi and Makarand Hastak

Toward Statistics on Construction Engineering and Management Research 1139
Dai Tran, Henry Lester, and Nathaniel Sobin

Optimal Crew Design for Masonry Construction Projects Considering Contractors' Requirements and Workers' Needs
Laura Florez and Daniel Castro-Lacouture

Infrastructure Management and Disaster Response

Leveraging Structural Health Monitoring for Bridge Condition Assessment
Manu Akula, Yilan Zhang, Vineet R. Kamat, and Jerome P. Lynch

A Mathematical Framework to Assess Vulnerabilities in Codependent Infrastructure and Natural System Networks
Christopher Van Arsdale and Amlan Mukherjee

Dynamic Social Network Analysis for Infrastructure Transportation Systems
Eric Vechan, Islam El-Adaway, and Marwa Hassan

Achieving Value for Money: An Analytic Review of Studies on Public-Private Partnerships
Wei Peng, Qingbin Cui, Yujie Lu, and Li Huang

Successes and Failures of the Post-tsunami Housing Reconstruction Program in Tamil Nadu, India
Elizabeth Jordan and Amy Javernick-Will

3D Data Collection and Automated Damage Assessment for Near Real-time Tornado Loss Estimation
Alireza G. Kashani, Andrew Graettinger, and Thang Dao

Using Alternative Project Delivery Methods to Enhance the Cost Performance of Trenchless Construction Projects
Tober Francom, Mounir El Asmar, and Samuel T. Ariaratnam

Evaluating the Feasibility of Decommissioning Residential Water Infrastructure in Cities Facing Urban Decline
Kasey Faust and Dulcy M. Abraham

A GIS-enabled Cost Estimation Tool for Road Upgrade and Maintenance to Assist Road Asset Management Systems
Kabindra K. Shrestha and Pramen P. Shrestha

Resilience-based Planning in Civil Infrastructure Using System-of-Systems Analysis
Ali Mostafavi and Dulcy M. Abraham

A Remote Sensing-based Approach for Assessing and Visualizing Post-Sandy Damage and Resiliency Rebuilding Needs
Jie Gong

A Framework for Post-disaster Facility Restoration Management: Needs and Requirements for the Use of Hybrid Simulation
Moonseo Park, Sang Hyun Lee, Hyun-Soo Lee, Minji Choi, Sungjoo Hwang, Myung Gi Moon, Seulbi Lee, and Jae-Ho Pyeon

Microeconomics for Infrastructure Rehabilitation 1279
Dina A. Saad and Tarek Hegazy

Bridge Inspection Practices Using Nondestructive Testing Methods for Concrete Structure 1289
Sangwook Lee and Nikolas Kalos

Use of Low-cost Remote Sensing for Infrastructure Management 1299
Su Zhang and Susan M. Bogus

Integrated Model for Evaluating Infrastructure Sustainability in China 1309
Min Cheng and Panpan Liu

Contracting and Legal Issues

Challenges and Opportunities for Expediting Environmental Analysis in Transportation Design-Build Projects 1319
David Hannon, Kia Mostaan, and Baabak Ashuri

Association between Construction Contracts and Relational Contract Theory 1329
Christofer M. Harper and Keith R. Molenaar

Zorana Popic and Osama Moselhi

Unsolicited Proposals for PPP Projects: Private Sector Perceptions in the USA 1349
Ahmed Abdel Aziz and Human Nabavi

Prioritization of Demand Risk Factors in PPP Infrastructure Projects 1359
Rajaa Alasad, Ibrahim Motawa, Stephen Ogunlana, and Prince Boateng

Assessing the Performance of Two-Step Design-Build Procurement 1369

Case Study of LMM Airport Concession in Puerto Rico 1379
Edwin E. González and Michael J. Garvin

A Meta-analysis of Literature Comparing Project Performance between Design-Build (DB) and Design-Bid-Build (DDB) Delivery Systems 1389
Vahid Nikou Goftar, Mounir El Asmar, and Evan Bingham

Emerging Project Procurement Trends in the Canadian Construction Industry 1399
Faisal Arain, Tim McFarlane, Don Mah, and Mehdi Zahed
An Evaluation of Current Practices of Road Maintenance Contracting Methods
Pramen P. Shrestha and Kishor Shrestha

Application of the Time "At Large" Principle to Standard Forms of Contract
Salwa Fawzy and Islam El-Adaway

Ontology-based Investigation of Construction Delay Analysis Methodologies in Egypt
Mohamed Magdy Ahmed, Maged Georgy, and Hesham Osman

Cost and Schedule

Unevenly Distributed Markup in Cash Flow Modeling with Singularity Functions
Yi Su and Gunnar Lucko

Spatially Constrained Scheduling with Multidirectional Singularity Functions
Gunnar Lucko, Hisham M. M. Said, and Ahmed Bouferguene

Mapping Relational Efficiency in Neuro-Fuzzy Hybrid Cost Models
Olubukola Tokede, Dominic Ahiaga-Dagbui, Simon Smith, and Sam Wamuziri

Optimization-based Approach for Organizing the Bidding of Nonserial Repetitive Projects
A. Samer Ezeldin and Ahmed M. Alhady

Accuracy in Design Stage Cost Estimating through Risk-contingency Analysis: A Theoretical Exploration
Johnson Adafin, Suzanne Wilkinson, James O. B. Rotimi, and Henry Odeyinka

Determining Standard Cost Estimating Methods for Negotiating Engineering and Related Services Contracts
David Rogge and Fan Zhang

Assessment of the Effect of Changing Activities’ Start Times on Cash-flow Parameters
Marwa Hussein Ahmed, Tarek Zayed, and Ashraf Elazouni

Supply Chain Cost Model in Integrated Approach
Yong-Woo Kim

Examining the Effects of Early Cost Drivers on Contingencies
Bo Xiong and Bo Xia

Contributions of the Construction Project Team to Cost Overruns: The Contractors’ Perspective
Olusegun Akinsiku, Adeyemi Akintola, Oko Ameh, and Ayokunle Ige

Construction Means and Methods
Potential of Nanoparticles and Nitrates Released to Water from Photocatalytic Pavements
Heather Dylla and Marwa M. Hassan

Influence of Clay Pozzolana on Some Properties of Portland Limestone Cement
Mark Bediako

Best Practices for Maintenance of Concrete Bridge Elements Against Mold and Mildew Growth
Angel Lence, Marwa Hassan, Adam Zayor, and Tyson Rupnow

Quad Pod: Ultra-efficient PV Racking System for Long-span Ground Mount and Canopy Applications
Tristan Al-Haddad, Bradley Brooks, Russell Gentry, Joseph Goodman, Joshua Lohr, and Keyan Rahimzadeh

Sustainable Construction Methods Using Ancient BAD GIR (Wind Catcher) Technology
Chris Soelberg and Julie Rich

Aircraft Sound Transmission in Homes Categorized by Typical Construction Type
Ashwin Thomas, Javier Irizarry, Erica E. Ryherd, Daniel Castro-Lacouture, and Rick Porter

Volume 3

Construction Planning and Control

Analyzing Scaffolding Needs for Industrial Construction Sites Using Historical Data
Lingzi Wu, Yasser Mohamed, Hosein Taghaddos, and Rick Hermann

4D-based Value Engineering
Yalda Ranjbaran and Osama Moselhi

Evaluating the Effect of Resource Utilization Decisions on Energy Consumption in Construction Projects
Reza Sheykhi and Wallied Orabi

The Potential of Construction Project Benchmarking in the Vicksburg District of the U.S. Army Corps of Engineers
Philip Labarre, Islam El-Adaway, and Mohamed Eid

Modularization Critical Success Factors Accomplishment: Learning from Case Studies
Jin Ouk Choi and James T. O’Connor

Development of a Takt-time Plan: A Case Study
Adam Frandson and Iris D. Tommelein

Biddability, Constructability, Operability, and Environmental Analysis at the Engineer Research and Development Center
Mark Ogburn and Islam El-Adaway

An Automatic Scheduling Approach: Building Information
Modeling-based Onsite Scheduling for Panelized Construction
Hexu Liu, Zhen Lei, Hong Xian Li, and Mohamed Al-Hussein

Strategies for Optimizing Labor Resource Planning on Plant Shutdown and Turnaround
Ming-Fung Francis Siu, Ming Lu, and Simaan Abourizk

The Project Screening Model for Natural Gas Projects: Focusing on the Gas Field Development
Woosik Jang, Seokjin Choi, Heedae Park, Seung H. Han, and Sangku Lee

Risk Assessment of a Ready-mix Concrete Supply Chain
Marcelo Azambuja and Xin Chen

Evaluation of Asphalt Pavement Deterioration Curves for Oklahoma Interstate Highways
Hossein Khalegian, Phil Lewis, David Jeong, and Asregedew Woldesenbet

Crew Cost and Productivity Performance Benchmarking Based on Commercial Cost Estimating Databases
Ming Lu and Chang Liu

Current Trends in Construction Site Layout Planning
Samaneh Zolfagharian and Javier Irizarry

Alternative Project Delivery Methods for Water and Wastewater Projects: The Satisfaction Level of Owners
Pramen P. Shrestha, Ruiko Maharjan, Binita Shakya, and Jacimaria Batista

Risk and Safety Management

A Mathematical Structure for Modeling Uncertainty in Cost, Schedule, and Escalation Factor in a Portfolio of Projects
Ali Touran

Modeling the Role of Social Networks in Situational Awareness and Hazard Communication
Alex Albert and Matthew R. Hallowell

Evaluation of a Mobile Work Zone Barrier System
Nicholas Tymvios and John Gambatese

Exploring the Relationship between Chronic Sleep Deprivation and Safety on Construction Sites
Umberto C. Gatti, Ken-Yu Lin, Christian Caldera, and Rayleigh Chiang

Implementation of Traffic Control Devices on Highway Preservation Projects to Enhance Construction Work Zone Safety
Fan Zhang, John Gambatese, and Ali Moghaddam Vahed

Developing a BIM-enabled Bilingual Safety Training Module for the Construction Industry
Caroline Clevenger, Carla Lopez Del Puerto, and Scott Glick

UAS4SAFETY: The Potential of Unmanned Aerial Systems for...
Construction Safety Applications  
Masoud Gheisari, Javier Irizarry, and Bruce N. Walker

Assessing Operational Risks in Road Projects Under the PPP Framework in Colombia  
Germán Pineda and Carlos A. Arboleda

Mapped Workflow for Safety and Reliability Assessments of Use and Reuse of Formwork  
Andre Barbosa, John Gambatese, Amrutha Das, and Ana Catarina Pestana

The Effect of Project Type on Risk Timing and Frequency  
Anthony J. Perrenoud, Kenneth T. Sullivan, and Kristen C. Hurtado

Accident Prevention through Production Control: Lessons from High-reliability Foremen  
Panagiotis Mitropoulos

Safety Assurance of Existing Pipelines in Tunneling Construction  
Limao Zhang, Xianguo Wu, Miroslaw J. Skibniewski, Yueqing Chen, and Hongyu Chen

Prediction of Safety Climate through a Neural Network  
D. A. Patel and K. N. Jha

Risk Management for Build-Transfer Plus Land Usage Fee Reimbursement Delivery Method in China  
Wei Zhang, Yong Bai, and Yilei Huang

Financial Provision for Construction Health and Safety (H&S)  
John Smallwood and Fidelis Emuze

Facility Management and Program Management

Using Discrete-event Simulation to Support Building Asset Management: An Exploratory Case Study  
Umberto Gatti, Omar El-Anwar, Giovanni Migliaccio, and Ken-Yu Lin

Motivation for the Development of an Information Management Framework for Healthcare Facility Management  
Arundhati Ghosh and Allan D. Chasey

Generating As-is Building Information Models for Facility Management by Leveraging Heterogeneous Existing Information Sources: A Case Study  
Bo Gu, Semiha Ergan, and Burcu Akinci

Energy Management Effects on Asset Value  
Sydney V. Roberts and Khalid Siddiqi

Noise as a Risk Factor in Elementary Classrooms: Applicability of Life-cycle Value Tradeoff of Noise-mitigating Measures Using Multicriteria Decision Modeling  
Parminder K. Juneja
Exploring BIM and Mobile Augmented Reality Use in Facilities Management  1941
Masoud Gheisari, Shane Goodman, Justin Schmidt, Graceline Williams, and Javier Irizarry

Intelligent Facilities: Applicability and Flexibility of Open BIM Standards for Operations and Maintenance  1951
Kevin Orr, Zhenhua Shen, Parminder K. Juneja, Nathaniel Snodgrass, and Hyunjoo Kim

Church Energy Audits in the United States  1961
George Ford and Sung Jun Suk

Organizational Issues

Evaluating the Usefulness of Knowledge Sharing Connections in Multinational Construction Companies  1967
John Wanberg and Amy Javernick-Will

Analysis of the Growth Dynamics and Structure of the Modular Building Construction Industry  1977
Hisham Said, Ayman R. Ali, and Mohammed Alshehri

Dimensions of Interoperability in the AEC Industry  1987
Erik A. Poirier, Daniel Forgues, and Sheryl Staub-French

Exploring the Role of the Team Environment in Building Project Performance  1997
Bryan Franz, Behzad Esmaeili, Robert Leicht, Keith Molenaar, and John Messner

Progress Loops in Interorganizational Project Teams: An IPD Case  2011
Angelo Joseph Garcia, Sinem Mollaoglu-Korkmaz, and Vernon D. Miller

Highway Data Quality Report Card (HDQ_{RC}): A Conceptual Framework of Pavement Management Data  2021
Asregedew Woldesenbet and H. David Jeong

Social Network Analysis (SNA) for Construction Projects’ Team Communication Structure Optimization  2032
Andreas Malisiovas and Xinyi Song

A Framework for Identifying and Measuring Competencies and Performance Indicators for Construction Projects  2043
Moataz Nabil Omar and Aminah Robinson Fayek

Developing Capability of Public Sector Procurement in Ghana: An Assessment of the Road Subsector Client  2053
Peter Addo-Duah, Tony Westcott, Jim Mason, Colin Booth, and Abdul-Majeed Mahamadu

Competitiveness of Construction Organizations in South Africa  2063
Organizational Issues Affecting Tacit Knowledge Sharing in Construction Organizations
Seokyon Hwang

An Action Research Approach to Implementation of Alternative Project Delivery Methods within Architectural, Engineering, and Construction Owner Organizations: Overcoming Resistance through Education
Brian Lines, Kenneth Sullivan, and Jake Smithwick

Framework of Construction Innovation: A Review of Diffusion of Sustainable Innovation in the Building Sector
Eunhwa Yang and Ying Hua

Diffusion Pattern Recognition of Technology Vendors in Construction
Samad M. E. Sepasgozar and Steven Davis

Global Construction Issues

Why Do They Acquire Each Other? Nexus between International Contracting and Construction Professional Service Businesses
Weisheng Lu, Kunhui Ye, Roger Flanagan, and Carol Jewell

Effect of Institutional Risks on the Performance of International Construction Projects
Heedae Park, Kang-Wook Lee, H. David Jeong, and Seung Heon Han

Trust in the Construction Industry: A Literature Review
Ghada M. Gad and Jennifer S. Shane

The Advantages of the Construction Sector of China and India: A Comparison
Chuan Chen, Igor Martek, and Mona Shah

Layered Boundary Spanning in Global Virtual Project Networks: Exploring the Role of Cultural Boundary Spanners at Knowledge Domain and Technological Boundaries
Andres Zelkowicz, Josh Iorio, and John E. Taylor

Housing and Construction Cost Escalation: Causes and Effects in Riyadh
Abdulaziz Saleh Alfouzan and Ahmed Khalafallah

Comparing Global versus Domestic Project Network Facilitation in Virtual Workspaces
Semra Comu, John E. Taylor, and Carrie Sturts Dossick

Building Performance and Life Cycle Analysis (LCA)
Structural Deterioration Prediction Modeling for Coastal Protection Structures in Alexandria Eastern Harbor
Ayman El Hakea, Soliman Abu-Samra, Ossama Hosny, and Hesham Osman

Building Energy Performance Estimation in Early Design Decisions: Quantification of Uncertainty and Assessment of Confidence
Roya Rezaee, Jason Brown, and Godfried Augenbroe

Optimal Selection of Sustainability Measures to Minimize Building Operational Costs
Moatassem Abdallah, Khaled El-Rayes, and Liang Liu

A Systematic Approach to Quantifying Energy Savings Potential Because of Improved Operations of Commercial Building Stocks
Elie Azar and Carol C. Menassa

The Role of Construction Detailing and Workmanship in Achieving Energy-efficient Buildings
Qinpeng Wang, Godfried Augenbroe, and Yuming Sun

Evaluating the Value of Investment in Building Insulation Retrofits Based on EPAR (Energy Performance Augmented Reality) Models
Youngjib Ham and Mani Golparvar-Fard

A Sensitivity Analysis of Energy Modeling Input Parameters for Energy Retrofit Projects
Tabitha L. Sprau Coulter and Robert M. Leicht

Hadia Awad, Mustafa Gul, Hamid Zaman, Haitao Yu, and Mohamed Alhussein

CII Research

Current State of Interface Management in Mega-construction Projects
Samin Shokri, Seungjun Ahn, Thomas Czerniawski, Carl T. Haas, and Sang Hyun Lee

Starting From Scratch: A New Project Delivery Paradigm
Rahman Azari, Yong-Woo Kim, Glenn Ballard, and Seong-Kyun Cho

An Assessment of Best Practices and the Efficacy of an Open Repository in the Construction Industry
Roberta Bosfield and G. Edward Gibson Jr.

Identification of Late Deliverables and Their True Effects on Industrial Construction Projects
William Barry, Fernanda Leite, and William J. O’Brien

The Predictability Index: A Novel Project Performance Metric to Assess the Early Prediction of Cost and Time Outcomes
<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Near-Miss Reporting Program to Enhance Construction Worker Safety Performance</td>
<td>2315</td>
</tr>
<tr>
<td>Eric Marks, Jochen Teizer, and Jimmie Hinze</td>
<td></td>
</tr>
<tr>
<td>An Analysis of Process versus Inspection Capabilities in Fabricated, Engineered-to-Order Construction Supply Chains</td>
<td>2325</td>
</tr>
<tr>
<td>Shamail Ahmad, Kenneth D. Walsh, Thaís da C. L. Alves, and Kim LaScola Needy</td>
<td></td>
</tr>
<tr>
<td>The 10-10 Performance Assessment Campaign: New Theories Regarding the Benchmarking of Capital Project Performance</td>
<td>2335</td>
</tr>
<tr>
<td>Youngcheol Kang, Jiukun Dai, Stephen Mulva, and Jiyong Choi</td>
<td></td>
</tr>
<tr>
<td>SAVES: An Augmented Virtuality Strategy for Training Construction Hazard Recognition</td>
<td>2345</td>
</tr>
<tr>
<td>Ao Chen, Mani Golparvar-Fard, and Brian Kleiner</td>
<td></td>
</tr>
</tbody>
</table>

**Urban Planning and Geographic Information Systems (GIS)**

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developing a Spatial Data Framework for Facility Management Supply Chains</td>
<td>2355</td>
</tr>
<tr>
<td>Ebrahim P. Karan and Javier Irizarry</td>
<td></td>
</tr>
<tr>
<td>A Framework for Assessing Environmental Implications of an Urban Area</td>
<td>2365</td>
</tr>
<tr>
<td>Seyed Mostafa Batouli and Yimin Zhu</td>
<td></td>
</tr>
<tr>
<td>Optimizing the Location of Out-Care Centers in Urban Space Using Agent-based Modeling</td>
<td>2375</td>
</tr>
<tr>
<td>Timo Hartmann and Vedran Zerjav</td>
<td></td>
</tr>
<tr>
<td>GIS-based Planning Support System for Waste Stream and Algal Cultivation in Residential Construction</td>
<td>2385</td>
</tr>
<tr>
<td>Perry Pei-Ju Yang, Steven Jige Quan, Daniel Castro-Lacouture, Charles Rudolph, and Ben Stuart</td>
<td></td>
</tr>
</tbody>
</table>