# TABLE OF CONTENTS

PREFA CE ............................................................................................................................... 1
Miroslaw J. Skibniewski, Miklós Hajdu

**HOW MANY TYPES OF CRITICAL ACTIVITIES EXIST? A CONJECTURE IN NEED OF PROOF** ................................................................. 3
M. Hajdu, M.J. Skibniewski, M. Vanhoucke, A. Horvath, I. Brilakis

COMPARING POINT-TO-POINT PRECEDENCE RELATIONS AND LOCATION-BASED MANAGEMENT SYSTEM IN LAST PLANNER SYSTEM: A HOUSING PROJECT OF HIGHLY REPETITIVE PROCESSES CASE STUDY .......................................................... 12
Xavier Brioso, Antonio Humero, Sarah Calampa

MULTI-OBJECTIVE CONSTRUCTION SITE LAYOUT PLANNING USING GENETIC ALGORITHMS ........................................................................... 20
Ioanna N. Papadaki, Athanasios P. Chassiakos

FACTORS AFFECTING LABOR PRODUCTIVITY: PERSPECTIVES OF CRAFT WORKERS ................................................................. 28
Aynur Kazaz, Serdar Ulubeyli, Turgut Acikara, Bayram Er

CONSTRUCTION MATERIALS-BASED METHODOLOGY FOR TIME-COST-QUALITY TRADE-OFF PROBLEMS ........................................................................................................ 35
Aynur Kazaz, Serdar Ulubeyli, Bayram Er, Turgut Acikara

DEFINING A MATHEMATICAL FUNCTION FOR LABOR PRODUCTIVITY IN MASONRY CONSTRUCTION: A CASE STUDY ........................................................................................................... 42
Laura Florez, Jean C. Cortissoz

COMPARING TIME AND QUANTITY SCALES FOR RELATIONSHIP AND FLOAT CALCULATIONS ........................................................................... 49
Adel Francis

PDM TIME ANALYSIS WITH CONTINUOUS AND POINT-TO-POINT RELATIONS: CALCULATIONS USING AN ARTIFICIAL EXAMPLE ............................................................. 57
Miklos Hajdu

REMOVING CONSTRAINTS TO MAKE TASKS READY IN WEEKLY WORK PLANNING ......................................................................................... 68
Farook Hamzeh, Emile Zankoul, Fatima El Sakka

THE POSSIBILITIES FOR BETTER PROJECT TRACKING BASED ON THE NEW DEVELOPMENTS OF THE PRECEDENCE DIAGRAMMING METHOD ................................................................................................. 75
S. Isaac, M. Hajdu

APPLYING POLITICAL APPORTIONMENT TO PRE-ALLOCATE FLOAT/BUFFER OWNERSHIP ......................................................................................... 82
Yi Su, Gunnar Lucko

LEARNING CURVE EFFECT ON PROJECT SCHEDULING ................................................................................................................................. 90
Levente Malyusz

MULTI-CRITERIA CASH FLOW ANALYSIS IN CONSTRUCTION PROJECTS ......................................................................................................................... 98
Augustin Purnus, Constanta-Nicoleta Bodea

FLOYD-WARSHALL IN SCHEDULING OPEN NETWORKS ................................................................................................................................. 106
Zoltán A. Vattai

A MEC HATRONIC SLIP COMPLEX CONTROL WHEN ERECTING MONOLITH OBJECTS ................................................................................................. 115
Alexey Bulgakov, Sergei Emelianov, Natalia Buzalo, Oleg Parshin

AIR CONDITIONING DUCTS INSPECTION AND CLEANING USING TELEROBOTICS ......................................................................................................................... 121
Alexey Bulgakov, Daher Sayfiedline

MAINTENANCE STRATEGY OF MULTI-EQUIPMENT NETWORK SYSTEMS BASED ON TOPOLOGY VULNERABILITY ANALYSIS ............................................................................................................. 127
Lieyun Ding, Qi Fang, Chengqian Li

A CLOUD-BASED MOBILE SYSTEM TO MANAGE LESSONS-LEARNED IN CONSTRUCTION PROJECTS ........................................................................ 135
Ximena Ferrada, Daniela Núñez, Andrés Neyem, Alfredo Serpell, Marcos Sepúlveda

BRIDGE MAINTENANCE AUTOMATION ................................................................................................................................. 143
Vladimir Kržetač

INFORMATION AND COMMUNICATIONS TECHNOLOGY IN CONSTRUCTION: A PROPOSAL FOR PRODUCTION CONTROL ................................................................................................................................. 150
Pablo Orihuela, Jorge Orihuela, Santiago Pacheco
APPLICATION OF ONTOLOGY IN EMERGENCY PLAN MANAGEMENT OF METRO OPERATION .......................................................... 158
Hanhin Luo, Xiaofan Peng, Botao Zhong

GETTING FIRED MATERIAL WITH VITREOUS BINDER USING FRAME TECHNOLOGY .................................................. 166
Vladimir Erofeev, Sergey Korotnov, Alexey Bulgakov, Ilia Tretiakov, Alexandre Rodin

EXPLORING A SIMPLE VISUALIZATION TOOL FOR IMPROVING CONCEPTUAL UNDERSTANDING OF CLASSICAL BEAM THEORY .......................................................... 172
Eivind Johnsen, Magnus Nilsen, Eilif Hjelseth, Christoph Merschbrock

CLASSIFICATION OF "I"-SHAPED GLASS COLUMNS .......................................................... 180
András Jakab, Kinga Nehme, Salem Georges Nehme

A SUITABILITY ANALYSIS OF PRECAST COMPONENTS FOR STANDARDIZED BRIDGE CONSTRUCTION IN THE UNITED KINGDOM .......................................................... 188
Min-Koo Kim, Scott McGovern, Michael Belsky, Campbell Middleton, Ioannis Brilakis

INVESTIGATION OF CONSTRUCTION STAKEHOLDERS' PERCEPTION ON THE EFFECTS & COST OF CONSTRUCTION DISPUTE IN SWAZILAND .................................................. 196
X.N. Mashwama, C. Aigbavboa, D. Thwala

A THEMATIC REVIEW OF MAIN RESEARCHES ON CONSTRUCTION EQUIPMENT OVER THE RECENT YEARS .......................................................... 206
Ilias Naskoudakis, Kleopatra Petroustiatou

USE OF RECYCLED PLASTIC WATER BOTTLES IN CONCRETE BLOCKS .......................................................... 214
Sina Safinia, Amani Akbalhani

RUTTING PREDICTION OF A REINFORCED COLD BITUMINOUS EMULSION MIXTURE USING FINITE ELEMENT MODELLING .......................................................... 222
Hayder Kamil Shanbar, Felicite Rudder, William Atherton

ATTITUDES OF OWNERS WHICH IMPEDES FIRM'S GROWTH: A CASE OF SMALL AND MEDIUM-SIZED CONSTRUCTION FIRMS IN GHANA .......................................................... 230
Bernard M. Arthur-Aidoo, Clinton O. Aigbavboa, Wellington D. Thwala

MANAGING CONCURRENT CONSTRUCTION PROJECTS USING KNOWLEDGE MANAGEMENT AND SET-BASED THINKING .......................................................... 235
Alemu Moges Belay, Olav Torp, Carl Thodesen

PROBABILISTIC APPROACH TO DETERMINING OVERHEAD-CUM-MARKUP RATE IN BID PRICE .......................................................... 243
Li-Chung Chao, Chiang-Pin Kuo

THREE ENTITIES TO MAXIMIZE CREATIVE CONSTRUCTION QUALITY .......................................................... 251
Nano Dosis Curiços, Miguel Baptista-Bastos

PRELIMINARY RESOURCE-BASED ESTIMATES COMBINING ARTIFICIAL INTELLIGENCE APPROACHES AND TRADITIONAL TECHNIQUES .......................................................... 261
Borja Garcia de Soto, Bryan T. Adey

IMPLEMENTATION OF SCRUM IN THE CONSTRUCTION INDUSTRY .......................................................... 269
Thomas Streule, Nino Miserini, Olim Bartlomé, Michael Klippel, Borja Garcia de Soto

APPLICABILITY OF THE EN 15221 STANDARD IN PUBLIC FACILITY MANAGEMENT .......................................................... 277
István Hajnal

REAL ESTATE VALUATION USING DATA MINING SOFTWARE .......................................................... 284
Eduard Hromada

A NETWORK-THEORY BASED MODEL FOR STAKEHOLDER ANALYSIS IN MAJOR CONSTRUCTION PROJECTS .......................................................... 292
Margaret K.Y. Mok, Geoffrey Qiping Shen

ENHANCING FACILITY MANAGEMENT THROUGH BIM 6D .......................................................... 299
Alekander K. Nical, Wojciech Wodylnski

A FRAMEWORK FOR AFFORDABLE HOUSING GOVERNANCE FOR THE NIGERIAN PROPERTY MARKET .......................................................... 307
AbdulLateef Olanrewaju, Paul Anavhe, Tey Kim Hai

MARKET ANALYSIS OF HOUSING SHORTAGES IN MALAYSIA .......................................................... 315
AbdulLateef Olanrewaju, Abdul Rashid Abdul Aziz, Seong Yeow Tan, Lee Lim Tat, Naoto Mine

SUCCESS FACTORS OF EXPORT FINANCING UNDER THE BUYER'S CREDIT SCHEME .......................................................... 323
Jan Picha, Aleš Tomek, Renáta Schneiderová Heralová

COMPARISON OF ANN AND MRA APPROACHES TO ESTIMATE BID MARK-UP SIZE IN PUBLIC CONSTRUCTION PROJECTS .......................................................... 331
Gul Polat, Befrin Neval Bingol, Asli Pelin Gurgun, Bulent Yel

URBAN RENEWAL PROJECT SELECTION USING THE INTEGRATION OF AHP AND PROMETHEE APPROACHES .......................................................... 339
Gul Polat, Atilla Damci, Asli Pelin Gurgun, Ilayda Demirli
<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMART HOME SUBCONTRACTOR SELECTION USING THE INTEGRATION OF AHP AND EVIDENTIAL REASONING APPROACHES</td>
<td>347</td>
</tr>
<tr>
<td>Gul Polat, Fatih Cetindere, Atilla Damci, Befrin Neval Bingol</td>
<td></td>
</tr>
<tr>
<td>EXAMINING HAPPINESS: TOWARDS BETTER UNDERSTANDING OF PERFORMANCE IMPROVEMENT</td>
<td>354</td>
</tr>
<tr>
<td>Djuen San Santoso, Hewagamage Eranga Ravihara Kulathunga</td>
<td></td>
</tr>
<tr>
<td>POSSIBILITY OF USING VALUE ENGINEERING IN HIGHWAY PROJECTS</td>
<td>362</td>
</tr>
<tr>
<td>Ahmed Senouci, Alaa Ismail, Neil Eldin</td>
<td></td>
</tr>
<tr>
<td>TIME DELAY AND COST OVERRUN IN QATARI PUBLIC CONSTRUCTION PROJECTS</td>
<td>368</td>
</tr>
<tr>
<td>Alfredo Serpell, José Ignacio Díaz</td>
<td></td>
</tr>
<tr>
<td>LINKING CENTRAL BUSINESS PROCESSES OF CONSTRUCTION COMPANIES WITH THE PERFORMANCE OF CONSTRUCTION OPERATIONS: A PRELIMINARY EXPLORATION</td>
<td>376</td>
</tr>
<tr>
<td>Renata Schneiderova Heralova</td>
<td></td>
</tr>
<tr>
<td>EXAMINATION OF JOB-SITE LAYOUT APPROACHES AND THEIR IMPACT ON CONSTRUCTION JOB-SITE PRODUCTIVITY</td>
<td>383</td>
</tr>
<tr>
<td>Edgar P. Small, Marwa Baqer</td>
<td></td>
</tr>
<tr>
<td>EVALUATING BARRIERS TO EFFECTIVE IMPLEMENTATION OF PROJECT MONITORING AND EVALUATION IN THE GHANAIAN CONSTRUCTION INDUSTRY</td>
<td>389</td>
</tr>
<tr>
<td>Tengan Callistus, Aigbavboa Clinton</td>
<td></td>
</tr>
<tr>
<td>IMPROVEMENT OF ECONOMIC EFFECTIVENESS OF ROAD HIGHWAY PROJECTS</td>
<td>395</td>
</tr>
<tr>
<td>Radan Tomek, Stanislav Vitések</td>
<td></td>
</tr>
<tr>
<td>DRIVERS FOR AND OBSTACLES TO ENTERPRISE RISK MANAGEMENT IN CONSTRUCTION FIRMS: A LITERATURE REVIEW</td>
<td>402</td>
</tr>
<tr>
<td>Berenger Y. Renault, Justus N. Agumba, O.A. Balogun</td>
<td></td>
</tr>
<tr>
<td>IDENTIFYING SUCCESS FACTORS OF HEALTHCARE FACILITY CONSTRUCTION PROJECTS IN IRAN</td>
<td>409</td>
</tr>
<tr>
<td>Reza Zandi Doulabi, Ehsan Asnaashari</td>
<td></td>
</tr>
<tr>
<td>MECHANICAL SAFETY AND SURVIVABILITY OF BUILDINGS AND BUILDING STRUCTURES UNDER DIFFERENT LOADING TYPES AND IMPACTS</td>
<td>416</td>
</tr>
<tr>
<td>Vladimir Travush, Sergey Emelianov, Vitaly Kolchunov, Alexey Bulgakov</td>
<td></td>
</tr>
<tr>
<td>AN ANALYSIS OF PROBLEMS WITH CURRENT INDICATORS FOR EVALUATING CARBON PERFORMANCE IN THE CONSTRUCTION INDUSTRY</td>
<td>425</td>
</tr>
<tr>
<td>P. Lee, M.C. Wang, E.H.W. Chan</td>
<td></td>
</tr>
<tr>
<td>PERFORMANCE OF LEED ENERGY CREDIT REQUIREMENTS IN EUROPEAN COUNTRIES</td>
<td>432</td>
</tr>
<tr>
<td>Asli Pelin Gurgun, Gul Polat, Atilla Damci, Hasan Giskberk Bayhan</td>
<td></td>
</tr>
<tr>
<td>SEVERITY PREDICTION MODELS OF FALLING RISK FOR WORKERS AT HEIGHT</td>
<td>439</td>
</tr>
<tr>
<td>Hainan Chen, Xiaowei Luo</td>
<td></td>
</tr>
<tr>
<td>ENERGY EFFICIENCY HOUSING IN SOUTH AUSTRALIA – A GAP ANALYSIS BETWEEN THE EXPECTED AND ACTUAL BENEFITS</td>
<td>446</td>
</tr>
<tr>
<td>John Smallwood, Fidelis Emuze</td>
<td></td>
</tr>
<tr>
<td>TOWARDS ZERO FATALITIES, INJURIES, AND DISEASE IN CONSTRUCTION</td>
<td>453</td>
</tr>
<tr>
<td>Responsible Research and Innovation in Construction</td>
<td>461</td>
</tr>
<tr>
<td>Žiga Turk</td>
<td></td>
</tr>
<tr>
<td>BIM AND SAFETY RULES BASED AUTOMATED IDENTIFICATION OF UNSAFE DESIGN FACTORS IN CONSTRUCTION</td>
<td>467</td>
</tr>
<tr>
<td>Guo Hongling, Yu Yantao, Zhang Weisheng, Li Yan</td>
<td></td>
</tr>
<tr>
<td>DETERMINANTS PREDICTING CREDIT ACCESSIBILITY WITHIN SMALL AND MEDIUM-SIZED ENTERPRISES IN THE SOUTH AFRICAN CONSTRUCTION INDUSTRY</td>
<td>473</td>
</tr>
<tr>
<td>Olanrewaju Abdul Balogun, Ansary Nazeem, Justus Ngala Agumba</td>
<td></td>
</tr>
<tr>
<td>EVALUATION OF MATURITY OF BIM TOOLS ACROSS DIFFERENT SOFTWARE PLATFORMS</td>
<td>481</td>
</tr>
<tr>
<td>Robert Bouška</td>
<td></td>
</tr>
<tr>
<td>A REVIEW OF BUILDING INFORMATION MODELLING FOR CONSTRUCTION IN DEVELOPING COUNTRIES</td>
<td>487</td>
</tr>
<tr>
<td>Nam Bui, Christoph Merschbrock, Bjørn Erik Munkvold</td>
<td></td>
</tr>
<tr>
<td>TEMPLATE CUSTOMIZATION FOR CONSTRUCTION SITE INFORMATION MODELS</td>
<td>495</td>
</tr>
<tr>
<td>Marco L. Trani, Manuele Cassano, Davide Todaro</td>
<td></td>
</tr>
<tr>
<td>INTEGRATING BIM AND WEB MAP SERVICE (WMS) FOR GREEN BUILDING CERTIFICATION</td>
<td>503</td>
</tr>
<tr>
<td>Po-Han Chen, Thanh-Chuong Nguyen</td>
<td></td>
</tr>
</tbody>
</table>
ANALYZING DESIGN WORKFLOW: AN AGENT-BASED MODELING APPROACH .................................................. 510
  Malak Al Hattab, Farook Hamzeh

CURRENT ISSUES OF BIM-BASED DESIGN CHANGE MANAGEMENT, ANALYSIS AND
VISUALIZATION ........................................................................................................................................... 518
  Michal Juszczyk, Andrzej Tomana, Maja Bartoszek

A BIM-BASED DYNAMIC MODEL FOR SITE MATERIAL SUPPLY .......................................................................... 526
  Qunzhou Yu, Kaiman Li, Hanbin Luo

APPROACHING INDUSTRIALIZATION OF BUILDINGS AND INTEGRATED
CONSTRUCTION USING BUILDING INFORMATION MODELING .............................................................. 534
  Reza Mohajeri Borjeghaleh, Javad Majrouhi Sardroud

A BIM-BASED CONSTRUCTION SUPPLY CHAIN FRAMEWORK FOR MONITORING
PROGRESS AND COORDINATION OF SITE ACTIVITIES ................................................................. 542
  Vito Getuli, Silvia Mastrolembo Ventura, Pietro Capone, Angelo L.C. Ciribini

THE INTEGRATION OF BIM IN LATER PROJECT LIFE CYCLE PHASES IN UNPREPARED
ENVIRONMENT FROM FM PERSPECTIVE .................................................................................................. 550
  Petr Matejka, Vít Kosina, Aleš Tomek, Radan Tomek, Vítem Berka, Dalibor Šalc

ACCEPTANCE OF CONSTRUCTION SCHEDULING VISUALIZATIONS: BAR-CHARTS,
FLOWLINE-CHARTS, OR PERHAPS BIM? .................................................................................................. 558
  Christian Nordahl Rolfsen, Christoph Merschbrock

THE EFFECTS OF BIM AND LEAN CONSTRUCTION ON DESIGN MANAGEMENT
PRACTICES .................................................................................................................................................. 567
  Matti Tauriainen, Pasi Marttinen, Bhargav Dave, Lauri Koskela

IMPACT-BASED DIAGNOSTIC APPROACH FOR MAINTENANCE MONITORING OF
HISTORIC BUILDINGS ................................................................................................................................. 575
  István Vidovszky

Author Index