

Abstracts for the

Proceedings of the 12th International Conference on Construction in the 21st Century (CITC 12)

May 16 – 19, 2022 | Amman, Jordan

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Foreword

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-12 conference is being organized by CITC and supported by Auburn University. CITC organizes international conferences to bring together like-minded construction management professionals. The CITC-12 conference seeks to bring together an international group of practitioners, researchers, and educators to promote a novel exchange of ideas in a multidisciplinary fashion.

CITC-12 is a peer-reviewed conference that acts as a dynamic collaboration for the exchange of knowledge. New methods and techniques must be scrutinized and rigorously tested before implementation, and CITC-12 plays an integral role in this process. As the industry moves forward in an ever-complex globaleconomy, multi-national collaboration is crucial. Future growth in the industry will undoubtedly rely on international teamwork and alliance.

This May marks the twelfth CITC conference. Previous conferences include CITC-I in Miami, USA of 2002, CITC-II in Hong Kong, China of 2003, CITC-III in Athens, Greece of 2005, CITC-IV in Gold Coast, Australia of 2007, CITC-V in Istanbul, Turkey of 2009, CITC-VI in Kuala Lumpur, Malaysia of 2011, CITC-VII in Bangkok, Thailand of 2013, CITC-8 in Thessaloniki, Greece of 2015, CITC-9 in Dubai, UAE of 2017, CITC-10 in Colombo, Sri Lanka of 2018, and CITC-11 in London, United Kingdom of 2019. All conferences were tremendously successful. As with previous conferences, this effort has been supported by our friends and colleagues across the globe. It is our pleasure to now present to you the Twelfth International Conference on Construction in the 21st Century (CITC-12, Amman). This three-day conference is being held in Amman, Jordan at the Inter-Continental Hotel. CITC-12 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,

Editors:

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CITC-12 Themes

- Leadership in Engineering & Construction
- Building Information Modeling
- Lean Construction Practices
- 3D Printing
- Augmented and/or Mixed Reality
- Legal Issues in Construction
- Value Engineering
- Project and Program Management
- Quality and Productivity Improvement
- Sustainable Design and Construction
- Concrete Technology
- Construction Contracts
- 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 Issue
- Materials and Technology Research
- Structural Design

CITC-12 International Scientific Review Committee

We would like to express our sincere gratitude to the members of the International Scientific Committee, who participated in the review process for the CITC-12:

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Keynote Speakers



Dr. Yiannis Xenidis

BIO: Dr. Yiannis Xenidis is an Associate Professor of Risk Management in the Life Cycle of Civil Engineering Projects at the Department of Civil Engineering in the Aristotle University of Thessaloniki (AUTH), Greece. He has also taught at the department of Spatial Planning and Development in AUTH during 2005 – 2008, and the school of Science and Technology in the Hellenic Open University during 2013 – 2020.

He is the vice chair of the Education Committee of the European Council for Computing in Construction (EC3), and a member of the Audit Committee of the European Association On Quality Control of Bridges and Structures (EuroStruct). He is also a member of the Task Group 1.08 - Design Requirements for Infrastructure Resilience of the International

Association for Bridge and Structural Engineering (IABSE), and a member of the Project Management Institute (PMI), the Society of Risk Analysis (SRA), and the International Association for Life-Cycle Civil Engineering (IALCCE). He has a professional experience as a constructor of public works and private projects and as a consultant of civil engineering projects.

He has authored several peer reviewed papers in scientific journals and conferences, and he has contributed, upon invitation, with book chapters to several publications. He has participated as member of the organizing and scientific committees and session chair at several scientific conferences. He is, also, a reviewer at several scientific journals and conferences and an evaluator of research proposals.

His current research interests are focused on the design, assessment, and monitoring of resilience of infrastructure systems, risk analysis and decision-making in civil engineering projects and infrastructure.

TITLE: Re-engineering Nature: A Comprehensive Paradigm for Physical Infrastructure Development

Keynote Speakers



Khalid Siddiqi, Ph.D.

BIO: Professor Dr. Khalid Siddiqi is Professor Emeritus of Construction Management at Kennesaw State University. Prior to his academic career spanning twenty-five years, Khalid served the Construction Industry in various capacities in organizations for fifteen plus years. His industry experience involved working with architects, developers, and contractors around the world in his employment with the World Bank, US Army Environmental Policy Institute, Public Housing Development, Master Planning, managing Building Permitting agencies, and working for Structural Engineering firms.

Advocacy of students and bold initiatives towards university advancement activities are the hallmarks of Khalid's career with the University System of Georgia. He initiated and sustained a variety of fund-raising efforts in support of department, college, and Kennesaw State University (KSU).

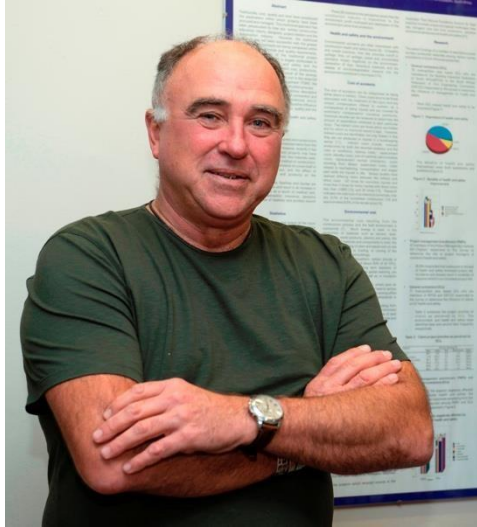
Construction Industry has established *Dr. Khalid Siddiqi Endowed Scholarship* at KSU to acknowledge his contributions to the industry. This endowed scholarship will help pursue Dr. Siddiqi's commitment to excellence in education and student success.

Khalid earned his Ph.D. in Civil & Environment Engineering from Georgia Institute of Technology. He was awarded a full scholarship by the Australian Government to pursue masters in Structural Engineering and Construction from Asian Institute of Technology, Bangkok Thailand. He completed bachelor's degree in Civil Engineering with Highest Honors (First in class) from NED University of Engineering and Technology Karachi, Pakistan.

During his academic and teaching career Khalid has received several distinguished teaching awards including Outstanding Faculty Award, Teacher of the Year Award, and Outstanding Educator Award from Associated Schools of Construction and was selected to participate in prestigious programs at the State level including Executive Leadership and Accelerated Leadership Programs of University System of Georgia. Khalid has served the construction community throughout his academic career. During the last twenty-three years he has judged projects for Build Georgia Awards (AGC), Excellence in Construction Awards (ABC), Project Achievement Awards (CMAA), and Georgia Concrete Industry Award Competitions (ACI). In addition, Khalid has collaborated with Bennett Thrasher, one of the country's largest full-service public accounting and consulting firms, to present Construction Outlook Survey findings to CEOs and CFOs of Georgia's Construction Organizations. The survey is conducted each year and findings are shared with the community to provide insight into how construction companies can remain relevant in an increasingly competitive environment.

TOPIC: Quality in a Construction Project – Who's Asking?

Keynote Speakers



Prof John Smallwood

BIO: Prof John Smallwood is the Professor of Construction Management in the Department of Construction Management, Nelson Mandela University, and the Principal, Construction Research Education and Training Enterprises (CREATE). Both his MSc and PhD (Construction Management) addressed construction health and safety (H&S). He has conducted extensive research and published in the areas of construction H&S, ergonomics, and occupational health (OH), but also in the areas of the environment, health and well-being, primary health promotion, quality management, and risk management.

TOPIC: Health, safety, and well-being is the current term used in many countries globally, which evolved from the initial safety, and then health and safety (H&S). This evolution is attributable to increased awareness, the development of knowledge and skills, and the development of construction materials, methods, plant and equipment, activities, and the overall process. A further aspect in terms of evolution is the transition from ‘injuries and fatalities are a part of construction’ to, among other, ‘zero harm’ and ‘one injury or fatality is one too many’. The evolution has continued to include ‘work life balance’, and a focus on ‘mental health’ due to compressed project schedules, overtime work, shift work, six- or seven-day working weeks, and suicides. Furthermore, due to the relationship between occupational health and primary health issues, H&S endeavors were accompanied by primary health promotion and interventions in many countries. This was underscored by the COVID-19 pandemic and the resultant workplace-related interventions.

Historically, safety and then H&S, was viewed as the contractor’s problem. However, landmark construction H&S legislation promulgated in the European Union in 1992, expanded the responsibility for H&S to include clients and designers. This legislation in turn engendered interrogation of the role, influence, and impact of clients, designers, and other project stakeholders on H&S, which in turn resulted in major related research globally.

The evolution inevitably resulted in the recognition of H&S as a ‘project parameter’ and a paradigm shift from the passe paradigm of cost, quality, and time. However, the advent of Industry 4.0 technologies has resulted in the realization that the persistent H&S-related problems can be resolved, and that the physical and harsh nature of many construction activities and the overall process can be mitigated.

TOPIC: Health, Safety, and Well-being in Construction

Workshops



TITLE: Historic Building Information Modeling – Use Advanced Design and Construction Technologies to Record and Conserve Heritage

INSTRUCTOR 1: Prof. Junshan Liu, *Associate Professor in the McWhorter School of Building Science at Auburn University*

BIO: Prof. Junshan Liu is an Associate Professor in the McWhorter School of Building Science at Auburn University. Prof. Liu has extensive experience of LiDAR scanning, scan-data processing and extrapolations, photogrammetry, HBIM, 3D modeling, and UAS. He has had numerous publications on HBIM, BIM, LiDAR and also led multiple digital documentation and heritage preservation projects.

Description:

As one of the fastest-developing research and practice fields, Historic Building Information Modeling (or Heritage Building Information Modeling, HBIM) is a multi-disciplinary process that requires the contribution and collaboration of scholars and professionals with very different skillsets. Unlike BIM workflows for new constructions, the tried and tested tools and methods must be adapted, and even reinvented, for HBIM applications. The digital revolution and opportunities to leverage modern technologies, such as light detection and ranging (LiDAR), photogrammetry, 360-degree photography, virtual reality (VR), artificial intelligence (AI), and unmanned aircraft systems (UAS), provide innovative means to document, interpret, preserve, and even restore heritage structures. The very same technologies and workflows associated with HBIM can also be applied to develop digital twins for elements of new construction.

In this workshop, participants will learn the concept of HBIM, its applications, and a feasible workflow with data management strategies. They will explore a few case studies for using HBIM to digitally document, restore, and interpret significant historic structures associated with the American Civil Rights Movement, assisted by LiDAR, 360-degree photography, photogrammetry, UAS, VR, and AI. The participants will also get the opportunity to interact with some of the cutting-edge equipment used for collecting data for HBIM.

Tentative Agenda (90 minutes):

- | | |
|-------------------------------------|------------|
| • Opening Section | 5 minutes |
| • Introduction to HBIM | 20 minutes |
| • Case Study: project-1 | 15 minutes |
| • Case Study project-2 | 15 minutes |
| • Experiment with 360-degree camera | 20 minutes |
| • Questions and Answers | 15 minutes |

Workshops

TITLE: Purdue University's New Paradigm for Construction Management Education: Lessons Learned

INSTRUCTOR: Z. (Željko) Torbica, Ph.D., F.ASQ



BIO: **Z. (Željko) Torbica** is Professor and Head of the School of Construction Management Technology at Purdue University. Dr. Torbica's international experience of over 35 years includes both academic positions at several leading U.S. universities and an extensive and industry-recognized background in construction, engineering, real estate development, leadership and strategic planning. During the course of his career, Dr. Torbica has received a number of distinguished awards; served as the conference keynote speaker at international conferences; published articles in the most selective professional journals; directed real estate development operations, with projects ranging from \$50- to \$550 million; served on prestigious Baldrige National Quality Award Board of Examiners; and completed leadership programs at Harvard University and Columbia University. Dr. Torbica received a Ph.D. degree from the University of Florida (Construction Management). Dr. Torbica is a Fellow of American Society for Quality, Certified General Contractor in the state of Florida, and holds Project Management Professional (PMP) and Quality Engineer (QE) certifications.

DESCRIPTION:

During the Fall 2015 School's retreat meeting the faculty were asked "*If you could start over from scratch, what would you do?*" The School took the challenge and set a goal to transform curriculum into an innovative learning environment that creates a "*seamless transition from college to industry*". The main idea behind curriculum transformation was horizontal and vertical integration of student learning outcomes in an authentic, project-based, team-taught environment. The horizontal integration refers to the integration of multiple subjects in a single course organized around the project life cycle ("pre-construction" and "construction") and vertical integration focuses on distributing the subject-oriented course material throughout the entire four-year curriculum.

The new curriculum was launched in the Fall 2017 semester. This undertaking is one of the most complex and unique transformation initiatives in a long history of Purdue University- we are not aware of any other academic program that has attempted to implement the integration of this magnitude encompassing the entire four-year curriculum. Since there is no roadmap to follow, the SCMT faculty have had to demonstrate a great deal of creativity and ingenuity in implementing this transformation.

The vertically and horizontally integrated construction courses provide students more opportunities to synthesize material earlier in their college career rather than waiting for a senior capstone and allows the students to potentially retain more of their education by scaffolding construction content throughout the four-year program rather than condense all information into a single 3-credit-hour course. As an example, the subject area of "estimating", which, in the "old" curriculum, was covered in a "stand-alone" 3-CH Estimating course in the junior year, is now included in (at least) 5 courses and is taught throughout the entire four-year curriculum, in the first year in CM 100, in second year in CM 200, in third year in CM 300, and in fourth year in CM 400 and CM 450.

ESTIMATING	CM 100	CM 200	CM 300	CM 400	CM 450
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Figure 1: Courses in which “estimating” is taught/ covered

Similarly, every course in the new curriculum is covering a number of subject areas, instead of being focused on a single subject area. As an example, CM 200, a 9-credit-hour course, is covering material from (at least) 15 different subject areas (see figure below), and is taught by a team of 10+ instructors.

	ESTIMATING	PLAN READING	ACCOUNTING	CAREER PREPARADNESS	COMMUNICATIONS
	SCHEDULING	SUSTAINABILITY	HISTORY	PROJECT MANAGEMENT	DESIGN MANAGEMENT
	STRENGTH OF MATERIAL/ SOILS/ STRUCTURES	SAFETY	MEP	COMPANY MANAGEMENT	OTHER

Figure 2: Subject areas that are covered in CM 200

The inaugural cohort that followed the new curriculum graduated in Fall 2020, one semester ahead of schedule. It will take at least 3-5 more years before we will be able to assess the success of this new educational model, but we are optimistic that the students indeed are acquiring the skills and capabilities that will enable them to quickly develop in top-notch professionals.

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(Paper, ID 1)

The Difference Between IRR and NPV in Capital Investment Appraisals

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Abstract

In the fields of architecture, engineering and construction, a clear concept of the appraisal methods of capital investment alternatives is very important. The NPV ranking of mutually exclusive alternatives is a correct approach if the MARR (minimum attractive rate of return) is based. The IRR ranking is an incorrect approach. If the IRR method is ever used to rank alternatives, the Incremental IRR Analysis must be used, and its result will be the same as the NPV ranking. In using the Incremental IRR Analysis, one may face the problem of multiple IRRs, but this is not really a hindrance to the Incremental IRR Analysis. The multiple IRR problem alleged in some articles is probably due to a misunderstanding of the multiple IRR theory. The author attempts to explain it in this article. The conclusion states that all other methods such as Modified IRR, Marginal Growth Rate, Incremental IRR Analysis, etc., are supplementary to the NPV method. The NPV is an economic indicator and always correct in evaluating the economic value of an investment and in ranking mutually exclusive alternatives based on the MARR. The IRR is a financial indicator and incorrect to be used for ranking mutually exclusive alternatives, but is to be used for finding the best financial strategy to achieve optimal gain for a single investment alternative.

Keywords

Engineering management; Engineering economics; Internal rate of return; Net present value; IRR; NPV

(Paper, ID 2)

A Review of Facilities Management Guidelines for the Living Environment of the Elderly

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Abstract

The population of elderly people is significantly increasing across different parts of the world. In fact, it is estimated that the number of elderly people in the world will exceed the

number of children in 2022. Due to the increasing number of cases of decline in the health of the elderly, there will be increased demand for special additional facilities to enable them to maintain their independence in the living environment. To understand the needs of the elderly, there is the need to identify the basic and special facilities required by the elderly in their living environment. Therefore, this study seeks to identify the facilities management (FM) needs of the elderly and the corresponding guidelines for different countries across the world. A comprehensive literature search was conducted to identify the FM guidelines for residential apartments of the elderly in different countries of the world. The FM guidelines were assessed to understand the basic and special needs for the comfort of the elderly in their living environment, while content analysis of the guidelines was conducted and presented under three different categories identified in literature namely space management, building services and supporting facilities. The study reveals that many of the suggested FM components in the guidelines were general needs of disabled individuals without adequate consideration of the specific health needs of the elderly. The study recommends that a comprehensive anthropometric measurement of different elderly groups is conducted in order to provide detailed FM guidelines for meeting both the basic and special needs of the elderly in the living environment.

Keywords

Elderly; Facilities Management; Living Environment; Sustainability

(Paper, ID 3)

Comparative Analysis of Critical Success Factors for Smart and Sustainable Developments Between Organizations and Among Construction Professionals

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Abstract

The development of smart and sustainable infrastructure projects requires great teamwork and a common understanding of the success requirements. There seems to be no general agreement among organizations and construction professionals about critical success factors (CSFs) for smart and sustainable development. This study thus compares CSFs for achieving smart and sustainable developments between organizations and among construction professionals. A questionnaire survey, including 40 CSFs was designed and distributed among various construction professionals working in different

organizations and involved in smart construction activities in Abuja, Nigeria. The responses were analysed using the mean score for identifying the level of agreement of the different construction professionals with different CSFs; and one-way analysis of variance for exploring the significant difference among the perception of the construction professionals. The result of the mean score indicates that the different organizational types and construction professionals rated all the CSFs high indicating that there is an agreement with the factors as critical to the success of smart and sustainable developments. The independent samples t-test shows the significant difference with cooperation and participation of stakeholders as well as energy efficiency; while the one-way analysis of variance reveals significant difference with clearly defined goals, cooperation and participation of stakeholders, project procurement system, energy efficiency, waste management and land use change. The study suggests the involvement of organizations and professionals at every stage of the development starting from the design brief to commissioning and maintenance of the project.

Keywords

Construction, Critical Success Factors, Smart Buildings, Sustainability, Nigeria

(Paper, ID 4)

Career Choice and it's Influencing Factors: Perception of Female Construction Students

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Abstract

This study explores the career preferences of female undergraduate students in construction programs and examines the factors that predict their choices to undertake a career in construction. Data was collected using close-ended questionnaire in a survey of 229 conveniently sampled university students enrolled in construction-related programs in South Africa. Results from the questionnaire survey revealed that outcome expectations, perceived barriers, goal representations, social supports and gender stereotypes had the most influence on the career choice of women in the construction industry. Although an extensive review of existing literature on the topic was conducted, the scope of the study is limited to the perceptions of women enrolled in construction-related undergraduate programmes in two universities in the Kwa-Zulu Natal province of South Africa.

Keywords

Career Choice, Construction, Gender, SCCT, Women

(Paper, ID 5)

Making the 'Available Desirable' Using Adaptive Reuse (AR) In Sustainable Construction: A Systematic Review and Directions from Case Studies

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Abstract

The future of construction will take a different look from the past considering that the conventional system of "take, make, and dispose of" appears more and more insecure in a resource-constrained future calling for more sustainable construction. Alternatively, the system becomes more attractive, in contrast to demolition and new construction projects given that the real estate resources are kept in use and their value retained resulting in increased efficiency. To guarantee resources for future generations, adaptive reuse and thus the reduction of waste, recycling, and efficient use of spaces is essential to ensure the prolonged life of developments. The study examined the role of adaptive reuse to identify critical indicators for sustainable development through adaptive reuse. A systematic review from the Scopus bibliographical database was used to identify the indicators of sustainable development. Subsequently, multi-case studies were used to explore the application of adaptive reuse in line with the sustainable development indicators. The progress made towards adaptive reuse as a tool for sustainable development in construction. Findings revealed that adaptive reuse can be applied to achieve economic, environmental, social, and cultural pillars of sustainable development. The paper recommends that practical actions and tools seem to be the optimal way of making sustainable construction more concrete and understandable for the construction sector, therefore it is of significance to look in the directions of the modeled cities and implements the lessons learned to promote sustainable development.

Keywords

Construction, Adaptive reuse, Systematic review, Sustainability, Sustainable development

(Paper, ID 6)

Success Factors for Effectively Implementing Lean Practices in the Construction Industry: A Case of North West Province, South Africa

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Abstract

The construction industry is and continues to struggle with productivity, in terms of waste generated, environmental issues and lack of improvement during the construction process, mainly because of limited employee autonomy, longer construction cycles as well as reoccurring time and cost overruns. The purpose of the study was to assess and rank important success factors for effectively implementing lean practices in the construction industry to respond to the challenges encountered. A survey design was adopted in the form of a closed-ended questionnaire. Seventy-two questionnaires were analysed using descriptive analysis. A Cronbach alpha value of 0.93. The results indicated that compatibility and suitability of lean techniques in relation to the existing conventional techniques/processes, commitment to lean culture and availability of resources were the top three important success factors for effectively implementing practices in the construction industry in the North West Province, South Africa. From the results appropriateness and suitability of integrating new and innovative (lean) methods with conventional construction processes supersedes any other factor, along with commitment to lean culture. Therefore, increased emphasis and focus must be placed at the design stage to determine compatibility and suitability. The small sample size of this research limited the study from making generalisable and definite conclusion on important success factors for effectively implementing lean practices in the construction industry, however the findings of the study can form the basis of future studies whose aim is to establish the level of effectiveness of the identified factors in the implementation of lean practices.

Keywords

Construction Industry, Sustainability, Lean Practices, Waste Minimisation, Employee Autonomy

(Paper, ID 7)

Learning from Construction Accidents: Input, Process and Context

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Abstract

Learning from past accidents has long been an important way to prevent similar accidents from happening again. However, given that accidents continue to plague the construction industry, learning is far from being an effective practice. Previous research indicated that failure to learn from safety incidents could result in repeat of similar incidents. To prevent the recurrence of similar construction accidents in the future, there is a pressing need of enhancing the incident learning system within the organisations. The aim of this study is to offer a research framework that examines the relationship between the three key components of the organization's learning system, namely, learning input, learning process and learning context. In the proposed research framework, the study will develop the instruments to measure the organization's learning process, resilient safety culture (learning context) and incident information flow (learning input) through a comprehensive literature review. A large-scale questionnaire survey will be administered among management staff and frontline workers to examine the relationship between learning process, resilient safety culture, and information flow. Several analytical tools, i.e. principal component analysis (PCA) and Bayesian network (BN) modeling, will be adopted to analyze the aforementioned relationships. The results will not only strengthen the current knowledge in safety but also enhance the learning system of organizations and individuals to avoid the recurrence of similar accidents in the future.

Keywords

Construction project organizations, Learning from accidents, Recurrence, Resilient safety culture, Incident information flow

(Paper, ID 8)

A Theoretical Assessment of Causes for Deferred Maintenance of Public Buildings in developing countries-The Kingdom of Eswatini

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Abstract

The study examines previous literature on causes of deferred maintenance in public buildings. Deferred maintenance

refers to routine maintenance, and structural part replacements required to prolong the facility life to meet its expected life expectancy but delayed past the scheduled service period. Maintenance technology is concerned with all factors influencing and triggering requirements for maintenance work. The event in a building's fabric can lead from numerous unrelated design decisions, inappropriate materials, inaccurate load evaluation, insufficient usage evaluation and insufficient exposure assessment. Previous researchers have identified problems and issues influencing the execution of feasible maintenance of buildings. These challenges have become a prevalent issue encountered in building maintenance by the building manager. The study is conducted with reference to existing theoretical literature, published and unpublished research. The study is mainly a literature review on the causes of public buildings maintenance to be deferred. Previous research findings will be applied to the situation in Eswatini. Budget restrictions make it difficult to organize building maintenance tasks and lack of maintenance software tools has a negative impact on maintenance. The objective of the study is to identify the causes from literature review for deferred maintenance in public buildings. This study will assist the public facility management and the government at large to avoid the challenges affecting maintenance of public infrastructure.

Keywords

Theoretical Assessment, Causes, Deferred Maintenance, Public Buildings, Developing Countries

(Paper, ID 10)

Experimental Analysis of Aggregate Densities and Deflections for Compaction Quality Control with Light Weight Deflectometer

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Abstract

Nuclear gauge has been widely used to determine the in-place dry densities of pavement layers in compaction quality control. However, there is a trend for transportation agencies to use light weight deflectometer (LWD) to measure compaction sufficiency of pavement construction. LWD measurement can provide the in-situ modulus of geomaterials that is one of the key parameters used to characterize the properties of pavement structural layers. Since the measurements of nuclear gauge (density) and LWD (deflection) are different, it is necessary to analyze their relationships with compaction properties, such as

moisture content, layer thickness, and construction condition. This study performed intensive laboratory experiments on the aggregate materials to evaluate the effects. Extensive experiments were also performed in the test pits with LWD to determine the effect of aggregate layers on pavement structure. Proctor tests were conducted on selected pavement base materials to establish the moisture-density relationships. Material deflections were also measured on the compacted materials in the Proctor molds to reveal the moisture-deflection relationships. Through the test pits experiments, the contribution of each aggregate layer to the pavement structure capacity was analyzed and quantified. It was concluded that moisture content has a significant effect on LWD deflection or modulus. Aggregates compacted near the optimum moisture are capable of providing a stable deflection value. After compaction, LWD measured deflection decreases as the moisture content decreases.

Keywords

LWD, Compaction, Moisture Content, Dry Density, Deflection

(Paper, ID 11)

Critical Success Factors for Human Resource Management Practices in the Nigerian Construction Industry: A Delphi Approach

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Abstract

Different practices influence the construction industry. One of such is the human resource management practices (HRMPs) that enhance the performance and productivity of the human resource (HR). The choice of HRMPs is influenced by varied factors which are unknown in the Nigerian construction industry. Based on this contextual setting, the study assessed the critical success factors by establishing the influence of the different critical success factors (CSF) on HRMPs and determined the impact of each of the factors in the Nigerian construction industry. The study adopted the Delphi survey method of data collection that involves a structured questionnaire to solicit views of fifteen (15) experts, including professionals in the built environment, academics, and human resource/ personnel managers. The evaluation of the success factors was done by identifying the influence of each CSF on HRMPs; these factors were measured from no impact to very high impact. Mean, median, and standard deviation was utilized to analyze the data. The study findings indicate that out of all the nineteen (19) critical success factors evaluated, priorities

of top management and the required working capital were ranked 1st among the CSF for HRMPs in the Nigerian construction industry. The Delphi study approach recommended that firms should prioritize management priorities and working capital availability since they are influential factors and have a very high impact in determining the choice of HRMPs in the construction industry. The study contributes to the body of knowledge on CSF for HRMPs in a developing country, especially the Nigerian construction industry.

Keywords

Construction Industry, Human Resource Management Practices, Critical Success Factors, Top Management Priorities, Working Capital.

(Paper, ID 12)

An Evaluation on the Implement of Artificial Intelligence Technology on South African Construction Projects

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Abstract

Artificial Intelligence(AI) technology has the power to unlock the industry's greatest challenges faced such as poor efficiency issues, design errors, low productivity, and accidents on site. Therefore, the study is a literature review on the assessment of the implementation of AI technology on construction projects in South Africa. The study was carried out with reference to existing theoretical literature, published research, and internet sources. The study has adopted a quantitative research approach. The study has revealed the positive impact of implementing AI technology on construction projects and how it can transform the construction sector. This includes timeous delivery of the construction project(s), enhanced profitability, increased productivity, enhanced efficiency, and reduction of construction accidents. However, the adoption of AI technology in South Africa is still at an early development stage. The study would contribute to the existing body of knowledge of AI technology, particularly to developing countries where literature is lacking. Again, it will assist and enlighten the construction inclusive of consultant company owners to advance their firms and construction projects.

Keywords

Automation, Artificial Intelligence Technology, Fourth Industrial Revolution, Construction Sector, Robotics.

(Paper, ID 13)

Challenges of Public-Private Partnerships in Low-Income Housing Provision in Nigeria

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Abstract

Low-income housing provisions through a public-private partnership with a quality facility, good services, and access to social amenities, among others, encountered different challenges through its process. This study considered the major challenges of Public-Private Partnerships (PPPs) in low-income housing provisions in Nigeria. A field survey was carried out among professionals involved in the provisions of low-income housing within Lagos state Nigeria to determine major challenges they encounter in the delivery of PPPs housing for low-income earners. A systematic random sampling method was used, and 84 questionnaires were retrieved from professionals that participated in the PPPs housing delivery system for low-income housing. The result shows that inadequate project funding, high cost of building material, faulty design, access to land, and problems of land grabbers were some of the challenges encountered by PPPs in low-income housing provision. The study, therefore, suggested that funding, existing land laws, and users' financial capacity need to be considered in the planning stage of PPPs low-income housing to avoid challenges that could create neglect of the project.

Keywords

Nigeria, Public-Public Partnership, Security of Tenure

(Paper, ID 14)

Assessment of Maintenance Needs in Public Educational Institutions Residential Facility

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Abstract

Residential facilities of Public Educational Institutions (PEIs) encompass the immediate environment of the PEI, such as housing, recreational facility, sanitation, and others that provide shelter and make life worthwhile for its users.

This study assessed the maintenance needs of residents of the PEI residential facilities. To collect data on their maintenance needs, structured questionnaires were distributed to ninety-eight (98) respondents within the PEI residential facilities in the study area through systematic random sampling techniques. Information gathered from secondary and primary data was used to analyse residents' maintenance needs of the PEI residential facilities assessed. The result showed that the major maintenance need of the residents of the PEI residential facilities is on services, especially toilet and water distributions facilities. It indicates further that most materials used to maintain toilet amenities and water distribution channels were substandard. There is a slow response to repairs on maintenance needs as requested by the residents on damaged components of the facility. The study suggested that in meeting the maintenance needs of residents of the PEI facilities, the maintenance unit should have a quality assurance unit that will certify materials required for maintenance activities before usage within the PEI residential facility.

Keywords

Building Services, Maintenance Need, Public Educational Institutions, Quality Standard, Quality Assurance.

(Paper, ID 15)

Unravelling the Encumbrances to Better Information Management Among Quantity Surveyors in the 4IR: A Qualitative Study

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Abstract

In the last decade, Building information modelling has become a topical issue of discussion in the construction industry. Its adoption has been researched from different perspectives. This is aimed at achieving a more productive and technologically driven construction industry. However, a dearth exists in the adoption among professionals in the construction industry. This paper investigates BIM adoption as a tool for an enhanced information management process in the fourth industrial revolution(4IR) among quantity surveyors in developing countries. The study adopted a qualitative research approach through interviews to achieve the study objectives. Using Nigeria as a case study, the study

identified the peculiar encumbrances to BIM adoption among quantity surveyors in developing countries. Furthermore, the drivers and solutions to the identified challenges were identified. The data collected was analysed and discussed. The result was thematically discussed under two major categories – private stakeholders and the government. The study provides a deeper and robust knowledge of the peculiar dynamics among Quantity surveyors regarding BIM adoption in developing countries. The implementation of the study findings will enhance the quantity surveyor's value management function and be 4IR aligned.

Keywords

BIM adoption dynamics, Building Information modelling, developing countries, global south, information management, qualitative research, 4IR

(Paper, ID 16)

Preliminary Assessments of Washrooms Conditions in Malaysia Hospital Buildings

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Abstract

Healthcare building conditions require efficient services delivery to afford the users and others stakeholders in the hospital buildings for a serene and safe environment that accelerates wellbeing. The objective of this study is to evaluate the washrooms conditions of hospital buildings, to achieve this goal, hospital buildings must adopt good approaches and services that will enhanced washrooms conditions in the hospital buildings. Apart from ensuring the safety of the environment, users of the buildings must be satisfied with the quality of available services, particularly, those offered to patients. Survey questionnaires were administered to users of hospital buildings in Malaysia. The most significant washrooms conditions reported concerned are hand driers, water closet, water taps, doors lock, plumbing (pipes) signage, wash basins, floors condition, floors (floor tiles / floor finishes), walls (finishes / painting), columns (finishes / painting), ventilators, doors, lighting bulbs, workable alarm bells and lamps ceilings. The washrooms conditions were slightly affected by defects that depreciate the appearance, functionality and utility of hospital buildings thereby lessening their performance and efficiency. Malaysia washrooms conditions are slightly good but require improvement. Therefore, this study asserts the pertinence evaluating of the washrooms conditions approaches employed towards the rectification of the washrooms conditions in hospital buildings across Malaysia. The study posits the adoption of systemic proactive maintenance procedures to preempt decay, causalities (falls of the users as a results of wetness and slippery floors), and

reduce cost implications of washrooms conditions. According to the washroom condition assessment, defects, tidiness and cleanliness of washroom areas as well as the quality of the service delivery are the main factors predicting maintenance service delivery efficiency. User attitudes, misuse, abuse, bad maintenance tactics, and weather are all important factors in determining the maintenance management practices of hospital buildings for washrooms conditions. Maintaining good washroom conditions is essential to ensuring service quality, meeting the expectation of users, and reducing the number of avoidable faulty washroom components.

Keywords

Construction Strategies, Poor Materials, Proactive Maintenance, Structural defects, Performance.

(Paper, ID 18)

Production Planners' Scope of Action in the Context of Digital Twin Construction

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Abstract

Production planning in construction requires numerous agents, or production planners, to make operational decisions that affect the project outcomes. Decisions are based on information collected on the job site and in the project supply chain. However, difficulties accessing real-time information, the numerous production planners involved, and limitations on the planners' degree of freedom of action can hinder decision-making. Digital Twin Construction (DTC) has emerged as a paradigm for systems that increase the situational awareness of the construction project among production planners and reduce uncertainty in the decision-making process. Under the DTC frame, this research seeks to determine the scope of action of production planners. To accomplish the research goal, semi-structured interviews and a literature review were carried out to identify production planners' degree of freedom in decision-making when faced with the need for product or process changes. First, the research identifies the operational decisions that production planners make during a construction project in response to developments (as-built, as-performed information). Second, it presents a detailed analysis of production planners' main limitations during decision-making. Finally, the freedom of action of production planners was defined according to their roles. The findings are summarized in a matrix that associates operational decisions, degree of freedom, and professional roles in the context of DTC. The study results showed that production planners' scope of action is limited by the lack of real-time information concerning the construction project status and

technical and legal limitations that affect their decision-making process.

Keywords

Digital Twin Construction (DTC), Production Planning, Production Planners, Scope of action, Building construction.

(Paper, ID 19)

An Experimental Investigation on Strength Characteristics of Concrete Using Wastepaper Sludge Ash (WPSA)

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Abstract

This study explores an experimental investigation in finding the strength characteristics of the concrete made with the addition of (WPSA) as a cementitious material. The WPSA has some sort of pozzolanic properties and is high in silica, magnesium and low in calcium. Due to silica and magnesium content, it behaves like cement, and they also increase its setting time. The properties of concrete investigated where compressive strength, flexural strength, split tensile strength, slump test and water absorption test while WPSA was added in different percentages from 0 % to 40 %. The maximum coarse aggregate size used is 20mm. The M30 grade of concrete is designed using British Standard of mix design. The cubes of 150x150x150 mm were casted for the compressive strength test, cylinders of 150x300 mm were casted for split tensile strength test and beams of 100x100x500 mm were casted for the flexural strength test. All the specimens were placed in the water and then tested in the 7, 14 and 28 days. The WPSA concrete has some better mechanical and durability properties as compared to normal concrete. The compressive strength of the concrete was increased by adding 30 % of WPSA. The results further indicates that the split tensile strength and flexural strength of the same samples don't increase. Overall, the addition of WPSA to a minimum of 30 % as a replacement of cement is helpful in increasing the strength value which is helpful in reducing the CO2 emission from the construction industry.

Keywords

Cement, Concrete, WPSA, Compressive strength, Construction Industry.

(Paper, ID 20)

Effects of Employee Turnover on Employee Performance in the South African Construction Industry-A Review

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Abstract

This study examines current literature on construction employee performance to identify the effects of employee turnover on employee performance. An employee's quality and characteristics are important attributes for success, for an organisation can't attain its goals and objectives without employees. The study is mainly a narrative review of the effects of employee turnover. The primary findings emanating from the study reveals that an organisation acquires cost when replacing employees who have left the organisation by training new employees. However, training must be carried out when there is a new employee to ensure that the new employee has the knowledge and expertise needed to perform work effectively. The study also identified loss of output, decreased business profitability, increased training cost of recruiting new employees, and deterioration in service quality as the effect of employee turnover on organisation performance and employee performance. The study pinpoints the effects of employee turnover on employee performance for policymakers to use the method for its minimisation.

Keywords

employee, employee performance, performance, effects of employee performance, employee turnover.

(Paper, ID 22)

COVID-19 Vaccine Mandates in the Construction Industry

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Abstract

In early 2020, Covid-19 became a global pandemic, the effects of which are ongoing. Economic impacts continue to be widespread, with an estimated economic loss of \$8.5 trillion (United Nations, 2020). The construction industry has been impacted by Covid-19 in various ways. Using

traditional legal research methodologies of searching primary and secondary legal resources, this paper explores the recent and developing policies related to Covid-19 vaccine mandates in the United States and their applicability in the construction industry. The Executive Order on Ensuring Adequate COVID Safety Protocols for Federal Contractors and the Occupational Safety and Health Administration's Emergency Temporary Standard applicable to employers with 100 or more employees will be analyzed and discussed. Relevant caselaw related to vaccine mandates and exemptions will also be analyzed and discussed. Legal challenges to these mandates are ongoing. Nevertheless, in deciding whether to require vaccines companies will need to weigh factors such as the type of projects the company undertakes, how best to protect their employees, and how to maintain their ability to obtain and deliver projects in the face of uncertainty about the future of Covid-19.

Keywords

Covid-19, Mandate, Vaccine

(Paper, ID 23)

BIM Material Passport to Support Building Deconstruction and a Circular Economy

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Abstract

Advanced computational tools like building information modeling (BIM) have great potential for facilitating environmental life cycle evaluation of buildings, including their construction, to support circular material flows from new and end-of-life (EOL) buildings. Here we introduce a method and case study that combine BIM and material flow analysis (MFA) to define a material passport for a LEED-rated commercial building in Israel. The building was designed using "BIM in the big room", a product development technique in which designers of different sub-systems are brought together to promote communication, collaboration and short-cycle problem solving. Material passports use BIM to classify and quantify building objects by their material constituents to assess their potential for recycling at the building's demolition stage. The material passport can be combined with life cycle inventory data to evaluate the environmental impacts of the embodied material in the building and guide best practices for deconstruction. The BIM analysis shows a high mass of concrete (110,000 ton) and glass curtain walls (27,000 m²). The concrete can be recovered from the structural frame if dismantled. The glass curtain walls may also be recovered for reuse in other projects or recycled into new glass products.

Keywords

Building information modeling (BIM), Material passport, Life cycle assessment (LCA), construction and demolition waste (CDW), greenhouse gas (GHG).

(Paper, ID 24)

Experimental Analysis of Aggregate Densities and Deflections for Compaction Quality Control with Light Weight Deflectometer

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Abstract

Nuclear gauge has been widely used to determine the in-place dry densities of pavement layers in compaction quality control. However, there is a trend for transportation agencies to use light weight deflectometer (LWD) to measure compaction sufficiency of pavement construction. LWD measurement can provide the in-situ modulus of geomaterials that is one of the key parameters used to characterize the properties of pavement structural layers. Since the measurements of nuclear gauge (density) and LWD (deflection) are different, it is necessary to analyze their relationships with compaction properties, such as moisture content, layer thickness, and construction condition. This study performed intensive laboratory experiments on the aggregate materials to evaluate the effects. Extensive experiments were also performed in the test pits with LWD to determine the effect of aggregate layers on pavement structure. Proctor tests were conducted on selected pavement base materials to establish the moisture-density relationships. Material deflections were also measured on the compacted materials in the Proctor molds to reveal the moisture-deflection relationships. Through the test pits experiments, the contribution of each aggregate layer to the pavement structure capacity was analyzed and quantitated. It was concluded that moisture content has a significant effect on LWD deflection or modulus. Aggregates compacted near the optimum moisture are capable of providing a stable deflection value. After compaction, LWD measured deflection decreases as the moisture content decreases.

Keywords

LWD, Compaction, Moisture Content, Dry Density, Deflection

(Paper, ID 25)

Bibliometric Analysis of Factors Influencing Poor Performance of Water Infrastructure

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Abstract

Purpose - Access to safe drinking water is still a challenge in developing countries. Water is a basic human needs and water quality already present a threat to serious health risks to humans, personal hygiene and livestock. Current droughts and poor performance of water infrastructure have a negative impact on the domestic demand for quality of water. Though, not much is published concerning factors influencing poor performance of water infrastructure in water sector.

Design/methodology – Scopus was used to gather existing literature for bibliometric analysis for this paper. Publications from the year 2017 and the year 2021 was gathered using bibliometric analysis. Keywords used for this search includes, *Water, Infrastructure, Poor and Performance*. From the analysis a total of 50 documents from Scopus database met these criteria. Further, Vosviewer (Visualization of Similarities) was used as a tool to analyse the data.

Findings – From the analysis, it was established that the number of studies on factors influencing poor performance of water infrastructure in water sector in the reviewed journals has not been increasing and not many articles are available.

Research limitations/implications – The dataset was mainly extracted from the Scopus database for the analysis.

Originality/value - This study will help policymakers in water sectors. Moreover, the study provides useful information on the key performance of water infrastructure and thus help in formulating better strategies and regulatory tools to enhance efficiency and effectiveness in the performance of water infrastructure.

Keywords

Performance, Water, Infrastructure,

(Paper, ID 27)

3D Simulation Game for Teaching Concrete Formwork

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Abstract

Engaging technology savvy students in the concrete formwork learning process with their preferred learning style is a challenging task. The differences in teaching and learning styles result in problems such as disengagement of

students and loss of learning aptitude. This active student engagement challenge can be addressed through three dimensional (3D) concrete formwork simulation game learning environment. This learning environment engages students in active learning processes and helps them to focus on their learning. It also encourages students to take more responsibility for their own learning process. This ubiquitous learning environment provides anytime time access, facilitates the students to learn at their own pace and promotes learning beyond the regular classroom boundaries. This paper discusses about the 3D simulation game for teaching concrete slab formwork to enhance the learning ability of the students. This paper also discusses about a usability study results of this game.

Keywords

3D, Simulation Game, Concrete, Formwork, Visualization

(Paper, ID 28)

Willingness of Users to Adopt Blockchain Technology on Construction Projects

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Abstract

This paper examined the main factors that influence the willingness and intention of construction project practitioners to adopt and use Blockchain technology in Nigeria. The examination has been done with reference to the UTAUT2 model and against the challenges identified in the general literature as being inherent in a developing country like Nigeria. [This seems redundant]. A quantitative approach and data surveyed from information and communication technology-savvy practitioners with regards to construction projects in Imo state, Nigeria, was utilized. Data analysis was achieved via Structural Equation Modeling (SEM) with the aid of IBM SPSS Statistics 25.0. The study's findings provide a framework which depicts the "intention to use and adopt" behaviours of practitioners in the Nigerian construction industry. Consequently, this study highlights trust, habit, perceived security, price value, and effort expectancy as the main constructs influencing users' willingness to adopt Blockchain technology in construction projects. This study provides an empirically based model of the factors influencing the intention to use and adopt

Blockchain technology. The findings of this study provide impetus for decision-making in both the public and private construction project service sectors in terms of policy development and practical implementation as a catalyst to achieving better project outcomes in developing country scenarios where project performance remains most critical to economic development and growth.

Keywords

Blockchain, Construction projects, Technology, UTAUT2, Willingness of users to Adopt/Use.

(Paper, ID 29)

Systematic Literature Review on Sustainable Construction Strategies for the Development of Affordable Housing

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Abstract

The building industry plays a critical role in attaining sustainable development. Despite its substantial contribution to nation-building, the construction industry has a significant environmental impact in both industrialized and developing countries. Even though sustainability is a global issue, developing countries must approach it differently than developed countries, and alternative strategies must be embraced and implemented. In this research, SLR was performed to understand sustainable construction strategies for the development of affordable housing. Using the PRISMA model, we selected and analyzed 22 papers published between 2011 and 2021. The publications were sourced from ScienceDirect, Scopus, Emerald Insight, Sage Journals and Engineering Village through conferences and journals. The systematic review indicates using affordable, locally sourced building material as a sustainable, affordable housing development strategy.

Keywords

Construction, Housing, Systematic Literature Review, Sustainable, Sustainability.

(Paper, ID 30)

AgiBuild: A Proposed Framework for Agile Building Adaptation Project Management Based on Literature Review

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Abstract

The Agile Building Adaptation (AgiBuild) framework is the adoption and adaptation of the large-scale agile framework for building adaptation projects. The agile methodology is proven to drive innovation by focusing on adaptation to change and user centricity. Similarly, the authors envision that the AgiBuild framework can fundamentally change the way that buildings are re-designed, refurbished, and operated. The AgiBuild framework is developed from the need of the building adaptation industry to manage uncertainties, overcome communication barriers, and improve innovation. In this study, a literature review of Agile and its impact on building adaptation projects was undertaken. Based on this systematic literature review, this paper defines the AgiBuild framework and provides its benefits and barriers to implementation. A key finding of the literature review is that leadership influence, and adequate training form the key foundation for the implementation of the AgiBuild Framework. In defining the AgiBuild framework, the paper described its components and how its implementation is likely to proceed. The authors propose that by adopting the AgiBuild framework, the industry can transform itself into a highly innovative and user-centred industry to improve productivity and performance of the construction industry.

Keywords

Agile project management, Agile construction, Building adaptation, Built environment, Scaling agile

(Paper, ID 32)

Collaboration as a Multifaceted Skill Set in Construction Education

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Abstract

Collaboration is a key element in many programs, especially those with common themes with other disciplines. The collaboration concept in recent years has been a focal point in educational models for multidisciplinary programs. A similar situation also exists in the professional environment. The construction industry is a broad industry with numerous interactions with trades, developers, engineers, and designers. Likewise, construction programs incorporate subject modules in their curricula that are shared with other relevant programs such as civil engineering, architecture, and business. The intertwined nature of several topics in construction makes collaboration an effective approach for

content delivery. The collaboration takes place in various forms and different capacities. This paper addresses the collaboration efforts in two major courses between the Building Construction Science and Architecture programs at Mississippi State University. A quantitative method was used to explore both majors' students' perceptions toward the different aspects of teamwork and collaboration. The result indicated that different components of the collaboration system, such as teammates, instructors, content, and tools, were perceived at different levels by students. The findings of this study not only provide insight on nuances of collaboration but also help construction educators and administrators to better design and develop collaborative environments and control factors that impact the efficiency of such educational realms.

Keywords

Collaboration, Construction, Education, Architecture.

(Paper, ID 33)

Challenges of Sustainable Construction Projects Delivery

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Abstract

As the construction industry plays a significant role in the growth of a country socially and economically, it is also considered a crucial contributor to environmental degradation. This has led to the development of several sustainable construction initiatives around the world. However, this uptake of sustainable construction comes with its fair share of challenges. This research sets out to identify the most significant challenges of sustainable construction projects delivery. Literature review was conducted to extract a list of the most cited challenges, thirty-three were shortlisted and used to create a questionnaire survey that was then distributed among construction professionals within the United Arab Emirates (UAE) to gather their perceptions on the significance of each of these challenges. Eighty-two questionnaires were returned and used for analysis. The Relative Importance Index was calculated in order to rank the challenges. The five most significant challenges were: owner's unwillingness to pay, client's funding issues, cost overruns due to tight schedule plans, lack of early involvement of construction professionals and lack of contractual incentives for the contractor. This research suggests increasing the levels of integration, investing in innovation and advanced technological systems as well as relinquishing traditional management practices to better achieve sustainability criteria among the main recommendations to overcome these challenges.

Keywords

Sustainability, Challenges, Construction Management, Sustainable Construction Practices.

(Paper, ID 36)

Decision Tree Analysis in Project Risk Management: A Systematic Review

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Abstract

The most critical step repeated at each process in risk management is "decision making." Decision trees, part of artificial intelligence, have been used in an integrated manner with different methods in decision-making under uncertainty in recent years. The main reason for this is the need to quantify uncertainty in project risk management and the need for a flexible decision-making process in project management. This article aims to determine which project risk management processes the appropriate methods are used more frequently and determine the literature gap. In this context, literature review and bibliometric analysis methods were used. The results indicate that the integrated use of related risk assessment methods has increased in the last five years. The methods were most frequently used in quantitative risk analysis, qualitative risk analysis, and risk identification processes. It has been determined that the number of studies conducted on risk monitoring and control processes is very few compared to the number of studies on other risk management processes.

Keywords

Project risk management process group, decision tree, event tree analysis (ETA), fault tree analysis (FTA), bow tie analysis

(Paper, ID 37)

Building Information Modelling Mandates and Government Efforts: A Systematic Review

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Abstract. While much advocacy has been given to adopting BIM in the built industry, the mandate or effort adopted by the government holds different implications towards disposition to adoption. This is imperative as resistance to change on BIM adoption is hinged by implementation strategies adopted by the government between national contexts. A review of government efforts is important to bring the strength of diverse mandating strategies for future national efforts from governments yet to adopt BIM.

Research studies have sought to produce a holistic review of the increasing BIM publications to establish the development trend. The studies have used different Scientometric reviews, bibliometric reviews, or systematic literature reviews (SLR) to show the trends. Although BIM adoption differs across firms and countries, these studies regularly take a global view of development. Few studies use a two-phase literature review to look at BIM mandates worldwide. This paper aims to present a two-phase bibliometric analysis and systematic literature review of BIM mandates and government efforts in the construction industry to investigate the current state of BIM across regions. The study used publications made between 2011 and 2022 using the Web of Science. Vosviewer was used to analyse the bibliometric data while AtlasTi was used to analyse and code the SLR data. The review findings revealed that the African continent lags in publications and governments' efforts to make BIM mandatory. The results of this study should be used to establish a BIM mandate roadmap for developing countries and their governments in the future.

Keywords: Building Information Modelling, Bibliometric Review Government, Mandate, Systematic Literature Review

(Paper, ID 38)

Key Indicators for Successful Value Management Performance in the Built Environment (A Literature Review)

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Abstract

This research seeks to identify the indicators for measuring successful value management (VM) performance in the built environment based on literature review. Value management (VM) is commonly considered as a beneficial technique for construction firms to address obstacles in the construction sector, such as resource constraints, delay in delivery, cost overrun, time overrun, project abandonment and complexity. However, despite numerous studies on VM, the indicators for measuring the performance of VM have not been thoroughly investigated. This paper, therefore, discusses the key indicators for measuring successful VM performance in the built environment. A comprehensive assessment and analysis of chosen published journals is fundamental of the research. Journal papers, books, and conference proceedings were all included in the study on indicators for measuring successful performance of VM from different databases including ScienceDirect, Web of Science, Google Scholar, Science Direct, Scopus, etc. The performance indicators were categorized into process performance indicators and outcome performance indicators. The process performance

indicators (integration, collaboration, standardization, organizational culture) are categorized as variables that must be considered in order to ensure effective VM practices while the outcome performance indicators are variables that indicates the effectiveness of VM practices. A careful evaluation of the performance indicators of VM studies is expected to enhance VM application and strengthen clients' confidence in their VM investment. The initial step in establishing a robust VM performance model is to identify variables that determines its successful integration. Thus, it is expected that the long pending quest of poor implementation of VM will be solved and successful delivery of construction projects will be enhanced. It will also become a useful reference to value managers, designers, architects and construction organisations for achieving building sustainability through VM practices.

Keywords

Performance Indicators, Value Management, Built Environment

(Paper, ID 39)

A Critical Review of Barriers Hindering BIM Integration of Operation And Maintenance Phase in Existing Buildings

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Abstract

Presently, researchers have made clear justices to Building Information Modelling (BIM) capability in new building production and management. Researchers' findings have proven that BIM plays a significant role in building facilities' operation and maintenance (O&M) phase, using information generated during the construction process in the BIM database. However, over 90% of existing residential buildings do not have a functioning BIM. Recently, there has been a growing consideration for BIM implementation in existing residential buildings. Through the critical review of this study, 18 barriers hindering BIM implementation in the existing residential building were identified and systematically grouped under six groups: Documentation Factor, Technical Factor, Personnel Factor, Professional Management Factor, Financial Factor, and Security Factor. The "Data interoperability problem" was identified as the primary barrier hindering BIM adoption in existing buildings that already use FM tools for their management.

Keywords

Existing Building, implementation, BIM, Barriers, operation, and maintenance.

(Paper, ID 40)

Environmental Sustainability Assessment of

Wastewater Treatment Processes: Case Study

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Abstract

An environmental sustainability assessment of a wastewater treatment plant (WWTP) operation in the United Arab Emirates (UAE) is presented in this study. Various emissions from the wastewater treatment facility, as well as their environmental parameters, are assessed using OpenLCA, a Life Cycle Assessment (LCA) software. The functional unit is 1 m³ of wastewater. The treatment process showed substantial negative effects on the analyzed categories: global warming, human toxicity, ecotoxicity, and eutrophication. The biggest contributors to global warming are two processes: wastewater transportation, which accounts for about 43% of the entire effect, and bioreactor air blowers, which account for 38% of the total impact. The transportation process, in addition to the filtration anthracite production, are the key contributors to the generation of fine particulate matter. Whereas, in terms of fossil resource scarcity, the operation and maintenance of activated carbon uses up to 0.5 kg of oil per functional unit, accounting for 93 percent of total fossil resource use. Briefly, The main contributors to the environmental impact were found to be the transportation of the wastewater in addition to the production of the materials used in the treatment processes.

Keywords

Environmental Sustainability, Wastewater Treatment Plant, Operational Assessment, OpenLCA Software.

(Paper, ID 42)

The Impact of Project Context on Management Practices in the North Cyprus Construction Industry

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Abstract

The environment in which projects take place has a major impact on how they are managed. This paper examines the context in which the North Cyprus construction industry operates. The North Cyprus economy experienced a construction boom in the aftermath of the UN Peace Plan for settling the Cyprus problem. However, the local construction industry is underdeveloped and unable to exploit any resulting commercial opportunities. Despite recognition of the need for improvement in project management practices, little has been done to address this. This paper examines the context of the North Cyprus construction industry

considering political, economic, social and technical factors (PEST analysis). It is shown that unresolved political conflict leads to a resistance to change in management practices in the local construction industry. This analysis of context can be useful in attempting to improve management practices in projects affected by political conflict.

Keywords

Construction, Cyprus, Islands, PEST analysis, Small economy

(Paper, ID 43)

Improving Health and Safety (H&S) on South African Construction Projects with Industry 4.0

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Abstract

The South African construction industry experiences a high level of accidents, injuries, and fatalities, despite efforts to reduce their occurrence. This study aims to investigate the potential of Industry 4.0 in terms of improving H&S on South African construction projects. A detailed survey was conducted among medium to large general contractor members of the East Cape Masters Builders Association (ECMBA), and candidates or professionally registered persons with the South African Council for the Project and Construction Management Professions (SACPCMP) who are based in the Eastern Cape such as H&S practitioners, construction project managers (CPMs), and construction managers (CMs). The salient findings include: monitoring H&S hazards onsite is difficult; design-originated and onsite hazards are often experienced onsite; fatalities, injuries, illnesses, and worker fatigue often occur; drone technology has the potential to improve H&S monitoring in construction; building information modelling (BIM) has the potential to reduce design-originated hazards, and virtual reality (VR) has the potential to improve H&S training. It is concluded that implementing Industry 4.0 technologies in construction will improve H&S. Recommendations include: construction H&S-related training and tertiary education should address Industry 4.0 technologies, and various industry stakeholders should promote Industry 4.0-related construction continuing professional development (CPD).

Keywords

Construction, Health and Safety, Industry 4.0

(Paper, ID 44)

Factors Influencing Selection of a Project Manager for Energy Retrofit Projects in Ghana

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Abstract

Project management is a complex process that requires commitment, strong will and teamwork to ensure success in terms of cost, time, quality, safety and client satisfaction. The concept of green renovation is new as actions to reduce CO₂ continue to capture the attention of the world. The main aim of the study is to align the concept of green renovation to the selection of competent project managers/consultants. A survey of selected district assemblies in Ghana was undertaken. The nature of green renovation influenced the selection of the district as those with no records of such renovations were not included. District assemblies are motivated to select project managers with adequate working experience and knowledge of sustainable technologies. The results indicate ability to work effectively in a team, evidence of adequate training and green renovation projects managed also influence selection of a project manager. The theory underpinning project management reinforces the results identified as challenges that hinder effective project delivery are addressed. The findings inform government decision to engage project managers for green renovation projects and provides literature for teaching and learning.

Keywords

Project Management, Project Manager, Green Renovation, Experience, sustainable technology, policy

(Paper, ID 45)

An Assessment of Trade Unions in the South African Architecture, Engineering and Construction Industry

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Abstract

The Architecture, Engineering and Construction (AEC) industry is known to be one of the largest employers of labour globally. The diverse and multi-faceted characteristics of the industry ensure it caters for the employment of both skilled and unskilled workers. However, the unfavourable working environment and conditions, exploitation of labour, and poor welfare of the workers are a few of the ills associated with the AEC industry. Hence, the establishment and proliferation of trade

unions for mitigating the numerous challenges facing construction workers. This paper aims to assess the state of trade unions in the AEC sector using South Africa as a case study. A questionnaire survey was used to obtain the required data for this research study. The respondents were quantity surveyors, site engineers, foremen, safety officers, and quality control officers who are actively affiliated with a trade union in South Africa. A quantitative approach to data analysis was employed. The results revealed the major factors responsible for the establishment of trade unions in the South African AEC industry. Poor impact on project performance, intimidation of striking workers, disturbance of project process, organizational conflict and drag in negotiations are identified in the study as the major adverse impacts of trade unions in the AEC industry. The results revealed securing better wages, improved fringe benefits, improved workplace safety measures, prompt management responsiveness to employees, and improved health and safety of employees are the major benefits of trade unions in the AEC industry. It is believed that the presence of a versatile and effective trade union will optimize productivity and create a safe workplace culture in the built environment.

Keywords

Built Environment, Construction Industry, Construction Workers, Health and Safety, Labour Unions, South Africa, Sustainability.

(Paper, ID 46)

Research Methods in Construction Robotics and Human-Robot Teams: - A Scientometric and Systematic Review

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Abstract

In the emerging studies on construction robotics, discussions on methodological approaches are lacking. Despite the potential of robotics adoption in construction to enhance productivity and improve safety, debates regarding research methods have been identified as an underlying factor in limited output in the area. With limited studies and publication in the domain, a methodology review is needed to further develop knowledge in this area. Using a two-phased literature review adopting scientometric review and systematic literature review, the study reviews 112 Journal

articles on the Construction robotics research domain and identified insights from the analysed publications. An overview of publications between 1987 and 2021 is presented, examining the topics and approaches researchers adopt most in construction robotics and human-robot teams. The findings offer insight into the popular methods and the need to adopt comprehensive methods specific to the nature of the research problem. The study's findings are vital to guiding subsequent studies in construction robotics on available methods, those frequently used and emerging approaches.

Keywords

Collaborative robots, Construction Robotics, Human-Robot teams, Research Methods, Scientometric, Systematic Review

(Paper, ID 48)

Evaluation of Atmospheric Exposure Test on Structural Steel and Hot-dip Galvanized Steel in the East of Thailand

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Abstract

In today's civil engineering industry steel is one of the commonly used materials due to its versatility, high strength, and durability. However, it is highly susceptible to corrosion. Corrosion is the deterioration of steel and its critical properties due to the chemical reactions between the steel and the surrounding environment. Corrosion is unavoidable but it can be minimized by galvanizing and painting. The rate of corrosion depends on the coating and environmental conditions. This research aims to study the corrosion rate of two types of structural steel SS400 and SM490 for bare steel and Hot-dip galvanized steel, which is exposed at three locations at Chachoengsao, Rayong, and Chonburi in the Eastern part of Thailand. To determine the corrosion rate, and atmospheric exposure test is conducted. Following the ASTM G50, a test site is selected at each location and the specimens are exposed to the real environment for three months and six months, and so on. Weathering station at the test site collects and monitors environmental parameters. The exposed specimens are

collected, cleaned and the data are gathered. The weight loss of the steel specimen's data is analyzed based on the ASTM standards. This analysis result shows the corrosion rate of both the bare steel and hot-dip galvanized steel, the changing appearance of steel specimen after three months and six months, and the importance of galvanizing. The result can be used for material selection and could contribute to the development of the steel corrosion manual of Thailand

Keywords

Steel corrosion, Atmospheric Corrosion Test, Structural Steel, Hot-dip Galvanized Steel, Corrosion Rate.

(Paper, ID 49)

Construction Site Top-view Generation Using Drone Imagery: The Automatic Stitching Algorithm Design and Application

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Abstract

This paper proposed an automatic stitching algorithm to process drone-captured top-view images (ortho-images) to generate a single frame high-resolution unified top-view image for construction site documentation. The initial step of the proposed algorithm is resizing adjacent ortho-images to the same scale. The next step is to find a common straight edge for merging the resized ortho-images. A vertical edge that closes to the right end of the left-image in left-right mode or a horizontal edge that closes to the bottom end of the upper-image in up-down mode is recommended. Then, merging adjacent ortho-images at the common edge. Stitching and aligning the corresponding elevation-maps at the common edge, if any. An automatic stitching tool was developed with comprehensive functions of automatic, semiautomatic, and manual stitching based on the stitching algorithm. Application results are presented and discussed in this paper, including grid stitching mode for large building sites and linear stitching mode for infrastructure projects. With the stitched ortho-image and elevation-map, the point cloud can be generated for 3D monitoring construction progress.

Keywords

Drone, Image stitching, Construction site, Documentation.

(Paper, ID 50)

Remote Sensing and Neural Network-driven Pavement Evaluation: A Review

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Abstract

This review paper aims to evaluate the remote sensing and neural network-driven pavement evaluation (RSNNPE) techniques. The collected studies were published in recent years and mainly relate to pavement distresses detection, classification, and quantification. The data collections were conducted by remote sensing and non-destructive techniques, including photography, hyperspectral imagery, satellite imagery, photogrammetry, laser scanning, ground penetrating radar, and laminography. The data analysis was conducted by neural network (NN) modeling, image filtering, threshold segmentation, template matching, SVM, and random forest. The NN architectures include MLP, RNN for structured data; CNN, Faster R-CNN, NIN for 2D/3D imagery patch-wise or object-orientated pavement distresses detection; and FCN, U-net, SegNet, PSPNet, DeepLabv3+, Mask-RCNN, DeepCrack, CrackSeg, FPHBN, CrackGAN for 2D/3D imagery pixelwise segmentation. Moreover, this paper discusses drone photogrammetry-based data acquisition, data preparation, and NN architecture selection for pavement evaluation. Based on the results of the review, future research recommendations are proposed.

Keywords

Pavement Distress Detection, Remote Sensing, Neural Network Modeling, Photogrammetry, Literature review.

(Paper, ID 51)

An Analysis of the Contractor's Project Performance based on Field Performance Rating

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Abstract

Project schedules are affected by several factors, and contractor's project performance is one of them. In many cases, contractors develop a schedule that is not accurate enough to represent work sequencing. Besides, their project delivery methods create plenty of challenges to track and monitor project progress. This paper illustrates the project performance of contractors based on seven different factors obtained from the contractor's field performance rating by one State Highway Agency (SHA). The purpose of this study is to analyze the field performances of the nineteen contractors that delivered thirty public transportation projects during the last three years in one state. The authors collected the contractor's project performance reports from one SHA. The performance reports summarize the overall contractor's performance throughout the project. This study contributes to the body of knowledge by identifying areas of improvement of the contractor's performance based on the

analysis of performance reports. The study also presents recommendations to the contractors to improve future transportation projects.

Keywords

Project Performance, Schedule Delay, Public Transportation Projects.

(Paper, ID 52)

COVID-19 Vaccination Hesitancy and Perceived Risk of Infection Among Construction Workers

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Abstract

The number of cases for COVID-19 is increasing across the United States. Construction workers are also affected by the COVID-19 as most of the construction work is done in person. Construction work is full of different hazards, and COVID-19 has introduced additional health hazards to the workers. Identifying hazards is an essential element to avoid injuries, illnesses, and accidents. Significantly less research has been done to determine how construction workers perceive COVID-19. The goal of this research is to observe based on vaccination status how construction workers perceive COVID-19. A questionnaire was prepared to test the research goal, and in-person interviews were conducted to get workers' responses. Workers who are working on the construction projects were only interviewed. Based on the data analysis work, it was observed that unvaccinated workers do not think COVID-19 is a risk or threat to them. Vaccinated employees ($M=7.13$, $SD=1.84$) had a significantly different assessment of COVID-19 risk than unvaccinated workers ($M=5.60$, $SD=1.74$), $t(41)=2.801$, $p<0.01$. The research finding indicates that more workshop and safety awareness programs are needed to create awareness among construction workers. The study's findings can assist safety practitioners and experts in implementing safety procedures that encourage workers to adopt a safety mindset.

Keywords

COVID-19, Risk Perception, Pandemic, Vaccination, Construction Hazard.

(Paper, ID 53)

Evaluation of Building's Life Cycle Carbon Emissions based on BIM and LCA: A Case Study of Affordable Housing in Morocco

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Abstract

Morocco is undertaking tremendous actions toward reducing the impact of climate change especially in terms of energy efficiency and building sector adaptation. However, until now neither Building Information Modeling (BIM) has been used in this context nor an analysis of Building's Life Cycle Carbon Emissions (BLCCE) of affordable housing has been conducted in Morocco. This paper aims to propose an approach using BIM and Life Cycle Assessment (LCA) to calculate and analyze the carbon emissions in different stages of building lifecycle of affordable housing named 'social housing'. For this purpose, an affordable housing parcel containing full-residential and mixed-use buildings was considered as a case study. Consequently, beside emphasizing the BIM capability to facilitate Embodied Carbon (EC) emissions, this study revealed that, concrete, bricks, steel, ceramic tiles, and paint are the most contributing materials in emitted EC with an approximative share of 90%. Meantime, glass is an impactful material for mixed-use buildings as it contributes to 8% of the total EC. Furthermore, this paper discloses that for social housing, the operational stage contributes to 98% of the BLCCE where 73% among it is due only to fossil energy consumption (butane), and full-residential buildings produce 11.6% more BLCCE than mixed-use buildings.

Keywords

BIM, Carbon footprint; CO₂ emission; Life Cycle Assessment; Embodied carbon; Operational Carbon; Green building

(Paper, ID 54)

Development of Reinforcement Schemes for Cold-Formed Steel Joists with Large Web Openings

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Abstract

The floor joists of cold-formed steel (CFS) structures may use large web openings and a cost-effective way to alleviate the detrimental effects of a large web opening is to affix appropriate reinforcements around the opening regions, to restore the original strength and stiffness of the member. The primary aim of this paper is to define the "Flexural Zone"

and the “Shear Zone” and establish construction guidelines for the reinforcement schemes for cold-formed steel joists with large web openings in these corresponding zones. To that end, a total of twenty-three laterally braced CFS joists were simply supported and subjected to uniformly distributed loads until failure for flexural tests, which considered solid sections, circular and square web openings (65% of web depth) and sections with reinforced web openings. The reduction in the flexural strength of a cold formed steel joist section due to a large web opening is less than 15%. Twenty-seven joist sections were subjected to short span, mid-span point load, shear tests to establish the shear resistances of sections having a large web opening and a reinforced web opening. The reduction in the shear strength of a CFS section with a web opening may be as high as 60%. Thus, the residual shear strength of a joist with a large opening may be as low as 40%. A Virendeel type reinforcement system can restore the original shear strength of a cold-formed steel joist section. Based on these studies it is established in this paper that; The mid 40% region of a joist (0.30L and 0.70L) can be defined as “Flexural Zone” and will need flexural reinforcements. The regions outside the mid 40% region of a joist can be defined as “Shear Zone” and will need the shear reinforcements.

Keywords

Cold-formed Steel Joists, Construction Guidelines, Experimental, Large Web Openings, Openings Reinforcements.

(Paper, ID 55)

A Critical Review of Wood Waste Cement Composite Properties (The Mechanical and Physical Properties) and its Use as Building Construction Material.

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Abstract

The gradual unreplaceable exploration of the natural aggregates has called for the attention of researchers and built professionals to devise suitable materials which can be used as a replacement for those aggregates. This has called for an inward investigation on using waste raw materials such as wood waste as supplementary for fine aggregate or pozzolana. Wood waste cement composites are great byproducts that can be used as building materials that are freely or cheaply available. Before any new material could be considered suitable in construction, the properties need to be known to see its suitability for construction works and the area it would be best suited for. This study aims to investigate the mechanical and physical properties of wood waste cement composite and its use as building construction material, through a critical literature review of selected

published articles between 2005 to 2021, focusing on the property of wood waste cement composite. The findings reveal the physical and mechanical properties of raw sawdust and properties of selected Portland cement. The findings of this study will go a long way in assisting built professionals in making intelligent choices on how to use processed and unprocessed wood by-products as a partial substitute for cement and sand.

Keywords

Wood Waste, Physical Property, Mechanical Property, Cement, Construction.

(Paper, ID 56)

Developing a VR Research Instrument for Participatory Design of Educational Spaces

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Abstract

Virtual Reality has a proven track record of benefits in the AEC industry. Participation of end-users in the design process has been advocated as a means to improve spatial quality in design. There is limited evidence of application of VR to promote design participation. This becomes even more important when the end-users of space are from different backgrounds. Design of educational spaces is challenging and demanding due to a multitude of reasons. This makes participation of higher importance in the design of such spaces. Traditionally paper-based methods have been used to facilitate participatory design of educational spaces. However, with the fast pace of migration to virtual environment solutions, VR applications seem to be a viable solution. Despite this, there is limited evidence of previous research in this area. This paper uses games engines to develop a virtual interaction environment to facilitate participation in design of educational spaces. A critical review of literature was used to set the boundaries of this research, interrogate the principles of participatory design, define a set of variables, and investigate the areas where VR can be applied as well as design features and aspects which can be comprised in participatory design of educational spaces. To enrich the scope and application of the knowledge claim of this research, the last section was also investigated through primary data collected from an expert survey conducted with school teachers. The development of the VR experiment is explained in this paper which will be verified as a part of future research. This will help close the loop on User Experience (UX) research process which has been utilized in this study.

Keywords

Virtual Reality, Participatory Design, Design Collaboration, Educational Spaces, Classroom Design

(Paper, ID 58)

The Last Planner System®: State of the Art

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ABSTRACT

Lean construction is an evolving philosophy introduced in the construction industry with the aim of delivering the project with maximum value, continuous flow, and improved reliability. Last Planner System® (LPS) is an important key lean technique, which increases the reliability of planning and reduces the variation at the construction site. LPS is an example of a production planning and control system that has been successfully implemented and applied to complex construction projects to improve workflow reliability, production performance and to promote production control by engaging all members of the project team. An extensive literature review was carried out to understand the origin, principles, planning stages, effectiveness, benefits, and barriers in implementing the Last Planner System in the construction industry. Finally, the areas that need further research are highlighted and the need for incorporating LPS is emphasized.

Keywords

Construction Planning, Lean Construction, Last Planner System®, Productivity, Look Ahead Schedule, Barriers, Benefits

(Paper, ID 59)

Energy Performance: Effects of Air Distribution Systems and Building Envelope Design on Indoor Air Quality and Energy Efficiency

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Abstract

Building design and systems are essential for indoor air quality and energy efficiency. This research emphasized enhanced building envelope design, which was related to measuring the exterior walls with a thermal resistance (R-value), the windows with window-to-wall ratio, and the rate of solar heat gain coefficient values based on building codes and standards. In addition, emphasis was placed on advanced

air distribution systems by comparing traditional and advanced air-handling unit systems. The systems were related to outdoor air airflow with ventilation requirements based on building codes and standards that include the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) 62.1; ASHRAE 90.1; the U.S. Green Building Council (USGBC) Leadership in Energy and Environmental Design (LEED) v4; and the International Energy Conservation Code (IECC). This research found significant improvements from manipulated building envelope and air system treatments. Total energy consumption was decreased, and indoor air quality was improved when building conditions were improved with an envelope design and building system changes.

Keywords

Building Envelope Design, Air Distribution Systems, Indoor Air Quality Factors, Energy Efficiency Factors, Building codes, ASHRAE 62.1—Ventilation for Acceptable Indoor Air Quality, ASHRAE 90.1—Energy Standard for Buildings, USGBC LEED v4, IECC.

(Paper, ID 60)

Investigating Design and Deployment of Eco-feedback Dashboards

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Abstract

This pilot study investigates the design and deployment of an eco-feedback dashboard, use of an eco-feedback dashboard as an educational tool, and the perceived influence of the dashboard on building occupants' behavior. A preliminary survey measured each participant's prior knowledge on sustainability, LEED, personal environmental behavior, and their personal understanding to how a building consumes energy and water and results showed that most participants considered themselves environmentally friendly (79%) and were familiar with sustainability regarding building operation (93%). A postliminary survey after deployment of the eco-feedback showed that all participants (100%) believed that the eco-feedback dashboard helped them learn more about energy consumption but only sixty-three percent (63%) of participants thought the dashboard influenced their behavior to be more environmentally friendly. Findings suggest that eco-feedback dashboards can help building occupants understand energy usage in building operation, but may not increase environmentally-friendly behavior, particularly within a population that has environmental awareness and understanding of energy use in building operation.

Keywords

Eco-feedback dashboard, LEED, sustainability, occupancy behavior, energy consumption

(Paper, ID 61)

An Investigation on the Impact of 4D BIM on Construction Scheduling

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Abstract

This research aims to investigate the impact of 4D BIM on construction scheduling and whether using 4D BIM reduces construction delays or not? Multi-dimensional Building Information Modeling (BIM nD) integrates different project applications with BIM, such as scheduling and estimation. 4D BIM is the process of linking the project schedule with the 3D model to generate relevant data for constructability analysis, safety planning, and building assembly. The methodology used in this paper consists of a comprehensive literature review on 4D BIM and then comparing the results with the data collected from a survey distributed to AEC industry professionals. Based on the findings, 4D BIM is improving project performance, enhancing decision making, and helping achieve on-time delivery. The main challenges are related to software interoperability issues and manually linking scheduling activities into model components. The three top barriers from survey results are (i) lack of training, (ii) high implementation cost, and (iii) software/hardware issues. Future research may focus on automating the 4D BIM process of linking scheduling activities into the model components. Another important research topic is the return on investment analysis for 4D BIM implementation on project objectives.

Keywords

Building Information Modeling, Scheduling, BIM, 4D, Construction

(Paper, ID 62)

Indoor Localization and Tracking of Building Components and Fixtures Using Ultra-Wide Band

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Abstract

Modern buildings create vast amounts of data throughout their lifecycle. Carefully managing the data makes it more valuable. This data is contained in static printed materials or

documents. These documents quickly become outdated, and all too often much valuable time is lost tracking down the relevant information. It is important to associate project information with specific elements in each location for future reference. Location based real-time information sharing is key to productivity for an organization. Position coordinates may be used to link important information with the given location and effectively connect data using indoor localization technology. This paper explores use of indoor positioning technologies for organizing and accessing information in construction industry using content analysis. Ultra-wideband (UWB) is a most promising technique that has proven effective in indoor localization. In addition, the research reviewed past five years papers to understand the application of UWB in various stages of construction. The research then studied potential stages where adoption of UWB can be an imminent research area to revolutionized information sharing in construction. The research found that no research has been focused on using UWB during the commissioning stage of construction, which is one of the important stages requiring real-time information sharing.

Keywords

Indoor Localization, Ultra-wideband (UWB), Digital Information Sharing, Content Analysis, Construction Stages

(Paper, ID 63)

Supply Chain Management in Construction: State of The Art

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Abstract

Supply Chain Management is a concept originally developed in the manufacturing industry and later implemented in the construction industry to reduce cost, on-time delivery, and better productivity. An extensive review of the literature published from 1982 to 2021 on the origin, types, and role of Supply Chain Management is discussed in this paper. Literature from the area of the supply chain in the construction industry was studied and a brief background on how Supply Chain Management can be diffused into the construction industry and the impact of Machine Learning in better decision making in Supply Chain Management are explained. This paper aims to review the existing literature and provide the synthesis and suggestions for future works. Further work on analyzing the compatibility of Supply Chain Management with the current strategies and its role in achieving sustainability in the construction sector can be carried out.

Keywords

Supply Chain Management, Construction Planning, Implementation, Project Management, Decision making

(Paper, ID 65)

Introducing Construction 4.0 into Construction Management Curricula

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Abstract

The rise of the Fourth Industrial revolution has forced many, if not all industries to embrace the transformation and adopt its concepts and technologies. Innovation that resulted from Industry 4.0 technologies gave rise to Construction 4.0, and the construction industry is adopting these Construction 4.0 technologies, as they are extremely beneficial. The adoption of Construction 4.0 has created a skills gap as the current and future workforce does not have the necessary skills for a Construction 4.0 environment. A quantitative study was conducted among recent construction management graduates of Nelson Mandela University between 2019 to 2021, to determine how Construction 4.0 can be integrated into the construction management curricula. The findings indicate the construction industry is slow to adopt Industry 4.0 concepts and technologies and it faces challenges in terms of increasing Construction 4.0 awareness; the current skills gap needs to be addressed and qualifications need to be restructured to include digital skills, and more digital training programmes need to be adopted on site. Conclusions include that universities and the construction industry both need to make progress in terms of adopting Industry 4.0 concepts and technologies so that they are current and can fully embrace the new innovations and trends that will be beneficial to them. Recommendations include: the relevant Construction 4.0 technologies need to be introduced into construction management curricula; students should develop the related skills, and vacation work should be a requirement, which will enable students to apply what they learn in the lecture environment in the workplace.

Keywords

Construction Management, Curricula, Industry 4.0.

(Paper, ID 67)

Exploring the challenges of attaining the required competencies for sustainable construction projects: A case of built environment professionals in South Africa

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Abstract

The purpose of this study was to explore the challenges that the built environment professionals encounter in pursuit of attaining the required competencies to enable them to successfully execute sustainable construction projects (SCPs) in the South African construction industry. The dearth of research in this area motivated the researchers to explore the aim of this study. Evidence in the previous literature suggest the focus has been on the challenges encountered in the construction industry in adopting sustainable construction methods, of which lack of competencies for SCPs has been a key factor. To achieve the purpose of this study, constructivism philosophy was adopted and data was collected using semi-structured interviews with 21 built environment professionals, who were purposively sampled. Atlas.ti version 7 was used to organize the data and interpret the themes and the sub-themes. Data saturation was achieved after the 21st interview was analyzed. The findings on the challenges encountered by the built environment professionals in acquiring the competencies for sustainable construction projects were: limited awareness of the required competencies, lack of finance, lack of training/education, no or little experience (technical skills) and corruption. The recommendations to the construction industry are that: awareness of the competencies required should be improved, financial support is required, motivate their professionals to go for training and improve their technical skills. Furthermore, any form of corruption relating to who should be upskilled regarding sustainable construction projects should be avoided entirely in the construction industry. These recommendations will ensure to some extent that the professionals' competencies are improved in order for them to deliver SCPs satisfactorily to the clients.

Keywords:

Built environment, challenges, construction, competencies, professionals, sustainable.

(Paper, ID 68)

Offshore Construction Progress Management by Indoor GIS Positioning: Post-COVID-19 New Normal

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Abstract

Travel restrictions have been imposed among countries since the outbreak of the COVID-19 pandemic. Time delays, budget issues, and poor-quality control in construction projects due to the pandemic have severely affected the construction industry. To reduce the influence of the pandemic, the paper introduces an offshore construction site progress management system with a real case study. With the integration of indoor location-based service technology and image processing method, site superintendents (architect, project director, site manager, engineer) can monitor the site progress easily and pinpoint defects for further investigation and measurement. The visualization of site images together with BIM provides a digital twin platform that can help senior management quickly review the site progress, perform quality checks, and resolve discrepancies in early phases. Positioning of workers and equipment with the adoption of digital maps is a further step in sustainable management. The proposed integration provides a new concept for construction site management during a pandemic and supports the post-COVID-19 new normal in the construction industry.

Keywords

Wi-Fi Fingerprint, Indoor Positioning System (IPS), Location Based Service (LBS), offshore management, Geographic Information System (GIS)

(Paper, ID 70)

Evaluating the Awareness, Barriers, and Level of Adoption of Innovative Digital Technologies in the Health and Safety of High-Rise Construction in South Africa

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Abstract

Innovative technologies have been used globally to improve health and safety practices in construction projects. This adoption has been proven to directly lead to significant decreases in the number of incidents experienced on construction projects. However, limited research has been done in South Africa to evaluate the level of awareness, adoption and barriers of Health and Safety (H&S) innovative technologies in high-rise construction projects. Therefore, this research seeks to fill this knowledge gap. A questionnaire survey was undertaken to collect data from H&S officers of high-rise construction projects across South Africa to answer the study objectives. Statistical analysis

was employed to analyze the collected data. The study found that the South African H&S officers are moderately aware of the innovative technologies that can be implemented on high-rise construction projects to improve health and safety management practices. However, the adoption of innovative technologies in these types of construction projects is less than 20%. Furthermore, the study determined the initial cost of technology, non-availability of technologies and high skill shortage as the main barriers to adopting innovative technologies in South African high-rise construction projects. The study concludes that the extent of adopting innovative technologies in construction projects could be increased with an awareness of innovative technologies' performance and availability. The acquisition of the technical knowledge associated with the technology-based construction processes and the recognition of the use of innovative digital technologies (IDT) in H&S of high-rise construction projects in building requirements and regulations were recommended in the study.

Keywords

Level of adoption, Barriers, Health and safety, High rise construction, Innovative technologies.

(Paper, ID 71)

The Embodied Energy Assessment of Various Building Assemblies in Residential Building Construction

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Abstract

Energy consumption in the construction and building industry is associated with significant depletion of natural resources, release of greenhouse gases emissions and related environmental impacts worldwide. An understanding of the direct and indirect, operational, and embodied, as well as life cycle consumption patterns due to building architecture plays a major role in reducing the negative impact of buildings. A review of existing literature shows that there is much less research on the impact of embodied energy and there is a need to provide a clear basis to substantiate its veracity. Previous studies on embodied energy have mainly focused on the overall embodied energy of different building types. However, there is limited focus on the embodied energy associated with various assemblies in a building. In efforts to reduce the embodied energy of buildings, it is important to understand the energy associated with various assemblies in a building. Therefore, this research was conducted to investigate the life cycle embodied energy (LCEE) consumed by various building assemblies in a residential building to provide reliable data for professionals. The findings indicate two levels of interest; firstly, life cycle embodied energy of the case study was

found to be 13096.47 GJ with the initial embodied energy being 7390.5 GJ (56%) and the recurrent embodied energy was 5690.01 GJ (43%). Secondly, the study presents the embodied energy impacts of various building assemblies and revealed that while the wall assembly was highest, responsible for 25% of the LCEE, the floors contributed 18% and the roof, 6%. The study reveals the significance of embodied energy consciousness in envelope design, as well as the design and specification of building assemblies.

Keywords

Life cycle embodied energy; initial embodied energy; recurrent embodied energy; Building Assemblies; Building materials; Input Output Hybrid Analysis

(Paper, ID 72)

Crime Prevention through Environmental Design (CPTED) in Pakistani Construction Industry – Benchmarking of Stakeholders’ Awareness

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Abstract

While in Karachi, one cannot ignore the fortress-type homes transformed into cages. Nobody wants to live in a fortress but if the crime statistics for Pakistan are put into perspective, the need for physical security has become critical over several years. Physical security is addressed by the intricate operation of several components to provide a secure environment. It has been observed that crime prevention stresses upon the built environment attributes in which building design can be value-added to reduce susceptibility to offense. Therefore, this study aims to assess the level of perception and awareness of key stakeholders about Crime Prevention through Environmental Design (CPTED) concepts, within the geographical boundaries of Karachi city. For the study, Contractors, Consultants, and Architects are considered as the target audience for the primary data collection. From the analysis of the responses, it can be concluded that the stakeholders feel that by including certain attributes in the design stage, the built environment can be made safer from the start. Residents’ perception of safety depends on housing quality.

Keywords

Crime Prevention Through Environmental Design, Crime Prevention, Secure Environment.

(Paper, ID 73)

VR-enabled Participatory Design of Educational Spaces: An Experiential Approach

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Abstract

Classrooms can have an impact on enthusiasm towards learning and aid teaching; given the day-to-day experiences and difficulties teachers endure, they possess a unique perspective on how to better facilitate the tutoring experience in their classrooms. Existing review of literature indicated clear areas for improvement in classroom design using participatory design (PD) approaches where virtual reality (VR) technologies can be utilized as an effective tool to facilitate this collaborative process. To address some of the existing knowledge gaps in this area, a study was designed to gauge teachers’ views on the teaching environment of their classrooms to be used to develop a collaborative design tool in VR. Considering the conventional nature of classroom design, the feedback collated from the survey was used to provide designers with the end-users’ input they were otherwise less likely to be able to incorporate into their design. These findings were used to design a VR experiment to facilitate teacher’s participation in the design process. The findings indicated that the teachers showed a surprising level of awareness of the design elements in educational spaces and the approach of this study. It was also noted that some of the teachers’ implicit knowhow regarding the design and layout of their classroom was very difficult, if possible, at all, to capture and apply using more conventional collaborative approaches to design, hence the significance of the current study.

Keywords

Virtual Reality, Participatory Design, Design Collaboration, Educational Spaces, Classroom Design

(Paper, ID 74)

The Future of Automated Plant in Construction – A UK Perspective

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Abstract

Within the construction industry, heavy mobile machinery is typically known as plant. Plant has seen a transformation from its earliest, animal powered form, through steam and combustion engine driven machines through to the modern multifunctional devices applied in construction across the globe. However, construction is facing a number of significant social, environmental, and technical challenges. In response there has been a rising interest in the use of digital and automated technologies which can be applied to the construction sector. One particular aspect of this is the use of Connected and Autonomous Plant (CAP) to replace traditional, human operated machinery. Incorporating CAP as part of the wider digitalisation of the construction industry promises to deliver gains in productivity, safety, welfare, sustainability, quality, and cost. However, the achievement of these benefits will require a step change in the approach to the design and construction of plant, and in the way that plant operates on construction sites.

This paper presents a potential future for the deployment of plant on construction sites. It discusses how sites could evolve to accommodate the new role of CAP and how people and CAP will need to work together. It discusses how National Highways have been seeking to drive transformation in construction through the development of a vision and roadmap for CAP, which encourages all stakeholders to collaborate and aims to catalyse the development and adoption of these technologies.

Keywords

Connected Autonomous Plant, Construction, Automation, Autonomy, Digitalisation.

(Paper, ID 75)

An Investigation of the Adoption of BIM and Value Engineering Barriers in the South African Construction Industry.

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Abstract

BIM has proven to be a great tool to facilitate Value Engineering. BIM and Value Engineering are tools that help projects be completed on time and within budget and can increase stakeholder involvement. This paper, therefore, presents findings on the barriers contributing to the level of implementation of BIM and Value Engineering in the South African construction industry. Primary data was obtained through unstructured interviews. BIM experts and

construction professionals who work with BIM were interviewed. Secondary data was obtained through a systematic review of literature from different academic sites, namely, google scholar, Scopus, Taylor Francis and ASCE Library, based on keywords related to the study. The findings confirm that BIM and VE are practised in the construction industry in South Africa, and the participants found them to be a valuable experience that is efficient and effective. The findings also confirm that although BIM is used, there are barriers to its adoption, which affect Value Engineering processes. These include lack of skills, high cost, lack of government involvement, BIM Infancy, IT Infrastructure and Resistance to change. The study addresses barriers that construction professionals encounter in implementing BIM and VE. This could lead to efficient problem-solving techniques and strategies based on the identified barriers.

Keywords

BIM, Value Engineering, Stakeholder buy-in

(Paper, ID 76)

Sustainability Culture in UAE Construction Companies – A Snapshot Assessment and Improvement Guidelines

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Abstract

The construction industry is the largest employer worldwide and shifting the core values and culture of construction companies toward sustainable practices could lead to significant progress in that direction. Hence, this paper investigates the current state of integration of sustainability maxims in the United Arab Emirates (UAE) construction industry and provides guidelines that facilitate employee awareness and attitudes modification towards sustainable practices. The study was conducted via a comprehensive literature review to identify the best practices utilized by companies to realign employees' mindsets with sustainability goals. A series of interviews with experts in the UAE construction industry were then carried out to validate the approach and create tailored guidelines. The developed guidelines were used in a survey form to collect data and assess the key professionals' attitudes towards these relevant practices. The study results indicated a reasonable level of awareness and that implementation of practices to foster the culture of sustainability in the UAE construction companies is underway, with the main emphasis on training and education followed by leading initiatives and

introducing incentives. The results also show that 80% of the survey participants assessed the identified practices as important, which shows a reasonably strong trend towards establishing a sustainable culture.

Keywords

Sustainable Culture; construction companies; Sustainable Practices; Green Culture; Organizational Culture; Sustainable Construction.

(Paper, ID 78)

Building Information Modelling at the Design Conceptual Phase and Effect on Project Quality and Budget: A Review

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Abstract

Building Information Modelling is revolutionizing the workflow and processes in the industry and the design approach in creating building models. Among the stages of design, conceptualisation is being affected by BIM adoption as well. BIM has brought a lot of benefits to design but still designers are struggling to implement BIM at the very early stage of the design process. Thus, this study has been conducted to investigate how BIM is transforming concept design process and what could be the possible answer to overcome the barriers of BIM adoption at conceptualisation. From previous studies, the transformation of the design process within BIM methodology is explained and also general features of concept design stage are depicted to study its transformation within the evolution of Information Modelling. The study preferred reporting items for systematic reviews and Meta-Analyses (PRISMA) was used to identify inefficiency in construction design and conceptual phase, its effect on project quality and budget. To identify benefits and barriers to BIM at the design and conceptual phase this study presents preliminary findings based on twenty journal articles from an extensive review of a larger study. Findings from the review of the journal articles revealed the benefits and barriers to BIM at the design and conceptual phase and identify inefficiency in construction design and conceptual phase and its effects on project quality and budget.

Keywords

Building information modelling, Design, conceptual phase, systematic review.

(Paper, ID 80)

Resilience in Construction Robotics and Human-Robot Teams for Industrialised Construction

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Abstract

Recent conversations in the built environment have been centered on the need for the built environment to be resilient and responsive. This has become imperative due to recent shock events such as the pandemics, which has revealed the sector's vulnerability in the face of shock events. However, sectors cannot be resilient and responsive when systems, processes and workflows are not built to be resilient. This paper, therefore, brings to the fore issues on the resilience of construction robotics, indicators for resilience in construction robotics, and why resilience is inevitable. Through a PRISMA construed systematic literature review, the paper links different theories and concepts from the social sciences and engineering to answer its applicability to the research objectives for built environment resilience. The study's findings inspire further conversations on the resilience of emerging digital technologies for the fourth industrial revolution and their potential to achieve a resilient and responsive AEC sector.

Keywords

Resilience, Construction Robotics, Human-Robot Teams, AEC

(Paper, ID 81)

Influential Factors Affecting the Diffusion of Building Information Modeling in South African Construction Projects

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Abstract

Sustainability has become the focus of many clients in construction projects, but conventional construction stakeholders' services do not promote sustainability throughout the construction process. Conversely, Building Information Modeling (BIM) has been identified as a tool that construction stakeholders can use to enhance the

sustainability of construction projects. However, the majority of South African construction projects still do not utilize BIM. Therefore, this study aims to understand the influential factors affecting the low adoption of BIM in South African construction projects. To achieve the aim of the study, the research study implemented the qualitative research approach. The data collected from semi-structured interviews with several South African BIM experts produced invaluable qualitative data. The collected data was thematically analyzed to extract key findings and themes concerning the key influential factor and their sub-factors on BIM adoption in construction projects. Four identified influential factors and their sub-factors affecting the diffusion of BIM emerged deriving from the findings discussed in the research study. Based on these findings, it was proven that BIM could improve the sustainability of construction projects. Numerous conclusions and recommendations were proposed in this research study targeted at increasing the adoption of BIM intended to enhance the sustainability of construction projects.

Keywords

BIM, Construction projects, Influential factors, Level of adoption, South Africa.

(Paper, ID 82)

BIM and Building Resilience: A Hybrid Mechanism to Integrate Measures against Flooding

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Abstract

For over a decade, there has been a rapid progression in applying the use of Building Information Modelling (BIM) across the whole life cycle in a construction project. Despite many of the benefits that BIM offers, there is limited evidence that portrayed the role that BIM plays in improving the resilience of built assets, especially against unprecedented events such as flooding. To date, many flood resilient measures were introduced, however, a hybrid mechanism that integrates these measures collectively integrating stakeholders' needs and requirements is currently lacking. This research aims to portray the role of BIM in facilitating an integrated mechanism toward improving the resilience of built assets against flooding. Data was attained using secondary data from existing studies in the literature and primary data using semi-structured interviews with six experts from one of the city councils in the UK. The findings show that despite the progressiveness of measures against flooding, it is often targeted at an urban level with limited emphasis at a building level. The analysis supported pointed out the role that BIM can play in

improving the resilience of built assets through informing design elements, which can support providing more informed decisions. The paper proposed a hybrid mechanism that supports recognizing BIM's role in integrating resilience measures of the built assets against flooding. Future work will examine the effectiveness of the proposed mechanism in a real-life scenario.

Keywords

BIM, Flooding, Resilience, Design, Risk.

(Paper, ID 83)

Earned Value Management with the Use of Building Information Modelling

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Abstract

Building Information Modelling (BIM) is rapidly becoming the prevailing approach for the delivery of construction projects. While, cost monitoring and control is among the main processes supported by BIM, the widely applied Earned Value Management (EVM) method has not yet been adequately introduced in the BIM context. This paper provides a simple walkthrough on how to easily apply a BIM-based EVM. The presented approach is based on the integration of BIM technology and EVM method in a single software platform (AUTODESK's Revit), thus minimizing manual handling and consecutive errors and more importantly facilitating a fast and accurate decision-making process on cost and time control issues. The integration is validated through a case study of a building project that explicitly demonstrates the various implementation steps of the presented three-stages process and provides an example for construction project control practitioners of BIM-based EVM in construction projects.

Keywords

Building Information Modeling, Earned Value Management, Earned Value Analysis, Project Monitoring, Project Control.

(Paper, ID 84)

Electric Vehicle Charging Stations Deployment Optimization using Genetic Algorithms

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Abstract

The incorporation of electric vehicles to the transportation system is considered to be imperative in order to mitigate the environmental impact of fossil fuel use and alleviate the current energy crisis. For that reason, it is of critical importance to establish methods for determining the location of the charging infrastructure in an optimal way. This study uses Genetic Algorithms to develop an optimization model that determines the optimal locations to place the charging stations and the number of stations that need to be deployed. This is implemented by combining into a linear objective function the goals of maximizing the electric vehicle user satisfaction (minimum travel distance) and minimizing the construction, operational, and maintenance cost for the charging stations deployment, while considering the user charging demand and the service area. The model has been applied to a simple project consisting of a 200-EV fleet and is tested for various scenarios in order to provide insight regarding the effectiveness of the algorithm by examining the quality of the solution and the required computation time. These scenarios assess the model efficiency in finding either the coordinates of the stations or both the required number of stations and their exact locations, while investigating how different initial solutions, in terms of number and distribution of the charging stations, affect the optimization outcome. Evaluating results indicate that the proposed model can effectively approximate the optimal solution in all cases.

Keywords

Electric vehicles, Electric vehicle charging stations, Charging station placement problem, Genetic algorithms, Multi-objective optimization

(Paper, ID 85)

Cementitious Paste Defects Correlated to Engineering Properties of Concrete

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Abstract

This study was aimed at investigating potential correlations between microstructure properties of cementitious paste samples and bulk properties of hardened concrete. In this study, defects in paste samples were detected and quantified by using X-Ray Micro-Computed Tomography (μ -CT) technique. These quantified defects in paste samples were correlated with bulk properties of corresponding concrete -

electrical resistivity, drying shrinkage and degree of hydration from eight cementitious combinations. The results showed correlations between the degree of hydration in concrete and defects in paste. Additionally, the degree of cracking of paste samples can help predict drying shrinkage of resultant concrete.

Keywords

Cement paste, microstructures, X-Ray Micro CT.

(Paper, ID 86)

Problem-Based Learning (PBL) for a Construction Capstone Course: Assessment Through Competing Values Skill Surveys (CVSS)

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Abstract

It has been widely recognized that traditional lecture teaching techniques in higher education may leave gaps in the skill development of students, especially soft skills. This gap can prove to be detrimental to graduating construction engineering and construction management students, as well as to their potential employers. But essential skills required to function effectively in the industry such as leadership, communication, mentoring, collaboration, and stress coping can be inculcated in students by implementing alternative teaching techniques such as Problem-Based Learning (PBL). It is therefore important to assess and quantify changes in soft skill development among students due to PBL. In this study, PBL was administered in a course titled "Construction Management Capstone" during the spring of 2015 by the Department of Construction Management and Engineering at North Dakota State University. By using an assessment tool called Competing Values Skill Surveys (CVSS), it was concluded that PBL can have positive impacts on certain soft skills, predominantly in collaborative and control-focused competencies, with some improvements in creative and competitive-focused competencies.

Keywords

Problem Based Learning (PBL), engineering education, capstone, soft skills, CVSS

(Paper, ID 87)

Mapping the Dynamics of Emerging Technologies Research Trends in Africa vis-à-vis Built Environment-Related Studies

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Abstract

Compared to the conventional ones, emerging technologies (ETs) offer numerous benefits and potentials in the health and safety, digitalization, and sustainability of the construction industry (CI). To mitigate the adverse impacts of conventional materials and technologies on the human and natural environment, ETs are perceived as a panacea, especially in this fourth industrial revolution (4IR) era. However, the global research and development (R&D) focus and discourse on the subject of ETs is pioneered and is continually dominated by the developed or western countries. On the African continent, the uptake, implementation, and utilization of ETs remain in their infancy despite their potential in aiding the transition of the CI to a sustainable and 4IR-compliant sector. Hence, this study is aimed at analyzing and visualizing ET research publication outputs in Africa. A quantitative method was used to analyze the 60 bibliometric datasets extracted from the Scopus database. The datasets are ET research publication outputs from 1990 to 2022. The findings presented the trend, citations, document sources, co-occurring keywords, and most-cited ET research in Africa. The study recommends that African research and higher education (HE) institutions should embrace and commit to research, teaching, and learning on ETs to bridge the knowledge gap between Africa and the rest of the world.

Keywords

Construction Industry, Emerging Technology, Fourth Industrial Revolution (4IR), Africa, Sustainability.

(Paper, ID 88)

Evaluating the Relationship Between Socio-Cultural Diversity and Collaboration Among Project Teams in Johannesburg, South Africa

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Abstract

The built environment sector is characterised by collaborative working relationships, which are traditionally adversarial, fragmented and incapable of delivering for its customers. The diversity of teams partly contributes to projects not being initiated, executed, and completed within a specific scope of time, budget, and quality, since collaboration between individual and alliance members could be affected. There is limited literature evincing this relationship, which could contribute to improving project success. Therefore, the objective of the study was to establish the relationship between team members' attributes (including socio-cultural diversity, level of association, social interaction) and collaboration. A quantitative approach was adopted to conduct the study. The study amassed data using a questionnaire distributed among eighty respondents, comprising engineers, supervisors, foremen, contractors, project managers, and other decision-makers in engineering, construction, and consulting companies in Midrand, Sandton, and Johannesburg in South Africa. Inferential statistical analysis was undertaken using Pearson's correlation to examine the relationship between team attributes and collaboration. Findings revealed positive and medium to relatively high significant relationships between the variables, indicating that the more the level of association, diversity, and social interaction among team members, the more collaboration among them. The findings from the study are envisaged to be beneficial to construction and project managers in managing teams with diverse social backgrounds and orientations. It was concluded that team collaboration could be maintained even though high social and cultural diversity exists.

Keywords

Collaboration, construction industry, diversity, socio-culture, South Africa

(Paper, ID 90)

Variation Orders add or Non Value Add- A case of South Africa

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Abstract

Construction project rarely reach completion stage without variation orders being issued by the client's representative, and variation orders can be good and bad for the project. Moreover, variation orders cannot be avoided completely, they can be minimised or prevented if their origin and

causes are clearly known. The greater the knowledge and awareness of non-value adding activities associated with variation orders, the greater the prospect of their avoidance and consequent reduction of overall construction delivery costs. This paper focuses on variation as a value add or wastage. Quantitative approach was adopted for this study, structured questionnaires were distributed online and 159 were received and analysed. The questionnaire was distributed to various construction professionals and contractors. Factor analyses was conducted, correlation matrix, coefficients has also been conducted to ensure visibility of co-efficients greater than 0.3 and Kaiser-Meyer- Oklim (KMO) and Bartlett's were conducted. From the study it transpired that waste of time, which resultant more labour charges, waste due to wrong use of material or wrongly specified, time and cost reduction, waste of material after demolition of a portion of work, compensation waste of resources such as unnecessary increased project budget, waste due to uneconomic use of machinery or lying idle on site due to change orders were the non value add of the variation orders. This non value add variation orders affect the productivity of construction projects. Therefore, proper channels of communication and planning should be in place, to reduce the occurrence of variation orders in construction projects.

Keywords

Demolition, Idle, labour, Materials.

(Paper, ID 91)

Drawbacks to the Attainment of Sustainable Road Infrastructure in South Africa

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Abstract

In the quest to attain sustainable cities, sustainable infrastructures such as roads are vital to the everyday activity of dwellers within every community. However, roads within the rural areas are in most cases adjudged to be defective and unsustainable. This unhealthy situation tends to cripple activities within these rural areas in many ways. It is based on this view that this study assessed the causes of defective road infrastructures within rural communities in Limpopo province of South Africa. The study sought answers from rural dwellers and construction workers within the study area through a questionnaire survey. Data gathered were analysed using percentage, mean item score, and factor analysis. The reliability of the questionnaire was also tested using Cronbach alpha. Findings revealed that the principal causes of defective road infrastructure in rural areas are government/municipalities related, construction and maintenance related, and traffic and weather-related. It is believed that the findings of this study will help increase the

delivery of sustainable road projects within the rural areas in a bid to provide a better standard of living for rural dwellers.

Keywords Defective roads, Sustainable infrastructure, Rural dwellers, South Africa

(Paper, ID 92)

Digital technologies for Effective Value Management in the Construction Industry

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Abstract

This study presents the result of an assessment of the drivers of digital technology diffusion in the value management (VM) process in the construction industry. This was done with a view to improving the use of digital technologies in the quest to create value for construction clients. The study adopted a quantitative research design which informed the use of a structured questionnaire administered to construction professionals that have participated in VM exercises within the South African construction industry. The data gathered were analysed using mean item score, standard deviation, Kruskal-Wallis H-test, and exploratory factor analysis. The study found that the use of digital tools to improve VM process is driven by three major components viz: (1) VM process requirement, (2) digital culture of the construction industry, (3) knowledge and understanding of the need for digital tools. The use of relevant technologies will help improve the speculation and creative phase of a VM workshop, the evaluation phase, the presentation of best value alternatives, the gathering of preliminary information and the overall success of the VM workshop. This study provides a theoretical backdrop for future studies exploring the use of digital technologies for VM practices – an aspect that has not gained significant attention in VM discourse in the construction industry.

Keywords Construction industry, Digital technology, Value for money, Value management

(Paper, ID 93)

A Smart Contract Framework as an Alternative Method for Letter of Credit Use in Construction Procurement

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Abstract

Letter of credit (L/C) use in construction procurement is a common practice particularly for international trades. L/C is a commitment of banks which reduces buyers' and suppliers' risks related to transactions. In international trades both buyer and supplier need a third-party involvement in order to ensure smoothness of procurement procedures. However, third party involvement makes trading more cumbersome, add extra fees, credit limit of individual parties may affect the whole process adversely and it is lack of physical control over delivered items such as materials or equipment.

A more reliable, cheaper and faster framework is proposed in this paper as an alternative method to common use of L/C. This framework is based on smart contracts where contractual agreement is made in a decentralized blockchain with smart contracts. Different from routine L/C practice, physical control over delivered item is possible using IOT devices and it makes whole procurement procure more straightforward, cheaper and more reliable.

Keywords

Smart Contracts, Letter of Credit, Construction Procurement

(Paper, ID 98)

Mechanical Characteristics and Durability of Concrete Made with Treated Domestic Wastewater and Recycled Concrete Aggregates

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Abstract

Massive amounts of fresh water and natural aggregates are annually used for concrete applications, resulting in a rapid depletion of freshwater and natural aggregate resources. This necessitates the need of replacing fresh water and natural aggregates with recyclable materials such as treated wastewater and recycled concrete aggregates (RCA). This study, therefore, investigates the mechanical characteristics and durability of three concrete mixes with different concrete mixing water types (fresh water and TWW) and coarse aggregate types (natural aggregates and RCA). Tests performed were concrete compressive and flexural tensile strengths and electrical resistivity. Test results showed that concrete with TWW recorded 6%, 7.9%, and 5.4% lower

compressive strength, flexural tensile strengths, and electrical resistivity than conventional concrete, respectively. Furthermore, the combination of TWW and RCA resulted in improving the compressive strength and electrical resistivity by about 10%, whereas it increased the flexural strength by 9.2% compared to concrete mixes with TWW and natural aggregates.

Keywords

Treated wastewater, Recycled concrete aggregates, Mechanical characteristics, Durability.

(Paper, ID 99)

Design Error Costs in Commercial Construction Projects: The US Perspective

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Abstract

Design errors are a part of almost all construction projects, and they have led to considerable impact in terms of project costs, quality and performance. These errors have contributed to project failures and deliberate efforts are required to analyze and restrain them for successful completion of projects. The objective of this study was to determine the magnitude of design error's costs in mid-sized commercial projects in Atlanta, US with project value up to 20 million, regardless of procurement or contract methods. The research methodology includes collecting data from industry experts who have completed projects in this range through a structured survey questionnaire. In addition, few general contractors were also interviewed in person to seek responses on design-error-based cost increases in their projects. The intended audiences for this study are design professionals and design firms associated with commercial construction projects. This study concluded that design errors, irrespective of contracting methods, contributed to an increase of up to 8 % of project cost in commercial construction projects.

Keywords

Design errors, error costs, project costs, commercial construction, procurement methods.

(Paper, ID 102)

Framework for the Classification of COVID-19 Force Majeure Delay Events

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Abstract

Time is always of the essence in the construction industry, and all projects depend on timely execution for their success. All stakeholders aim to achieve a project's goals within the time constraints set during the planning stage. However, delays do occur, and often some could be due to foreseen or unforeseen risks or an act of God. Moreover, the current outbreak of COVID-19 has meant that the construction industry suffered even more delays. Most of the delays are labelled as force majeure which are events that cannot be foreseen by any party due to the outbreak; however, significant consideration of an event's material circumstances and the forecast-ability of the specific reasons for the delay are required before this labelling is considered in its legal sense. Thus, this study aimed to develop a framework for the identification of delay events during the outbreak of COVID-19 via a logistic regression model, and assessed if such events could be labelled as force majeure. The study examined the literature to identify the factors that lead to the delay event and the force majeure conditions. Moreover, data was collected from industry experts in semi-structured interviews to identify and confirm the factors that are usually considered when a claim of force majeure is evaluated. Finally, the study developed a framework and a Claims Scoring Metric (CSM). The CSM saves contractors the cost of preparing ineligible claims and saves the project owner the cost of reviewing such claims. It assists in the initial identification of delays caused by the COVID-19 pandemic before a thorough evaluation is needed. The framework was validated via a case study with results matching the outcome of the delay analysis.

Keywords

Project Delays, COVID-19, Force Majeure, EOT, Claims Scoring Metric.

(Paper, ID 103)

Utilizing the EC3 Calculator to Compare the Environmental Impacts of Mass Timber and Structural Steel

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Abstract

Due to the popularity of lean construction and sustainability, utilizing carbon analysis to form educated, well-informed decisions for a more sustainable built environment can provide a strong case for mass timber construction. This

dissertation uses extensive embodied carbon analysis of structural steel and mass timber during the preconstruction phase of a project using data from incomplete construction documents of a confidential project. A critical review of previous literature was conducted and used as precedents for the research. The data from the project estimates were input through the Embedded Carbon in Construction Calculator (EC3 Calculator) to provide extensive total carbon emissions measurements with emphasis on structural steel and mass timber. The data indicated that using structural steel as the primary framing option would decrease the project's overall environmental impact by roughly 84% compared to using mass timber. Additionally, implementing strict sustainability plans on the job site and responsible sourcing of materials can lead to a potential 54% reduction in the project's overall carbon output. From the results, detailed, data-driven decisions can be made regarding the project's more sustainable framing option. The results provide additional evidence supporting mass timber as a sustainable framing substitute for structural steel.

Keywords

Mass Timber, Structural Steel, Preconstruction, EC3 Calculator, Carbon Analysis.

(Paper, ID 104)

Drivers of Industry 4.0 Implementation in the Construction Industry

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Abstract

The construction industry significantly influences the economy and development of a country. However, the construction industry is conservative and cannot make quick changes. The main reasons are the uncertainty and complexity of the construction projects. Compared to the speed of development of the manufacturing industry, the construction industry is relatively slow to change the usual practice and develop technologically. Therefore, the construction industry must review and implement modern technologies that make the construction processes faster and cheaper. The fourth Industrial Revolution may become a decisive factor and a driver for its development. This work analyzed the importance of Industry 4.0 for the construction industry and the main driving factors for its implementation. Its driving factors are technological, economic, social, and environmental. The state of the construction industry in Kazakhstan was studied using the example of a leading construction company. The results yield that private construction companies should investigate and implement more digital technologies. The limitation of the part about Kazakhstan is the lack of available information due to low transparency. Thus, more companies with various statuses and from different locations should be evaluated for a more rigorous analysis.

Keywords

BIM, Construction Industry, Cyber-physical systems, Industry Revolution 4.0, IoT

(Paper, ID 105)

A New Metric for Labor Productivity: Case Study of a Multi-Family Residential Project

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Abstract

The aim of this study is to present a labor productivity metric analysis with a case study. The objectives of this analysis include (1) to help project managers compare the project progress with labor productivity and take managerial actions quickly regarding the project performance; and (2) to fill the gap in the literature on case study-based labor productivity examinations of repeated construction units. In the first step of this research, a literature review was conducted on the productivity measurement of labor in the construction sector. After the literature review, the labor productivity metric was developed as a gap analysis that uses labor productivity to revise the schedule in project management and make quick decisions. A case study of a multi-family residential project involving multiple repetitive processes was performed to identify challenges and lessons learned. According to the results of the case study, a delayed project was rescheduled using efficiency data. During the case study, interviews with experts involved in the project were conducted, and relevant site reports were examined for data collection. The consensus of the experts is that the metric is useful and applicable. However, in order to increase the practicality of the metric, it is necessary to try it in more numbers, on a larger scale and in some specific projects, and to create a broad knowledge base.

Keywords

Worker Productivity, Case Study, Schedule Delay, Project Controls

(Paper, ID 106)

The Identification of Underpinning Criteria of Employee Mental Health and Wellbeing in the Construction Industry

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Abstract

Over time, the concept of mental health has been viewed as a critical issue for a community's well-being and a nation's success. Where one out of every four people on the planet suffers from some type of mental health problem, resulting in a global economic cost of one trillion dollars per year in lost productivity. As a result, it is critical that the concept be adopted as part of the policymaking process and political agenda. Several research on the idea of individual mental health have been documented in the literature. However, one component of personal life, the work-life, was not addressed in depth. Though the literature has proposed criteria and scales for mental health. However, these studies and scales, are narrowly focused on a certain component and set of criteria that affect employee mental health and wellness. Furthermore, there has been little or no report of mental health studies in terms of conceptual framework in the construction industry. As a result, the aim of this research is to identify the set of underpinning criteria that describe employee mental health and wellbeing in the construction industry to propose a conceptual framework.

Keywords

Mental Health, Construction sector, Social Sustainability, Employee Wellbeing

(Paper, ID 107)

An Analysis of Contract Modifications: USACE Jacksonville District, Jacksonville, Florida

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Abstract

Construction projects generally solve someone's problem or situation whether it be new construction, renovation or operations and maintenance projects. During the process of solving these problems, various issues arise along the way and must be addressed. These issues lead to changes and result in modifications to the contract called change orders. From 2003 to 2019, U. S. Army Corps of Engineers, Jacksonville District awarded four hundred fifty-seven (457) construction contracts and executed a total of four thousand six hundred seventy-seven (4677) contract modifications on these contracts. This research seeks to identify the causes of these change orders and determine if actions could be taken on future contracts to reduce the number of change orders. The results of this study indicate that additional design phase and pre-award activities such as additional scrutiny, review and vetting have a definite possibility to reduce the number of these types of change orders. This study is relevant to USACE project managers, construction contract administrators, and other Construction Management Professionals.

Keywords

Change Orders, Government Contracts, U. S. Army Corps of Engineers, Jacksonville District, Contract Administration

(Paper, ID 108)

Artificial Neural Networks for Predicting Conventional Cost of Industrial Construction Projects

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Abstract

Artificial neural networks (ANN's) are an important tool for solving complex problems leading to an extensive application in project management. For that purpose, the aim is to develop a model to predict the actual cost of construction projects related to industry infrastructure. A literature review is carried out on the latest research regarding the application of ANN's in the construction industry followed by the relevant findings. Then the research methodology for the implementation of artificial neural networks is presented, and finally construction of ANN based models took place, based on a sample of 20 industrial construction projects.

The most successful models for forecasting actual cost of industrial construction projects are presented and the results are considered satisfying despite the limited amount of case studies. The considered independent variables included: Type of premises, contact with neighboring construction, distance from headquarters (km), project budget (€), initial project duration (days), area of premises (m²), earthworks (m³), reinforced concrete (m³), metal bearing construction weight (tn) and finally average daily number of workers. Finally, ANNs' predicting capabilities is discussed, showing great accuracy, and a number of suggestions are presented for further improvement and future research.

Keywords

Project Management, Project Organization and Planning, Artificial Neural Networks, Industrial Projects, Cost Forecasting.

(Paper, ID 123)

A Comparative Study on Dispute Resolution in Industry and the Departments of Transportation

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Abstract

Construction industry disputes are common, and the amounts in dispute generally tend to be high. Dispute Resolution (DR) helps the resolution of antagonisms between parties involved in the process. It can also be used interchangeably with conflict resolution when the conflicts are more profound and complex than disputes. Several DR methods can be implemented in construction projects. However, there are differences between the "industry" where arbitration is frequently utilized and the state Departments of Transportation (DOTs) where arbitration is not used as common. The reason is that DOT has an internal claims resolution process. When exhausted with an unacceptable result to the contractor, the contractor's only option to "appeal" the decision is to file suit against the DOT in the state's claims court. Several concepts have evolved to resolve claims on a relatively informal basis through early cooperative intervention. Standard practices in different states are seen under Negotiation, Mediation, Dispute Review Boards, Arbitration, and Litigation. This research provides a comparative study of arbitration and litigation on DOT projects among several states. The current dispute resolution methods utilized by various Departments of Transportation in the U.S. versus industry were examined with a particular focus on analyzing the use of arbitration and its outcomes compared to litigation. Arbitration can be more efficient in time and money, and therefore stands to be a valuable tool in dispute resolution for DOT construction projects; it is known that states function differently about arbitration resolution, but the need to analyze the variations exists if the industry is to identify a best practices approach that harmonizes the processes between the states and industry in the US.

Keywords

Disputes, Arbitration, Mediation, Negotiation, Litigation

(Paper, ID 124)

Evaluating the Benefits Experienced by Professional Women Working in the Construction Industry in South Africa

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Abstract

The construction industry is male-dominated and has been viewed as a hostile environment for women to work and

thrive in it. However, despite its hostility towards the female gender, some women have thrived and are successful in the construction industry. Therefore, the aim of this study was to determine the benefits the professional women working in the construction industry in South Africa have experienced while they continue to work in a male-dominated construction industry. To achieve the purpose of this study, a deductive research approach was adopted. An electronic questionnaire survey was used to collect the data. An exploratory factor analysis and reliability analysis was conducted to determine the validity and consistency respectively of the questionnaire. A total of 110 respondents participated in the research study. The findings deduced indicate that the professional women have gained confidence which has enabled them to manage construction projects, gained technical skills and are able to mentor other candidates in the field.

Keywords

Benefits, Career, Construction Industry, Gaining Skills, Professional Women

(Paper, ID 125)

Reengineering Project Management Processes for EPC Contractors: A Saudi Arabia Case Study

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Abstract

Engineering Procurement Construction (EPC) contracts provide an effective framework for projects where integrated interdisciplinary engineering expertise is required for large-scale industrial projects such as power generation, processing plants, oil and gas sector, and mining development projects. However, project management processes in EPCs contracts are complex due to overlapping project phases, interface management among the project stakeholders, and specific requirements of various industrial sectors. Hence a complex and well-integrated project management process is required to deal with the structural, technical, directional, and temporal complexities of EPC projects. This paper presents research findings of a study that investigated the project management performance of an EPC contractor on a large power transmission revamps project in Saudi Arabia. The research findings are based on a single case study research methodology that investigated EPC contractor's project management processes using a detailed project audit including site visits, document review, team interviews and focus group sessions with various project stakeholders. This paper presents the overall case study, identified gaps in capacity and competencies of the EPC contractor in various project management areas, i.e., initial planning and proposal development, engineering

management, procurement management, etc., and presented recommendations to enhance the project performance of the EPC organization.

Keywords

EPC; Case study; Project management; Process reengineering; Performance improvement; Saudi Arabia

(Paper, ID 128)

Automated Construction Progress Monitoring – Industry perspective

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Abstract

The project schedule is an important control mechanism, yet the construction schedule monitoring practices are largely manual and document-centric. This leads to poor tracking of project progress, resulting in delays, cost overruns, bitter stakeholder relationships, schedule changes, and legislative proceedings to settle construction claims. Advancements in technology (such as Building Information Models, Cloud Computing, Sensors, Computer Vision, IoT, etc.) have shown the potential to automate construction progress monitoring (ACPM) with real-time data tracking and reporting for effective decision making in managing construction projects. However, applications of these technologies are largely experimental and have yet not been adopted in the construction industry. The objectives of this paper are to summarise the potential of available technologies for automated CPM (ACPM), examine the current industry needs, and present the industry perspective on adopting ACPM. This paper presents the findings of a survey that assessed the awareness of the construction industry (CI) professionals regarding the available technologies and techniques which enable and facilitate ACPM. The research limitations and future work directions are also discussed.

Keywords

Construction Progress, Progress Monitoring, Automation, Awareness, Construction Industry.

(Paper, ID 129)

3D Concrete Printing; The Material Point

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Abstract

The growing application of automation in manufacturing and construction processes, leveraged by advances in computer aided design, presents a growing opportunity for 3D Concrete Printing technology (3DCP). This sector of additive manufacturing is receiving considerable attention with social and traditional media references to projects by companies achieving certain levels of efficacy generating a high level of public awareness of its potential. Our estimation is there's an emphasis on projects and equipment over 3DCP material science, and at this time open collaboration in research will support the development of the material science central to this technology.

Keywords

3DCP, 3D Concrete Printing, 3DCP Mix Design, 3DCP Mortar Mix Design, Open Source 3DCP, Mortar Rehology, Mortar Pumpability, Mortar Extrudability, Mortar Printability, Portland Cement, CSA Cement.

(Paper, ID 130)

Analysis of Personnel Retention Strategies within South African Construction Industry A Case Study Of Gauteng Province

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Abstract

Globally, the retention of skilled workers in the construction industry has been a serious concern to management due to higher turnover of professionals in the construction industry. The desired critical measures for retention strategies of skilled workers need to be done to sustain competition among construction professionals. This paved way for the study to analyze the current retention strategies within the construction industry in South Africa. The study adopted a source technique with the administration of a well-structured questionnaire to active stakeholders and professionals in the construction industry as well as interviewing human resource managers in the Gauteng Province of the South African construction industry. Data for this study was obtained through primary and secondary sources. The primary data collected was achieved through administering a well-structured questionnaire to 100 respondent

professionals in the construction industry, in which 75 respondents completed and returned the questionnaires. Data for this study were analyzed by percentage distribution. The questionnaires were administered to active professionals in the construction industry in the Gauteng Province of the South Africa. The findings of the study revealed that the significant retention strategies within the construction industry in South Africa are performance appraisal bonuses, training, also by Construction Education Training Authority (CETA), recognition, good working conditions and competitive salaries in some companies outside South Africa. The study concluded that all the retention strategies need to be improved because they have been found to have a positive and significant effect on organizational performance. The study recommended that stakeholders in the construction industry and management of construction organizations should improve on retention strategies because they have been found by this study to have a positive effect on the organizational performance and by extension, the construction industry.

Keywords

Retention, Training, Strategies, Organizational Performance, Construction Industry.

(Paper, ID 131)

An Investigation into the Causes of Job Hopping within South African Construction Industry A Case Study of Gauteng Province

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Abstract

This study was carried out to investigate the causes of job hopping within the construction industry in South Africa. The study adopted a source technique with the administration of a well-structured questionnaire to active stakeholders and construction professionals as well as interviewing human resource managers in the Gauteng Province of the South African construction industry. Data for this study was obtained through primary and secondary sources. The primary data collected was achieved through administering a well-structured questionnaire to 100 respondent professionals in the construction industry, in

which 75 respondent professionals completed and returned the questionnaires. Data for this study were analyzed by percentage distribution. The questionnaires were administered to active professionals in the construction industry in the Gauteng Province of the South Africa. The findings of the study revealed that the significant causes of job hopping within the construction industry in South Africa are money and recognition, personal growth and new challenges, lack of experience and bad treatment from managers, not working as a team, and circumstances surrounding the individual that requires him or her to job hop. The study therefore suggests that to drastically reduce the causes of job hopping within the construction industry in South Africa, stakeholders in the construction industry must come up with strategies used as retention strategies by companies from a neutral or fair extent and hence, its practicality and effectiveness to retain employees.

Keywords

Job Hopping, Causes, Strategy, Construction

(Paper, ID 132)

Perspectives of Women in Construction to Encourage More Women to Join Construction

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Abstract

Despite a range of equality legislation and initiatives in the United States Congress, the construction industry remains one of the most male-dominated sectors. The construction industry is one of the largest job providers in the U.S., and the construction industry suffers from critical labor shortages in the workforce. Research shows that women are significantly underrepresented in all the construction occupations and professions in the United States construction industry. For years, there has been a wealth of research and many initiatives to tackle equality and diversity in the construction industry, specifically concerning female representation. In this research a quantitative study was conducted using an online survey. Results indicate that there is a significant level of dissatisfaction within the female workforce in the construction industry. Opinions of a significant percentage of respondents indicate that they feel overlooked, that their opinions are considered and that they are underpaid. However, the respondents also provided valuable feedback to include more women to participate in the construction industry. Mentoring and equal pay were prominent answers to the question of empowering more women to join the construction industry.

Keywords

Women in Construction, Survey, Diversity and Inclusion

(Paper, ID 135)

Fatalities and their Root Causes in Pakistani Construction Industry

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Abstract

The Pakistani Construction industry is known to be second hazardous industry after our agriculture industry; reputed highly for its peculiar high rate of injuries, fatalities and deaths on construction sites. ILO (International Labor Office) report such incidences and identifies the type of accidents and their impact on the Labor Safety policies as it estimates 25-40% of occupational fatalities (rounding upto 60,000 fatalities occur on construction sites in industrialized countries which takes place each year throughout the world (ILO, 2005). Similarly, a questionnaire survey was conducted to determine the multiple accidents occurring at construction sites where the data was collected from multiple stakeholders. This research identified multiple occupational accidents like burning, structural failures, falling from height, struck by heavy objects, electrocution from faulty tools and many more; occurring on construction sites with high impact within the Pakistan Construction industry.

Keywords

Fatalities, Root Causes, Labor Safety Policies, occupational hazards, high impact, Pakistan Construction industry.

(Paper, ID 136)

Identification of Major Risk Events for Construction Industry

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Abstract

The construction industry is subjected to more risk than many other industries. One of the major parameters in every aspect of the project management life cycle is cost, and can be termed as one of the key variable of a project and have major impact on project success. Construction projects having many risk events that leads project to cost overruns. This study focused towards the identification and assessment of major risk events, causing overrun in construction projects of Pakistani construction industry. Study conducted with the identification of risk events by the literature review, 156 risk events were identified by the literature after through questionnaire surveys and some statistical

techniques, 156 risk events were shortlisted to 40 and were denoted as major risk events. Project cost overruns was also found out with the help of questionnaire surveys. Assessment of the events was done on the basis of risk score that is product of probability and impact.

Keywords

Construction Industry, Cost Overrun, Risk, Major Risk Events.

(Paper, ID 137)

An Empirical Assessment of Decision Making in the Public Procurement Lifecycle

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Abstract

Public procurement is generally an important sector of the economy and, in most countries, is controlled by the introduction of regulatory and policy mechanisms, National law in most countries regulates public procurement more or less closely in an attempt to prevent fraud, waste. The economic progress in the region, to be sustained, depends upon continuing improvements in public governance. One important hallmark of a high standard of public governance is a well-developed and efficient system of government procurement, which provides value for money. Though initially considered a clerical activity, public procurement has become one of the most important functions of the government for the following reasons. First, as the size and activities of the governments have increased in the last fifty years, the procurement outlays have also burgeoned, making them a substantial part of the annual budgets. The Bank is preparing the Sindh Public Sector reforms project. The project focuses on public financial management, procurement, and property tax. Various institutional reviews have identified that there is no data to substantiate the procurement performance of the various implementing agencies. While SPPRA is in the process of setting up the performance benchmarks and developing a monitoring and evaluation system, but currently there is no such data available. The findings are expected to aid in determining the root causes of underperformance of the procurement practices in Sindh, Pakistan.

Keywords

Public Procurement, SPPRA, Procurement Timeline, Probabilistic Analysis

(Paper, ID 141)

Optimizing Commuter Travel Times on Traffic Signals Using Phasing Techniques – A Pathway for Cost-Effective Intelligent Transportation

System

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Abstract

In recent times, population growth has contributed to increased motorization and urbanization in Pakistan which hinders traffic mobility. As a consequence, the country is faced with urban sprawl that leads to almost daily recurrent gridlocks on roads. Due to the changing landscape of the Central business district and suburban development, accessibility to workplaces is decreasing and people see cars and other automobiles as a necessary addition to their life. Burgeoning twin cities like Rawalpindi and Islamabad incur economic costs due to traffic congestion observed during peak hours, as people move to their workplaces, schools, colleges, business centers, recreational places, etc. through the main thoroughfare i.e. Peshawar Road, Rawalpindi highway. The traffic congestion has inflated the twin cities and is exacerbated due to a lack of proper transportation planning and design needs resulting in an imbalance between the demand and capacity of road networks. These traffic delays lead to road damages and environmental degradation and end up costing road users fuel costs in terms of lost time. Furthermore, the public well-being is impacted by air and noise pollution having health implications. The paper attempts to address and mitigate traffic delays and congestion issues on Peshawar Road, Rawalpindi by using pre-timed split and protected phasing with signal coordination, offset, and bandwidth techniques in the software Synchro Studio. The preliminary data for this research was collected through an extensive literature review, traffic counts, and the geometrical features of the Peshawar road highway. The current traffic condition analyzed, is based on pre-timed split phasing without signal coordination. Subsequently, improved design alternatives are considered for an efficient movement of vehicles which are based on pre-timed split and protected phasing with signal coordination. These simulations are modeled in Synchro to optimize road user travel time. The benefits of each phasing scheme are compared to conclude that protected phasing with signal coordination reduces the travel time and total delays of the vehicles traversing the corridor by up to 52.8 % and 56% respectively when compared with the prevailing situation.

Keywords

Travel time, Delays, Signal Coordination, Pre-timed Split, Protected Phasing, Delay costs, Traffic Signals

(Paper, ID 142)

Identifying Building Information Modeling

Potentials for Construction Dispute Avoidance and Resolutions

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Abstract

The time and cost invested in dispute avoidance and resolution are massive. Therefore, various studies on effective construction dispute avoidance and resolution have been conducted in the past. However, still many disputes related to time and quality of work have not been fixed to its true potential e.g., using adequate technologies. Building Information Modeling (BIM) assists project stakeholders to improve dispute avoidance and resolution in the planning, design, and construction stages. Therefore, identification of potential opportunities of BIM for efficient dispute avoidance and resolution in the construction industry and challenges faced for the adaptation of BIM for dispute avoidance and resolution are discussed in this paper which is related to design review, drawing generation, 3D Co-ordination, extraction of quantity take-off, record modeling, 4D or Phase Planning, and 5D or Site Operation Planning, etc. This paper mainly adopts a review-based methodology to identify the potential of BIM in this dimension of Dispute Avoidance and Resolution. It is learned from the review that the BIM-based approaches can support construction dispute avoidance and resolution. BIM models in a combination with some cloud-based services like primavera unifier can open a new way to deal with dispute avoidance and resolution.

Keywords

Building Information Modeling, Dispute Resolution, Dispute Avoidance, Technology.

(Paper, ID 143)

Water and Energy Retrofitting – A Case Study of Community Building

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Abstract

Efficiency and effectiveness are the decisive parameters for most of the appliances. It is the same when it comes to planning, designing, constructing, and maintaining a building. Less consumption of electricity and water are key parameters which are being focused by regulatory agencies, water authorities and a variety of stakeholders due to their

increasing cost, scarcity, and losses. Green community buildings serve this purpose of making buildings efficient, effective, and environmentally friendly. This case study took NED University Mosque as case study for community buildings. This study investigates; first the latest energy efficient equipment available in the local market to save the energy consumption, followed by economic analysis and its lifecycle cost for different Light-emitting diodes (LEDs) products, based on these parameters the most efficient energy equipment was selected. Water consumption was also considered and for that, different types of button faucets and aerator were analyzed and among them the best one was selected. The application of these alternatives in NED University Mosque proved to be more effective and efficient which is reflected in this study.

Keywords

Efficient, Green Building, Community, Energy and Water

(Paper, ID 144)

A BIM Based Model for Energy Efficient Retrofitting of an Existing Building – A Case Study

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Abstract

Construction sector is responsible and accounted for 40% of the energy consumption globally. As one of the largest energy consumers of the world, buildings have great potential to save energy (Liu & Ning 2019). It is also predicted that around half a million tons of CO₂ emission, each year is accredited to the energy use by the residential buildings; the use of retrofitting strategies for better energy efficiency of the existing buildings is the way forward. The improvement of the energy consumption of the already existing buildings represents a key challenge in the past but the modern technology and techniques provide a good platform to analyze what impacts any specific retrofitting strategy will have on an existing building. This research focused on to perform a detailed analysis of retrofitted strategies implemented on a 3D model of a library building (base model) of main campus of NED University. It is aimed to give a complete set of information about the 3D model development, energy analysis and life cycle cost analysis of different retrofitted energy efficient models. Retrofitted models that showed a payback period of the initial cost of the retrofitting, within six years were highly encouraged.

Keywords

Building Information Modeling (BIM), Retrofitting Strategies, Energy Analysis, LCCA, 3D Modeling

(Paper, ID 145)

Knowledge Management Framework for Integrated Project Delivery

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Abstract

Knowledge has become pertinent in this digital age, especially with the advent of Industry 4.0. Various forms of knowledge are continuously collected for use in the construction industry to overcome its fragmentation and many inefficiencies. Integrated Project Delivery (IPD) has been promoted as a delivery method because it relies on the involvement of all stakeholders during the project stages to successfully deliver a project with the highest value to the owner and lowest waste. This necessitates that all information must be shared with the stakeholders in a timely manner for swift and informed decision-making. Therefore, this paper proposes a framework for Knowledge Management (KM) in IPD projects using the Internet-of-Things (IoT). Firstly, the knowledge components in an IPD are discussed and classified into KM pillars. The framework is then delineated and discussed, which consists of four stages: data acquisition, data integration, knowledge management, and visualization. This framework is beneficial to IPD participants because it promotes the collection and storage of tacit and explicit forms of knowledge to create an inclusive repository. It also promotes real-time sharing of information for value-based decision-making.

Keywords

Knowledge Management, Integrated Project Delivery, Internet-of-Things.

(Paper, ID 146)

A GIS Evaluation for Accessibility to Wash Facilities in Mantapala Refugee Settlement

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Abstract

The paper sets to address the challenges of planning, implementing and monitoring of Water Sanitation and Hygiene (WASH) interventions in Mantapala Refugee Settlement (MRS) through combination of the paper-based method and geographical information systems (GIS). This method was used to assess the accessibility of WASH services by monitoring the interaction with other infrastructure such as the distance between water points and households. To incorporate spatial, qualitative and quantitative concepts, the research adopted the socio-spatial grounded theory and a non-experimental design specifically a cross-sectional study. The study identified 51 water points which translated to providing 31.88 litres per person per day (l/p/d) of clean water, with 75.69% of households covering less than 200 meters to fetch water. 21.88% of the households had decent latrines, 70.71% had permanent substructures and 7.41% had no latrines. 62 households walked less than 50 meters to the constructed refuse bays out of 3,574 households. The study concluded that organizations should consider employing this approach because decisions can be made with adequate information, leading to the optimization of scarce resources. Additional features such as contours made it possible to identify and avoid constructing dump sites/landfills along the flood-prone areas as well as a basis for designing drainage networks and solid waste management plans.

Keywords

Geographical Information system (GIS), Mantapala Refugee Settlement (MRS), United Nations High Commissioner for Refugees (UNHCR), Water Sanitation and Hygiene (WASH)