International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

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Jordan, December 18th - 20th 2025

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International Conferences on Digital Technology Driven Engineering 2025

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3rd International Conference on Optimization Driven Architectural Design (OPTARCH2025)
3rd International Conference on Engineering and Applied Sciences Optimization (OPT-iii2025)
1st International Conference on Digital Tools in Construction for Efficiency and Sustainability (DiGiCES2025)

Jordan, December 18th - 20th, 2025

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Table of contents

Preface xxi
Non-Financial Sponsors xxii
Committees xxiii
Acknowledgements xxv
ICDTDE_220: 6D Printing: Exploiting Full Programmability of Smart Structures through Additive Manufacturing 1
Stelios K. Georgantzinos
ICDTDE_222: A Systematic Review of Protective Shelters for Archaeological Sites: Design, Environmental Control, and Sustainability 2
Özge Deniz TOKÖZ1, Ali Berkay AVCI
ICDTDE_226: Towards Automated Summarization of Cybersecurity Reports Using Fine-Tuned Large Language Models 3
Jaybie Perigo, Ala Abdulhakim Al-areqi, Farnaz Farid, Farhad Ahamed
ICDTDE_238: Investigating Tribological Performance of Si3N4-hBN Ceramic Composite using BHARAT Approach 4
Mohammad Hayat, Sandeep Thorat, Sachin Ghalme
ICDTDE_240: Quantile Regression Modeling of Unit Gompertz–Poisson Distributions for Digital Optimization of Urban Water Leakage Reduction 5
Zahra Shokooh Ghazani
ICDTDE_250: Applications of Physics-Informed Neural Networks for Static Analysis of Plates 6
Nguyen Pham Dinh, George Papazafeiropoulos, Dai-Nhan Le, Quang-Viet Vu
ICDTDE_265: Design and Implementation of an Intelligent Question-Answering System for Low-Carbon Technologies in Green Buildings 7
Cunqian, You, Xiaobo, Chen, Xiaojun, Wang
ICDTDE_271: Application of negative pressure assisted filling method in contour control of soluble microneedle array 8
Shiming Du, Zhiwei Luo, Xueqiu You
ICDTDE_272: Analysis of Fluid Dynamics and Gas Flow Characteristics of Compressed Gas Ejection System for UAV 9
Xianwei Huang, Yu Ji, Song Li, Jiaojiao Han, Tong Yan
ICDTDE_273: Cross-embodied reinforcement learning control method for quadruped robots on complex terrain 10
Hongyi Hao
ICDTDE_274: Design of high-energy cathode materials for lithium-ion batteries based on first principles 11
Lei Zhu, Qianru Zhu, Huang He
ICDTDE_275: International Hydrogen Energy Trade Flow Forecast and Transaction Optimization Model Based on 5G and Blockchain 12
Zherong Zhang, Zixu Ding, Tian Su, Shuaixiang Xi, Xintong Bai, Tianwen Zhao
ICDTDE_276: Research on the Application of Blockchain Smart Contracts Driven by Generative Large Language Models in Industrial Automation 13
Wenlin Liu, Zhenzhou Zhou, Zikai Zhao
ICDTDE_277: Strength improvement of poured concrete in bridges in high-cold areas based on integration of vibration mixing and non-destructive testing 14
Yi Shen, Nurul Izzatul Lydia Binti Zaba, Nor Faiza Binti Abd Rahman, Kai Gao4, Zhao Li
ICDTDE_279: Compact and Smart: An IoT-Integrated Smartwatch for Gas Hazard Detection and Safety Alerts 15
Huu Q. Tran, Lai Thanh Thai, Srikanth H Kamath
ICDTDE_280: A High-Performance Gradient Descent MPPT Algorithm for Fast and Stable Power Extraction in PV Systems 16
Thanh-Dong Ngo, Huu Q. Tran, Srikanth H Kamath
ICDTDE_285: Unsupervised Anomaly Detection Using Segmentation and Object Localization for Real-Time Surveillance Applications 17
Shistiyah Mohamad Halid, Yan Chiew Wong, Faiz Arith1, Ser Lee Loh, Haoyu Zhang
ICDTDE_286: Product Classification by Weight Using Computer Vision and YOLO11n on Jetson Nano 18
Tran Van Hung, Huu Q. Tran
ICDTDE_287: Efficient CNN-Based Maize Leaf Disease Detection for Embedded Agricultural Applications 19
Jun Yi Thoo, Yan Chiew Wong, Ser Lee Loh, Elfadil Mohammed
ICDTDE_292: Real-Time Zero-Shot Object Grounding on Edge Devices with Vision-Language Models 20
Nurul Syaheera binti Ahmad Nazran1, Yan Chiew Wong, Syafeeza Ahmad Radzi, T. Joseph Sahaya Anand
ICDTDE_293: Identifying Systemic Super-Spreaders Using Triangulated Maximally Filtered Graphs 21
Hafizah Bahaludin
ICDTDE_294: Comparison of Credential Management Systems Based on the Standards of IEEE, ETSI, and YD/T 3957-2021 22

Abel C. H. Chen

ICDTDE_296: Implementing Management Accounting in Small and Medium-Sized Enterprises: Opportunities, Challenges, Constraints, and Development Strategies 23
Cong-Du Nguyen, Tran Duy Vu Ngoc Lan, Huu Q. Tran

ICDTDE_297: Aerodynamic Design and Structural Evaluation of a TPMS-Core, Composite-Reinforced Nose Cone 24
Nikolas S. Nikolaou, Panteleimon Bakalis, Antonis Fatsis, Stelios K. Georgantzinos

ICDTDE_299: Integrated Aerodynamic and Structural Design with Experimental Evaluation of a Solid-Propellant Model Rocket 25
Nikolas S. Nikolaou, P. Bakalis, Antonios Fatsis, Stelios K. Georgantzinos

ICDTDE_300: Traceroo: An Innovative Educational Game for Teaching Primary School Children English Writing Skills 26
Karima Boussaha, Samia Drissi

ICDTDE_303: EduSpeakAI: An AI-Powered Real-Time Speech Evaluation and Coaching System for Elocution and Public Speaking 27
Gowri Arun Menon, Sangheethaa Sukumaran, Sadhiya Saleem

ICDTDE_304: Generative IA for Cybersecurity Learning in Higher Education: A literature review 28
Salsabil Boukhari, Karima Boussaha, MakhloufDerdour

ICDTDE_305: Uncharted Models for Dropout Prediction: A Comparative Benchmark in Online Learning 29
Houssam Ahmed Amin Bahi, Karima Boussaha, Zakaria Laboudi

ICDTDE_306: Survey On Quantum Light And Its Applications 30
Phan Tuan Anh, Huu Q. Tran

ICDTDE_308: Using Thermoelectric Generators to Power Pipeline Monitoring Devices from Waste Heat 31
Amani J. Majeed, Elaf J. Majeed

ICDTDE_309: Stochastic Modeling of Corrugated Board Compression Using Random and Brownian Node Perturbations 32
Ricardo Fitas

ICDTDE_312: Discussion on Structural Facade Using Perforated Structural Wall Panel for Multi-Storey Buildings 33
Ilda Rusi

ICDTDE_313: Efficient Intrusion Detection with RNA Encoding and Random Forest Classifier on CIDDS-001 Dataset 34
Omar F. Rashid, Humam Al-Shahwani

ICDTDE_314: Unveiling the Latest Trends in Recommender Systems for MOOCs: A Review 35
Hadjer Mosbah, Karima Boussaha, Samia Drissi

ICDTDE_315: The Effect of Superplasticizers on the Strength and Elastic Properties of B30 Concrete 36
Botirov Bektosh, Botirova Nodira, Berdiyev Oblokul, Boboqulova Shaxzoda

ICDTDE_316: The Evaluation Climate-Resilient Infrastructure Projects to Encourage Digital and Optimization led Engineering 37
Aditya Singh

ICDTDE_317: Basketball Pose Coach: An AI-Powered Real-Time System for Shooting Form Analysis and Biomechanical Feedback 38
Chandrakala L1, Monish L, Manjula M1, Mahendra MK, Sameia Suha, Virika Olivia Soans

ICDTDE_318: Fortification of Iris Images: A Combined Approach using Pixel Transposition and Modified Logistic Map based Substitution 39
Manjula M1, Monish L, Shahedhadeennisa S, Chandrakala L, Akshatha Preeth P, Keerthan V

ICDTDE_319: Bank Customer Churn Analysis: Leveraging Power BI, Python & SQL Workbench for Predictive Insights 40
Mahendra MK, Prajwalasimha S N,Monish L, Manjula M, Shridevi Sali, Sameia Suha

ICDTDE_320: Research on Comprehensive Error of Digital Image Correlation Methods 41
Keqi Huang, Yikang Li, Junlong Zhou, Zhiyong Wang, Yanwei Wang, Yumeng Bai, Chenglong Ji, Jie Tang

ICDTDE_326: Knowledge Base-driven RAG System for Additive Manufacturing Standards 42
Cunqian, You, Miao, Wei, Xiaobo, Chen, Xiaojun, Wang

ICDTDE_328: A Value-Focused Thinking approach for teacher-course assignment and school timetabling under personnel scarcity 43
M. L. Chew-Hernández, G. J. Espinosa-Martínez, C. Mercado-Zuñiga

ICDTDE_329: Reconstructing RAG Systems for Green Buildings and Additive Manufacturing from Economic and Sustainable Development Perspectives: A GPTCache-Enabled Semantic Caching Approach 44
Cunqian, You, Tianbian, Zhou, Xiaobo, Chen, Miao, Wei, Xiaojun, Wang

ICDTDE_330: Machine Learning Driven Streamflow Prediction Using Vegetation and Soil Indices for Sustainable Water Management: A Texas Case Study 45
Rishith Kumar Vogeti, Uday Bhanu Prakash Vaddevolu

ICDTDE_331: Analysis with Index Matrices Harvesting Energy from Vibration 46
Stela Todorova
ICDTDE_332: Integrating Embedded Control and Machine Vision in a 5-DOF Robotic Arm for Automated Sorting 47
Ho Thanh Hoang, Huu Q. Tran
ICDTDE_335: Hardness Behaviour of FDM-Printed PLA-CF under Varying Process Parameters 48
Nejmeddine Layeb, Istvan Olda and László Zsidai
ICDTDE_336: Effect of Precursor Composition and Oxide Ratios on the Performance of Geopolymer Mortars 49
Keqi Huang1, Yun Zhao, Xiaomin Liu, Junlong Zhou, Yanwei Wang, Yunlong Xu
ICDTDE_343: Unified Pathways: Enhancing Communication and Collaboration for Accelerated Innovation 50
D.Sudheer Reddy, Dr.K.Narendra Kumar
ICDTDE_348: Nonlinear Associations Between Streetscape Visual Features and Perceived Safety in Historic Districts: An Interpretable Machine Learning Empirical Study 51
Zhangjingyi Liu, Chengyu Liu, Yangyang Song, Mohd Iskandar Bin Abd Malek, Nor Zalina Binti Harun
ICDTDE_355: Optimizing Demand Forecasting in Supply Chains through Machine Learning: Practical Implications for Business Performance 52
Rouhi Faisal
ICDTDE_360: Experimental Investigation of the Effectiveness of Dynamic Fenestration Insulation in Canadian Climate 53
N. MacDonald, A. Gupta, A. Houle, J. Marston, B. Armstrong, G. Aguilar and H.M. Teamah
ICDTDE_365: Enhancing Network Performance through Service, Memory, and Access Monitoring 54
Dr.E.Sujatha, Dr.R.G.Sakthivelan, J.Sathiya Jeba Sundar, Aswana Lal
ICDTDE_366: Controlling Localized Potential to Govern Soliton Dynamics in Optical Communication Systems 55
Anis Sulaikha Samiun, Nor Amirah Busul Aklan, Bakhram Umarov
ICDTDE_367: The Importance of Improving Methods for Determining the Load-Bearing Capacity of Reinforced Concrete Bridges in Operation Based on Technical Diagnostics 56
Erboyev Shavkat, Kasimov Odil, Shodmanov Anarkul, Khakimov Khojakbar, Barnoyeva Zilola, Botirov Bektosh
ICDTDE_369: A Cloud Container Workflow Scheduling Algorithm Based on Multi-Agent Reinforcement Learning with Affinity Constraints 57
Lingqi Kong, Dayu Zheng, Weiqi Hu
ICDTDE_370: High-Performance Failure Prediction in Industrial Engines: A Random Forest Approach with Advanced Feature Engineering and SHAP Interpretability 58
Mst Jannatul Kobra, Xianchun Zhou, Md Owahedur Rahman, Arman Mohammad Nakib
ICDTDE_371: Hussein Search Algorithm Mathematical Model and its application on Inverted Indexes for Efficient Information Retrieval 59
Omar H. Abu El Haija, Arwa Zabian
ICDTDE_375: Global trade flow prediction based on spatiotemporal graph neural network (ST-GNN) 60
Guoqing Chen, Tianwen Zhao, Yuxiao Long, Qinghuan Guan, Xinting Hu
ICDTDE_376: Cross-border e-commerce logistics demand forecasting based on XGBoost and GRU integration model 61
Guoqing Chen, Tianwen Zhao, Yan Wang, Yutong Chi, Jiajia Tong
ICDTDE_377: Study on the optimal path of emergency material distribution in 5G network environment for delivery vehicles and UAV 62
Guoqing Chen, Tianwen Zhao, Xinwei Li, Shangdong Li, Yicheng Li
ICDTDE_378: Design and implementation of an autonomous four-wheel drive Mecanum wheel robot system for infrared thermal anomaly inspection of refinery pipelines 63
Jianyong Zhang, Yinghao Wang, Anyue Qi
ICDTDE_379: Optimization of autonomous grasping strategy for warehouse robots based on vision-language large model 64
Xiaoyue Zhang, Yunfei Li, Fanqi Meng, Keyu Zhang
ICDTDE_380: Metaheuristic Landscape Analysis for Multi-Objective Structural Design in Complex Environments 65
Tarun Madan Kanade
ICDTDE_381: A Hybrid Loss Function Approach with Diverse Backbones for Robust Waste Segmentation 66
Lenh Phan Cong Pham, Nhu Huynh Thi Le, Vinh Phong Vo
ICDTDE_382: Hybrid Semantic-Web Architecture for Context-Aware Agricultural Decision Support 67
Mohammad Kamil, Muhammad Hussain Mughal, Duygu Cakir
ICDTDE_384: Steel Fiber-Reinforced Concrete and Features of Calculating the Strength and Crack Width of SFRC Structures 69
Matniyazov Bakdurdi, Kasimov Odil, Shodmanov Anarkul, Kurbonov Zavkiddinjon, Botirova Nodira, Kuralova Norigul, Rasulova Nargiza, Botirov Bektosh

ICDTDE_387: 4D Printing of complex ABS Structures 70
Grigorios Kostopoulos, Konstantinos Dimitras, Stelios K. Georgantzinos
ICDTDE_388: Shape Recovery Behavior of PETG Structures in 4D Printing 71
Grigorios Kostopoulos, Aristidis Pothitos, Stelios K. Georgantzinos
ICDTDE_389: The Effect of Technology Transformational Leadership on Human Resource Employees performance and job satisfaction in Insurance Companies in Palestine 72
Eman I. Issa, Ishaq Ibrahim
ICDTDE_390: Experimental Investigation on the CFRP Strengthening Efficiency of Flexural-Deficient RC Slabs 73
Ayman N. Ababneh, Rajai Z. Al-Rousan, Mohammad S. Bani Hani, and Bara'a R. Alnemrawi
ICDTDE_391: The Flexural Behavior of Thin RC slabs Strengthened with Different CFRP Ratios 74
Rajai Z. Al-Rousan, Ayman N. Ababneh, Mohammad S. Bani Hani, and Bara'a R. Alnemrawi
ICDTDE_392: The Extent Depth Effect on the Behavior of Strengthened and Unstrengthened One-Way RC Slabs: Experimental Study 75
Rajai Z. Al-Rousan, Ayman N. Ababneh, Mohammad S. Bani Hani, and Bara'a R. Alnemrawi
ICDTDE_393: Smart Mapping and Decision Tools for Localized Material Reuse in Circular Construction 76
Eleni Papadopoulou, Stelios K. Georgantzinos
ICDTDE_394: Digital Twin for Fused Filament Fabrication (FFF) 77
Eleni Papadopoulou, Stelios K. Georgantzinos
ICDTDE_397: Research Of Energy Consumers And Consumption Of Fuel And Energy Resources In The Construction Of Small-Story Residential Buildings In The Conditions Of Uzbekistan 78
Xamza Yusupov, Tutiyo Egamberdiyeva
ICDTDE_398: Developing Competency Clusters For Future Engineers: A New Educational Taxonomy Approach 79
Alimov Azam Anvarovich, Bakhodirjon Sabirovich Nuridinov, Savrieva Ikbol Bakhodirovna, Turgunov Abdurashid Abdumannobovich, Sayfullayeva Dilafruz Ahmadovna
ICDTDE_400: Studying The Properties Of Gas Concrete Barrier Walls In Hot Climatic Conditions And Calculating Their Indicators 80
Zafar Sattorov Muradovich, Dilbar Rustamova Baxodirovna
ICDTDE_401: Digital Spatial Analysis of Historic District Renewal: A Space Syntax and GIS Approach 81
Chengyu Liu, Yihan Wang, Zhangjingyi Liu, Nor Haslina Ja'Afar
ICDTDE_403: Automated Seismic Detection Algorithm applied for Iraq's Mesopotamian Seismological Network 82
Loay E. George, Hala A. Jasim, Sinan Sameer Mahmood Al-Dabbagh, Enas Kh. Hassan, Najah A. Abd
ICDTDE_404: Digital Transformation to Improve Government Performance in Bangka Belitung Province Indonesia 83
Etin Indrayani, Ika Sartika, Mansyur Akhmad
ICDTDE_405: Food Prediction and Alert Automation Using Stacking Ensemble Machine Learning Model 84
Dr.E.Sujatha, Dr.S.Palpandi, K.Gopinath, Preethi Ponnan
ICDTDE_406: Enhancing E-Content Development for Engineering Courses with Machine Learning: A Graph Neural Network Approach 85
Dr.E.Sujatha, Padmasheela Keshvan, Dr.D.Naveen Raju, Aswana Lal
ICDTDE_407: Shear Force in a Beam-Column Connection from a Linearly Distributed Load Occupying Various Possible Positions on a Cantilever Beam 86
Albena Doicheva
ICDTDE_408: A Lightweight Open-Data QGIS Workflow for Walking Accessibility of Heritage Nodes in Dali Dong Village 87
Yihan Wang, Chengyu Liu, Hai Huang
ICDTDE_409: Helmet and Reflective Vest Recognition System Based on the Improved YOLOv11 Algorithm 88
Dehan Yao, Keqi Huang, Yanwei Wang, Xiaomin Liu, Junlong Zhou, Yikang Li
ICDTDE_410: Estimating the Potentials for Indoor Thermal Comfort and Electric Vehicle Charging with BIPV in Nigeria 89
Nnabuike Ngwu, Josué Rock Segnon, Michael E. Nwokedi, Howard Njoku
ICDTDE_411: The Impossibility of Complete Restoration of Buildings Damaged by Warfare 90
I. Kaliukh, Y. Slyusarenko, M. Marienkov, V. Dunin, I. Yakovenko, Y. Berchun
ICDTDE_412: Geometric Digital Twin of a Partially Destroyed High-Rise Building 92
I. Kaliukh, O. Tytarenko, V. Tytarenko, M. Yakovenko, V. Vapnichna, Y. Berchun
ICDTDE_413: Application of Construction 4.0 Technologies to Detect a Hidden Vibration Source in a High-Rise Residential Building 94
I. Kaliukh, V. Dunin, V. Siedin, V. Zahilskyi, V. Kovba, Y. Berchun
ICDTDE_419: Yield-Stress Rheology, Fluid Mechanics and Machine Learning for Predictive Concrete Pumping 95
Yanwei Wang, Keqi Huang, Liguang Lin, Chenglong Ji, Jie Tang, Yikang Li

ICDTDE_425: Experimental Study on the Compressive Strength and Ultrasonic Pulse Velocity of Seaweed-Modified Geopolymer Concrete 96
Nehemia Yulius Wijaya, Andy Prabowo, Jack Widjajakusuma
ICDTDE_428: From Smoke to Fire: Improving Early Detection with Pre-trained CNNs 97
Robert Lepădatu, Simona Moldovanu, Felicia Anisoara Damian, Luminita Moraru
ICDTDE_430: A Predictive Machine Learning Framework for Proactive Customer Satisfaction Management in Electricity 98
Kien Trung Ngo, Le Quyen Luu
ICDTDE_433: Revealing the Visual Cues: How YOLO-Nano Learns to Detect Objects in Adverse Weather 99
Vinh Phong Vo, Nhu Huynh Thi Le, Lenh Phan Cong Pham
ICDTDE_434: Valorizing Olive Pomace Lignin as a Sustainable Chemical Admixture for Cement Paste: A Mechanistic and Performance Appraisal 100
Ala Alobeidyeen
ICDTDE_437: Studying On The Basis Of Modeling The “Foundation -Wall-Superstructure” System Operating Under Dynamic Influence 101
Buzrukov Zakiryo Sattixodjaevich, Adilov Zafar Ravshanovich, Xatamkulov Bekzod Iskandarbek o‘g‘li, Dadaxanov Farrux Adxamovich
ICDTDE_438: Integrating University Social Responsibility into Institutional Strategy Amidst Higher Education Autonomy in Vietnam 102
Nguyen Thi Van, Huu Q. Tran
ICDTDE_439: Sound Absorption Performance of a Layered Recycled Metamaterial with Machine Learning-Based Acoustic Simulation 103
Giuseppe Ciaburro, Virginia Puyana-Romero
ICDTDE_446: Improvement Of External Insulation Processes Of Residential Buildings 104
Salimova Iroda Nazarbayevna, Saydaxmedova Zahroxon Rustam qizi
ICDTDE_447: Variable Neighbourhood Search for Solving Edge Dynamic Graph Coloring Problem 105
Rani Kumari, Kamal Srivastava
ICDTDE_448: Durability of aerodrome horizontal markings: a literature-based framework linking AI, lifecycle optimization, and sustainability 106
Blaha Gregory Correia dos Santos Goussain
ICDTDE_449: Early Detection of Parkinson's Disease using a Multi-modal Transformer: A Synergistic Fusion of Audio Spectrograms and Brain MRI 107
Thang Hoang Nguyen Pham, Vinh Phong Vo, Nhu Thi Huynh Le, Nhan Trung Tran, Lenh Phan Cong Pham
ICDTDE_450: Research on the Mapping Between Visual Semantic Features of AI-Generated Architectural Images to Styles and Typologies 108
Zonghui Wang, Huadi Liu, Shuangle Ding
ICDTDE_458: Sustainable Magnetic Biochar–Alginate Beads for Adsorption and Photocatalytic Degradation of Methylene Blue in Textile Wastewater 109
Hala Naseer Abdelkareem, Ibrahim Abdulwahhab Atiyah, Mohammed Ali Abdulrehman, Ahmed K. Al-Kamal
ICDTDE_459: Rice Husk Ash-Based Sustainable Foamed Geopolymer Concrete with Eco-Friendly Foaming Agents for Improved Mechanical and Thermal Insulation 110
Mohammed Ali Abdulrehman, Kadhim K. Resan1, Ali M. Flayyih, Ahmed K. Al-Kamal, Ahmed Subhi Abbas
ICDTDE_460: Comparative Study on the Impact Resistance and Mechanical Properties of Slag-Based Geopolymer Concrete Modified with Dual Types of SBS Polymer Reinforcements Using Micro- and Macro-Sized Granules 111
Ahmed K. Al-Kamal, Yasir Khalil Ibrahim, Rasha Ahmed Alsamurie, Mohammed Ali Abdulrehman, Aous Abdulhussain Moyet
ICDTDE_461: Spatial Variability of Particle Size, Suction, and Water Content in Flood-Prone Atyrau, Kazakhstan 112
Eriko Dewangga, Alfrendo Satyanaga, Sabina Bexultanova, Jong Kim
ICDTDE_466: Discussion and Research for Inverted Rubber Players to Overcome Long Pimpled Rubber Opponents in Table Tennis 113
First A. Xing Yang, Second B. Kaiyan Lu, Third C. Congdian Cheng
ICDTDE_467: Grasp strategies of 3D printed soft robotic actuators: A systematic review of materials, mechanics and mechanisms 114
Krishnakumar Sankar, Mohamed Yusuf Noor Mohamed Khan, Niranjana Arulnambi, Madhavan Murugan
ICDTDE_468: AI-based diagnosis and treatment of BPPV: A systematic review 115
Krishnakumar Sankar,Niranjana Arulnambi, Anjali Ganeshbabu Sheeba, Mohamed Yusuf Noor Mohamed Khan and Gayathri Krishna Manju Rajeev
ICDTDE_469: Finite element Programming of the Damage Model for Composite Structures 116
R. Smahi
ICDTDE_470: The Importance Of Using Alternative Energy Sources In Modern Buildings 117

Botir Isakov, Tutiyo Egamberdiyeva, Ne'matullox Xidiraliyev, Kamila Yusupova

ICDTDE_473: Development of a Nonlinear Analytical SDOF Model for Progressive Collapse Analysis Verified through Finite Element Analysis and Experimental Data 118
Christoforos Dimopoulos

ICDTDE_474: Seismic performance of EC8-based designed tall steel buildings with braced core and outriggers 119
Prasanna Lansakara, Christoforos Dimopoulos, Theodore Karavasilis

ICDTDE_475: Low fatigue resistance prediction of steel braces with square hollow steel sections 120
Christoforos Dimopoulos, Prasanna Lansakara, Theodore Karavasilis

ICDTDE_478: Numerical Investigation of Reinforced Concrete Beams Strengthened with Basalt Fiber Reinforced Polymer **121**
Themistoklis Tsalkatidis, Asadullah Taraki

ICDTDE_479: The Sustainability of The Construction Process and Its Relation to Sustainable Development Goals **122**
Hassan Judah, Nour Betoush, Ayah A. Alkhawaldeh, Maria Al-Mdanat

ICDTDE_480: Multi-Objective Optimization for Daylighting and Energy Efficiency in Tall Buildings **123**
Ayah A. Alkhawaldeh, Hassan Judah, Nour Betoush

ICDTDE_481: AI-Driven Digital Twins for Energy Efficiency and Lifecycle Optimization in Smart Buildings **124**
Nour Betoush, Ayah A. Alkhawaldeh, Hassan Judah

ICDTDE_482: The Principle of Equality and Non-Discrimination in the United Arab Emirates **125**
Dr.Buti Obaid Saeed AlFalahi

ICDTDE_488: Development and Validation of a Scale for Employee-Perceived AI Sycophancy in China **126**
Aidana Sailikea, Xiaoping Tong

ICDTDE_492: Optimization Of The Content Of Personnel Training In Vocational Educational Institutions **127**
Qalanov Hasan Yakubovich, Nuridinov Bakhodirjon Sabirovich, Ashurova Sanobar Yuldashevna, Alimov Azam Anvarovich

ICDTDE_499: An intelligent platform for lifting device selecting and analysis on construction engineering **128**
Yikang Li, Yanwei Wang, Keqi Huang, Xiaomin Liu, Junlong Zhou, Liwei Wu, Shudong Hu, Chenglong Ji, Jie Tang, Yumeng Bai, Dehan Yao

ICDTDE_504: Advanced Wearable Sensors Combined with Random Forest Regression for physiological activity recognition **129**
Cervellieri Alice

ICDTDE_507: Improvement of Academic Paper Title Generation using Modify Yake Algorithm **130**
Ali Ahmed Ali, Mohammed Ali Mohammed

ICDTDE_508: Combined approach for the design of robust controls by providing for the stability of the Lyapunov algorithm with Feed-Forward Neural Network method **131**
Cervellieri Alice

ICDTDE_509: Investigating the Combination of Reinforcement Learning with Liquid Neural Networks **132**
Kaouthar Oubbad, Ilias Elmouki, Abdelilah Jraifi, Mohammed Madiafi

ICDTDE_510: DIHA: Sentiment Analysis for Online Reputation Management in Retail Companies **133**
Diego E. Galarza-Quezada, José Santisteban

ICDTDE_512: Advanced SOC Prediction for Lithium-Ion Batteries Using FNN Machine Learning Techniques: A Bayesian Regularization Training Approach **134**
Cervellieri Alice

ICDTDE_513: A critical review of lithium-ion batteries cycling process from a safety testing prospective **135**
Cervellieri Alice

ICDTDE_514: Percolation Models of Competition and Monopoly **136**
Ivan G. Grabar, Olena S. Kilnitska, Yuri O. Kubrak, Maryna I. Yaremova

ICDTDE_517: Literature review of SOH of lithium-ions batteries and their transformative role within sectoral innovation systems. **137**
Cervellieri Alice

ICDTDE_518: Artificial Intelligence in the Philippine Aquaculture Industry: Applications, Challenges, and Pathways for Inclusive Development **138**
Jonald C. Bornales, Aslanie S. Limbona, Johaimen M. Omar, Bai Rafsan-Zahna I. Mama, and Keriman Yürüten Özdemir

ICDTDE_521: Optimization method for the evaluation of effects of pull on chains in historic masonry buildings applied to the case study of the Basilica of S. Maria Maggiore in Bologna. **139**
Cervellieri Alice

ICDTDE_522: Optimization of performance of different air quality methods of cyber physical system with energy and comfort analysis **140**
Cervellieri Alice

ICDTDE_524: Application of Hybrid algorithm of artificial intelligent in association to PANAMA system's network in predict the accidents on the road **141**

Cervellieri Alice
ICDTDE_526: Automated Detection and Classification of Plant Leaf Diseases Using Image Processing 142
M PRADEEP, S HANUMANTHA RAO
ICDTDE_527: Challenges in the Optimization of Adjustable Joints of Lightweight Reconfigurable Structures 143
Stefanos Gkatzogiannis, Eleftherios G. Vourkos, Eftychios G. Christoforou, Marios C. Phocas
ICDTDE_529: Asymmetric Edge Support Degradation and its Effect on Slab Response under Touch-off Explosion 144
S. M. Anas, Rayeh Nasr Al-Dala'ien, Mohammed Benzerara, Sief Addeen Rababa
ICDTDE_530: A comparative analysis of thermal comfort in green building assessment standards across countries: The case of China, the United Kingdom, the United States and Germany 145
Yajing Wang, Olga Vladimirovna Volichenko
ICDTDE_531: Investigating the mechanical properties of 3D foam subjected to uniaxial tensile load 146
Debela N. Gurmu1, Krzysztof Wacławiak, Hirpa G Lemu
ICDTDE_532: On the Sustainability, Life Cycle Assessment, and Artificial Intelligence Integrations in Construction and Built-Environment 147
Mohammad A. Alhassan, Layla K. Amaireh, and Nour A. Betoush
ICDTDE_534: A FBPNN Artificial Intelligent approach to predict State of Health for Integration of Electric Vehicles into Vehicle-to-Grid (V2G) 148
Cervellieri Alice
ICDTDE_536: State of Health Analysis of Lithium-Ion Batteries and Their Transformative Role in Sectoral Innovation Systems 149
Cervellieri Alice
ICDTDE_537: Evaluation of energy and comfort analysis of rural buildings: Literature review and further research 150
Cervellieri Alice
ICDTDE_539: An End-to-End Hybrid Framework for Customer Churn Management: From Predictive Models to Explainability and Generative Retention Strategies 151
Meryem Houssam, Abdelilah Jraifi, Ilias Elmouki
ICDTDE_549: Improved Dimensional Accuracy in 3D Printed Components of PLA Using Taguchi Design of Experiments 152
George Dimitrakopoulos, Grigoris Kostopoulos, Stelios Georgantzinos
ICDTDE_551: Tolerance Analysis and Assembly Performance Enhancement in 3D Printed Mechanical Components 153
George Dimitrakopoulos, Grigoris Kostopoulos, Stelios Georgantzinos
ICDTDE_552: Sustainable IoT Sensors and Efficient Measurements in Aircraft Maintenance 154
Nouhaila Chouarfa, Abdelilah Jraifi, Ilias Elmouki
ICDTDE_553: Analytical Asymptotic Theory of 2D Flows in Compressible Heterogeneous Viscous Fluids: Ligaments and Waves. 155
A.A. Ochirov
ICDTDE_554: On the Initial Conditions in the Problem of the Numerical Modeling of Fluid Periodic Perturbations Propagating. 156
A.A. Ochirov, A.S. Chernov
ICDTDE_555: Asymptotic theory for obtaining regular and singular solutions to annular periodic fluid surface perturbations. 157
A.A. Ochirov, U.O. Trifonova
ICDTDE_556: A.H. Naifeh's ideas and methods impact for the theory of flows of heterogeneous fluid 158
Yuli D. Chashechkin
ICDTDE_559: Analysis of High-Frequency Vibration and Noise in Permanent Magnet Linear Synchronous Motor 159
Ting Dong, Jiabin Wang, Bo Zhang, Guilin Zhao
ICDTDE_561: Enhancement of Electrical and Viscosity Properties of PVDF Composites Doped with Surface-Modified Nano (KNN+BaTiO3) for Biomedical Actuators 160
Hussain Ameer Aljawad , Hatam Kareem Kadhom, Ahmed Hameed Reja
ICDTDE_562: Inductance Characteristics Analysis of Grain-Oriented Silicon Steel Sheets Permanent Magnet Synchronous Linear Motors Based on the Equivalent Magnetic Network Method 161
Guangheng Pan, Ting Dong, Bo Zhang, Guilin Zhao
ICDTDE_566: A user-interactive vision-based Robotic arm for real-time object detection 162
Krishnakumar Sankar, Dhaanush Venkateskumar, Kanimozhi Gowtheman , Keerthivasan Sundararajan
ICDTDE_567: Evolution of smart construction in the "Construction 5.0" sector analyzed using a forecasting method based on an Artificial Intelligence (AI) algorithm 163
Alice Cervellieri

ICDTDE_570: Leveraging Agentic AI for Enhancing Digital Twins in Civil Engineering **164**
Dr. Jay Nanavati
ICDTDE_571: Intelligent Energy Management Approaches for PV System Performance Using MPPT, Internet of Things, and Neural Networks **165**
Mousa Bani Baker, Takialddin Al Smadi
ICDTDE_572: Mechanical Performance of Concrete Incorporating Waste Glass as a Supplementary Material **166**
Mousa Bani Baker, Altayeb Qasem, Read Abendeh, Zaydoun Abu Salem, Takialddin Al Smadi, Abdulla Sharo
ICDTDE_573: Design-Oriented Charts for Passive Earth Pressure for Normally Consolidated and Over-Consolidated Sands in Homogeneous and Stratified Profiles **167**
Mousa Bani Baker, Adel Hanna, Batool Al-Shorman, Abdulla Sharo
ICDTDE_574: Seismic performance of cold-formed steel in moment-resisting frames **168**
Hussein S. Osman, Mohamed H. Serror, Mousa Bani Baker, Elsayed Fathallah
ICDTDE_575: Investigating the Impact of Smart Automation on Operational Efficiency and Workforce Safety in Saudi Manufacturing Sector **169**
Ahmed Al-Ali, Rami Alawneh, Mousa Bani Baker
ICDTDE_576: GIS-based Multi-Criteria Decision Analysis for Retention Pond Site Selection in Flood-Prone Sites in Amman-Jordan **170**
Mohammad Almawas, Mousa Bani Baker
ICDTDE_579: A Comparative Study of On and Off Reinforcement Techniques in Stock Trading **171**
Imane Abouelkheir, Fadwa El Kihal, Ilias Elmouki
ICDTDE_581: A Data-Driven Reinforcement and Adaptation Strategy for Aerospace MRO Systems **172**
Kaoutar Ajmili, Abdelilah Jraifi, Ilias Elmouki
ICDTDE_587: DFT-Based Study of Pressure-Induced Modification of Eco-Friendly Perovskite Material of K2InNaBr6 for Optoelectronic Applications **173**
Mohammad Jahidul Islam, Md Sharif Ahmed
ICDTDE_597: Spectral Methods In Nonlinear Problems Of Heat And Mass Transfer **174**
Yaroslav Pyanylo, Roman Kushnir, Oksana Vovk
ICDTDE_598: Formulating Location and Allocation Problems for Smart Lockers in Last-mile Delivery **175**
M. Seifbarghy, S. Kasap
ICDTDE_616: Early Adoption of Two-Wheeler Electric Vehicles (EV) in India: A Data-Driven Strategy for Market Segmentation **176**
I. Sundara Siva Rao, Seetayya Narthu, Gunisetty Krishna Sai Jyoteesh, P. S. Brahmanandam
ICDTDE_617: Predicting Household Financial Vulnerability during COVID-19 Using Gradient Boosted Trees **177**
Dr Saragadam Sridhar, Dr I S Siva Rao, Mr. Kiran Kumar Velala, Dr. P. S. Brahmanandam
ICDTDE_618: Enhanced Deep Learning Framework for Robust and Universal Fruit Detection and Classification in Diverse Agricultural Settings **178**
Jalampelli Thirupathi, N. Malarvizhi, I. Sundara Siva Rao, P. S. Brahmanandam
ICDTDE_619: Semantic Condensation through Self-Attention Mechanisms in Transformer Architectures for Automatic Text Summarization **179**
Dr T.Srinivasarao, Ch. Kodanda Ramu, Teja Karri, Dr. Sasanko Sekhar Gantayat, Sunil Chandolu, Dr. P. S. Brahmanandam
ICDTDE_622: Students Preference on the type of textbook in Higher Education **180**
Dr Jashwini Jothishna Narayan
ICDTDE_625: Integration of Decision-Making Factors and Strategy Formulation in Offshore Platform Brownfield Projects for Oil and Gas Business Sustainability **181**
Agus Sujatmoko, Nur Syahroni and Haryo Dwito Armono
ICDTDE_638: A Novel Algorithm for Process-Specific Marginal Abatement Cost Curves: Resolving Technology Conflicts in Multi-Step Manufacturing **182**
Laureana Mari Baylon, Bernadette T. Magadia1, Ramon Christian P. Eusebio, Dominic C.Y. Foo, Maria Victoria Migo-Sumagang
ICDTDE_639: Milestone-Gated, Donor-Governed Crowdfunding: Security Properties and the Price of Safety **183**
Aryavardhan Modi, Anisha Ray, Dr Perepi Rajarajeswari
ICDTDE_640: Long-Term Performance of Ladle Slag/Fly Ash Geopolymer Mortars Under Ambient Curing **184**
Omar Najm, Hilal El-Hassan, Amr El-Dieb
ICDTDE_643: Study on fabricating and controlling humanoid robot integrated with medical expert system applying voice recognition technique **185**
Duong Xuan Bien, Pham Van Toan, Nguyen Van Trung, Nguyen Ba Khanh, Mai Ngọc Anh, Dao Van Duong
ICDTDE_644: Kinematics analysis and control of drone tracking test system based on image processing technique **186**
Nguyen Van Nam, Duong Xuan Bien, Le Tuan Tu, Nguyen Xuan Thuy, Vuong Anh Tuan, Hoang Phan Binh, Tran Xuan Trung

ICDTDE_646: Integration of 3D Printing and Sustainability Concepts in High School Education: Preparation of Future Engineers **187**
Eman Zaitoun, Sherin Alamassi, Muzzafar Shaukat, and Mohammad Alhassan
ICDTDE_647: Integration of Artificial Intelligence in Sustainability Project-Based Learning: Multidisciplinary University Students Perspectives **188**
Eman Zaitoun, Azhar Shater, Ahmed Abuibaid, and Mohammad Alhassan
ICDTDE_648: New design and technological solutions for ensuring the technological reliability of the installation of prefabricated slabs in civil buildings **189**
Matgoziyev Xusan Melibayevich, Kumakov Jahongir Xamzayevich, Ibraximov G‘ayrat Abdumuminovich, Ibraximov Shuxrat Abdumuminovich
ICDTDE_650: Influence of 3D Printing Parameters on the Tensile Performance of ASA Specimens **190**
Konstantinos Dimitras, Grigorios Kostopoulos, Stelios K. Georgantzinos
ICDTDE_653: A Comparative Analysis of Change Point Detection Methods for the Length-Biased Weibull-Rayleigh Distribution in the Hydrological Time Series of Chiang Mai, Thailand 191
Tanachot Chaito, Manad Khamkong
ICDTDE_654: Factors Influencing Hybrid Working Model Preference From Gen Z's Perspectives In Vietnam 192
Ngoc Thi Kim PHAM, Dan Thi Thanh NGUYEN
ICDTDE_656: Research and integrated innovative application of virtual simulation smart sports system framework based on AI optimization 193
BEI HAN, JINXIA YANG
ICDTDE_657: Solutions for Developing Technology Startup Incubation In Vietnam 194
Dan Thi Thanh NGUYEN
ICDTDE_658: Comparative Analysis of Regression and ANN Models for Predicting Tensile Strength of Jordanian Limestone 195
Abdulla A. Sharo, Mohammad O. Taamneh, Samer R. Rababah, Saja F. Alkhateeb, Mousa Bani Baker
ICDTDE_661: Deep Learning of Sequential Data with Transformers: A Dual Implementation in Computational Biology and Medical Imaging 196
Konstantinos Kapenis, Stergios Papadimitriou, Eleni Vrochidou, George A. Papakostas
ICDTDE_662: Multi-Objective Optimization and Active Control of Vibration and Noise in High-Speed Reciprocating Permanent Magnet Linear Motors 197
Shuai Zhu, Ting Dong, Bo Zhang
ICDTDE_664: Analysis of Subsidence Characteristics in Northern China’s Mining Engineering Areas with SBAS-InSAR: A Digital Monitoring Approach Based on Satellite Remote Sensing 198
Pengfei Ma, Zhi Yang, Sihang Zhang, Hui Chen, Zezhou Zhao
ICDTDE_668: An Integrated Dynamics Model of Vector-Borne Disease with Multiple Transmissions Modes 199
Eric N’Zi, Jacques Tano, Gerard Kanga, Mohamed Coulibaly, N’Guessan Anastase Mian
ICDTDE_671: Design and experimental fabrication of a mobile robot model for automatic fire extinguishing based on image recognition technique 200
Mai Ngoc Anh, Duong Xuan Bien, Hoang Hai Long, Hoang Van Hoc, Nguyen Van Minh
ICDTDE_672: A Machine Learning Approaches to Binaural Beat Detection 201
Mohammed Hussein Ali
ICDTDE_676: Robust measurement of silicon carbide epitaxial layer thickness based on two-beam interferometry and multi-angle fusion 202
Shangdong Li, Lianyu Wu, Yicheng Li, Longji Tang, Ziqi Xiong, Guoqing Chen, Tianwen Zhao
ICDTDE_678: Turntable mechanism designing and manufacturing in automatic assembly system Lock Shuntjoint and Lock Coupler in medical area 203
Pham Van Toan, Nguyen Van Trung, Duong Xuan Bien
ICDTDE_679: Study on the topology optimization design: the case of the load-bearing hanger optimization design 204
Nguyen Van Trung, Pham Van Toan, Duong Xuan Bien
ICDTDE_680: Establishing a model to predict the stress concentration coefficient of welds using industrial welding robot arms and multivariate regression method 205
Le Van Tan, Dao Van Duong, Duong Xuan Bien, Vu Minh Hoang, Truong Khanh Nghia
ICDTDE_681: Industrial appearance defect detection method based on knowledge graph and visual perception 206
Shuyang Li, Yuxuan Yang, Xinyu Li, Jianghan Yu
ICDTDE_682: EfficientNet Small Target Detection and Tracking in UAV Aerial Images 207
Weicong Ma, Zeyi Liu, Jinzhou Zheng
ICDTDE_683: Industrial Enterprise Reconstruction Systematics 208
Ganiev Karim Barovich, Salimova Iroda Nazarbayevna, Khodjaeva Shakhnoza Nazarbayevna, Ganieva Feruza Karimovna
ICDTDE_684: Bi-objective Optimization of Dynamic Construction Site Layout Planning for Highway Projects Using NSGA-II 209

Thi-Thanh Nguyen, Viet-Hung Truong

ICDTDE_686: Machine vision-based intelligent surface garbage cleaning ship system 210
Chengyang Gu, han Hai, Haochen Sun, Ruiqi Wang, Xiaoming Huang

ICDTDE_688: Securing Supply Chain Management - Enhancing RFID Integrity through Blockchain and IPFS Integration 211
N Nasurudeen Ahamed, Thangavel Murugan

ICDTDE_691: Multi-objective optimization of semi-rigid steel frames using nonlinear inelastic analysis 212
Quoc-Anh Vu, Viet-Hung Truong

ICDTDE_692: Enhancing Intrusion Detection in IoT Networks with Extra Dimension Optimization Algorithm and Spatial-Temporal Graph Convolutional Networks for Smart Cities 213
Nandita Sengupta, Ramya Chinnasamy, Malliga Subramanian, Ramkumar M.P

ICDTDE_693: Machine learning-based classification and regression of semi-rigid steel frames using nonlinear inelastic analysis 214
Hieu - Nghia Hoang, Quốc – Anh Vũ

ICDTDE_694: Optimized Soil Stabilization Techniques for Stabilizing Cycle Track in Al Hudayriat Island, Case Study. 215
Abdulla A. Sharo, Dalia Darwish, Mohammed Radwan,
Mousa Bani Baker, Deema Darwish

ICDTDE_697: An eco-friendly geopolymer adsorbent for dyes and pharmaceutical compounds removal from aqueous solutions 216
Omar Najm, Esraa Sami Hijah, Ahmad Ayman, Ayman Alswaitti, Abdulrahman Ayman

ICDTDE_698: Integrating Life Cycle Assessment and Performance Evaluation of Engineering Cementitious Materials: A Mini-Review Using TOPSIS Analysis 217
Esraa Sami Hijah, Abeer Isam AbuAli, Salem Al-Jaberi

ICDTDE_703: Integrating ELECTRE and Goal Programming for Enhanced Decision-Making in ERP System Selection 218
O. Chaanoune, M. Naimi

ICDTDE_704: Factors affecting the adoption of Innovative Asset Management Technologies for infrastructure systems 219
Z. Doomah

ICDTDE_705: Qualitative study of the Misbalance Deg Index 220
Alexandru-Petre Tache

ICDTDE_707: Diminished Euler Sombor Index 221
Maria-Rozica Tache, Alexandru-Petre Tache

ICDTDE_708: Chemistry Educators' Insights into the 'Salts' Subtopic and Its Impact on Rural Students' Mental Health and Learning 222
Thelugu Novah Mary Guruloo, Kamisah Osman, Tan Siok Yee

ICDTDE_709: Digital Microwave Characterization of Ice-Accreted Power Transmission Conductors for SAR-Based Monitoring 223
Sihang Zhang, Zhi Yang, Junhui Li, Pengfei Ma

ICDTDE_710: Machine Learning Algorithms for the Segmentation of Brain Tissues- Bibliometric Analysis 224
S.N Kumar, Nor Asilah Wati Abdul Hamid, Dafik, R. Sunder, Siva Shakar S, Arun S, S. Kannadhasan

ICDTDE_742: Diagnostic Study on the Matching Degree of Supply and Demand for Community-Based Elderly Care Facilities in Megacity 225
Yushan Su, Xuanhui Wang, Dingyue Zhang, Ruobin Wang

ICDTDE_743: Big Data-Driven Structural Equation Modeling for Interactive Effects Analysis of Health and Longevity Factors in Chinese Elderly 226
Dingyue Zhang, Yushan Su, Xuanhui Wang, Ruobin Wang

ICDTDE_744: Base on Reinforcement Learning for Adaptive Operator Scheduling: The Animated Oat Optimization Algorithm and Its Application to Engineering Optimization Problems 227
Xu Cheng, Jing-Wen Zhang, Ruo-Bin Wang

ICDTDE_746: A Privacy-Preserving and Scalable Blockchain Framework for Intelligent Recommender Systems 228
Tamara Abdulmunim Abduljabbar

ICDTDE_747: From Waste to Pavement: Life Cycle Assessment of Recycled Additives in Asphalt Pavement 229
Ansam Sawalha, Mai Alawneh, Ansam Qsymah

ICDTDE_753: Optimization of Burning Temperature and Cooling Rate of Rice Husk Ash for Enhanced Pozzolanic Reactivity and Concrete Performance 230
Ali Yousif Awad, Mohammed Ali Abdulrehman

ICDTDE_754: Extremal Graphs for the Inverse Degree Index 231
Iulius Stroe, Maria-Rozica Tache, Alexandru-Petre Tache

ICDTDE_755: Synthesis of two-level control in constructing the optimal trajectory of the UAV using a predictive model 232
Nikolay Baranov, Sergey Kabanov, Nadezhda Tarazanova
ICDTDE_756: Enhancing Hyperparameters for Solar Energy Forecasting in Kirkuk, Iraq: Grid and Cuckoo Searches Techniques 233
Ahmad Hussain AlBayati, Azheen Hussain AlKaki
ICDTDE_757: Identifying Key Risk Factors for Breast Cancer Using Comparative Feature Selection Techniques 234
Z. Maalej, N. Kaouther, R. Fahmi
ICDTDE_758: Adoption of AI-driven Project Quality Management Systems in the construction industry in Small Island Developing States from a TAM-TOE perspective 235
Y. Boojhawon, Z. Doomah, S. K. Nunkoo
ICDTDE_767: Acehnese Traditional Ornament Simulations in Polar Coordinate and Fractal 236
Salmawaty Arif, Syarifah Meurah Yuni, Aulia Nur Fadina, Hayatun Ulfa
ICDTDE_768: AI-Driven Innovation in Sustainable Buildings: Large-Scale Sensor Data Framework 237
Attila Balogh, József Kovács
ICDTDE_772: Intelligent Power Allocation in NOMA-IBFD Systems: A Hybrid Machine Learning and Reinforcement Learning Approach for Interference Mitigation and Performance Optimization 238
Omer Waseem AL-Zaidi, Abdukhamıd MIRZAAKHMEDOV and Mohanad Alayedi
ICDTDE_773: A framework of digital metrics for justifying the value of human capital investments in engineering 239
Valentyna Ivanova, Oleg Ivanov, Tetyana Kostyshyna, Maryna Morozova, Larysa Piddubna, Vitalii Shapovalov
ICDTDE_783: Integrating Physics-Based and Data-Driven Modeling: A New Paradigm for Multiscale and Multiphysics Problems 240
Zhisong Ou
ICDTDE_784: SIPENDA Intelligent E-Governance: A Web-Based Archival Optimization Model for Retired Employee Data Management in Public Enterprises 241
Amaliyah, Syafira Nur Arofah, Erindah Dimisyqiyani, Rizky Amalia Sinulingga, Gagas Gayuh Aji
ICDTDE_785: Integrated RAMS–OEE Framework for Reliability Growth in High-Temperature Polymer Shrink Packaging Systems 242
Soheil Yousefi
ICDTDE_786: The Effect of Integrating Scratch Programming with Project-Based Learning in Fostering Students' Disposition 243
Noraini Lapawi, Kamisah Osman, Hazrati Husnin
ICDTDE_787: Digital Transformation through Next-Generation Archiving: Empirical Insights from DOF Implementation 244
Amaliyah, Azzahra Rahma Syabistari, Erindah Dimisyqiyani, Rizky Amalia Sinulingga, Gagas Gayuh Aji
ICDTDE_788: BIM in Healthcare System: A Strategic Roadmap for Adoption in Egyptian Healthcare Facilities 245
Carole A. ElRaheb
ICDTDE_790: The Use of Artificial Intelligence Applications in University Education from the Perspective of Early Childhood Program Students at the University of Sharjah 246
Najeh Rajeh Alsalhi, Abdellateef Abdelhafez Alqawasmi, Noura Nasir Al-Karbi
ICDTDE_792: An Approximate Method for Analyzing Self-Excited Oscillations Using Elements of Bifurcation Theory 247
Volodymyr Verbytskyy, Oleksandr Kravchenko, Valerii Khrebet, Ruslana Kolodnytska
ICDTDE_795: A Scalable and Adaptive Big Data Pipeline for Real-Time Anomaly Detection in Distributed Systems 248
Mouhim Sanaa1, Maryem Ait El Hadj, HANANE CHLIAH
ICDTDE_794: Instructions for Preparing a one Page Abstract for the International Conference 249
Doaa Subhi, Lina Mohammed Nori, Yousif Hosain
ICDTDE_797: From Spatial to Semantic Tools and Back to Support the Resilience Analysis of Critical Infrastructures to Natural Hazards 251
M.L. Villani, A. Forlenza, S. Giovinazzi
ICDTDE_798: Readiness and Equity in AI-Supported Science Teaching: A Survey of Pre-Service Teachers 252
Samri Chongo, Alia Nabeela Ruzaimi
ICDTDE_804: Impact of AI-Generated Content on Social Media: A Case Study Across Domains 253
Sangeeta Bhattacharya, Debashis Das, Chandrima Sinha Roy, Manisha Das
ICDTDE_809: Multivariate Statistical Analysis of Readiness for Music and Yoga Interventions in Stress Management through a Pilot Study 254
Dona Sebastian, S.N Kumar, S. Kannadhasan
ICDTDE_811: Vibration Control Using Piezoelectric Synchronized Switch Damping Techniques 255
Maria-Styliani Daraki, Konstantinos Marakakis, Georgios E. Stavroulakis
ICDTDE_812: A Hybrid Approach for Forecasting Arable Land in Iraq 256

Marwan abdul hameed ashour, Ahlam Ahmed Juma

ICDTDE_813: GC–MS OF BIODIESEL (FAME) PRODUCTION FROM BLENDED FEEDSTOCK OILS USING POTASSIUM HYDROXIDE AS A CATALYST 257
Ofor, Helen Obianuju, Okosun Senator Endurance, Charles Ndego

ICDTDE_818: AI-Driven Software Engineering for Immersive Metaverse Experiences: Challenges and Opportunities 258
Yazan Alahmed, Dareen Anwar Awwad, Abdulla A. Sharo, Muath AlShaikh, Yanal Alahmad

ICDTDE_835: Machine-Learning–Assisted Wavelet Whittle Estimation of Gegenbauer ARMAX 259
Alex C. Gonzaga

ICDTDE_840: Plan2FEM: Can Large Multimodal Models Turn Plans into Finite-Element Graphs? 260
Christos A. Papapostolou, Nikolaos D. Lagaros

ICDTDE_845: Generative AI–Driven Corrugated Board Design Recommendations on the Pareto Front 261
Gurpratap Singh, Ricardo Fitas

ICDTDE_846: Implementation of Dispatching Rules for Job Scheduling in a Mobile Printer Assembly Line: A Case Study in Electronic Components Manufacturer 262
Huynh Nhat Trieu

ICDTDE_847: Examining Forest Disturbance Using Artificial Intelligence and Remote Sensing Techniques 263
Nawras N. Shatnawi, Aslam A. Al-Omari

ICDTDE_849: Machine Learning-Based Employee Productivity and Retention Analytics for Small and Medium Enterprises (SMEs) in Ghana 264
Prince K. Owusu, Gibson A. Owusu, Moses Aggor, Suleman Zakaria, Martins L. Nuertey, Cecil S. Mensah, Gaberiel F.A. Amponsah

ICDTDE_850: Implementing an Internet of Things (IoT)-Based Street and Traffic Light Monitoring System in the Cities in Ghana 265
Gibson A. Owusu, Prince K. Owusu, Moses Aggor, Gaberiel F.A. Amponsah, Martins L. Nuertey, Suleman Zakaria, Cecil S. Mensah

ICDTDE_851: An IoT-Enabled Water Quality Monitoring System for Communities Affected by Illegal Mining (Galamsey) Activities in Ghana 266
Cecil S. Mensah, Prince K. Owusu, Gibson A. Owusu, Moses Aggor, Martins L. Nuertey, Suleman Zakaria, Gaberiel F.A. Amponsah

ICDTDE_853: Sustainable Tourism: A Multi-Objective Optimization Framework for Juneau and Beyond 267
Zeen Song, Xiaohan Chen

ICDTDE_855: AI-Driven FinTech for Sustainable and Inclusive Green Finance 268
Dhavalkumar Pambhar, Rahul Jain, Harsh Nagar

ICDTDE_857: Innovative Tools for Cost Management in the construction industry: A systematic review 269
Z. Doomah, Y. Moonshiram, A. Seeboo, S. K. Nunkoo, S. T. Chutoori

ICDTDE_862: Rule-based expert system for risk analysis and mitigation in construction projects 270
Álvaro Vieira Marques, Marina Laís Rosa, Maria Clara Lopes Prudente Ribeiro, Roque Antônio de Moura, Blaha Gregory Correia dos Santos Goussain, Marco Rogério da Silva Richetto

ICDTDE_863: Portable machine tool design for large-diameter component machining: a field-oriented engineering approach 271
Antonio Lima da Silva Filho, Evandro Luís Nohara, Blaha Gregory Correia dos Santos Goussain, Roque Antônio de Moura

ICDTDE_867: Enhanced MPPT Algorithm for Photovoltaic Systems Based on Fuzzy Logic Control 272
Tran Minh Hong, Huu Q. Tran

ICDTDE_868: Optimization of Onshore wind turbine foundation. - Analysis of the method and advantages 273
Emmanouil Vougioukas, Athanasios Stamos, Charikleia Pappa, Nikos D. Lagaros

ICDTDE_869: Comparison of Onshore & Offshore Wind Turbine Foundations – A Comprehensive Review 274
Emmanouil Vougioukas, Athanasios Stamos, Charikleia Pappa, Nikos D. Lagaros

ICDTDE_870: Literature Overview of Offshore Floating Wind Turbine Foundations. 275
Emmanouil Vougioukas, Athanasios Stamos, Charikleia Pappa, Nikos D. Lagaros

ICDTDE_872: Multi-Scenario Simulation and Performance Analysis of Intelligent Transportation Systems Based on VANET Using SUMO and OMNeT++ 277
Rafid M. Khaleefah, Elaf J. Majeed, Amani J. Majeed, Iman G. Mohammed

ICDTDE_873: Numerical Study on Enhancing Convection Heat Transfer in Back Step Cavity 278
Iman G. Mohammed, Ali K. Hadi1, Amani J. Majeed , Elaf J. Majeed, Rafid M. Khaleefah

ICDTDE_875: Optimization Design of a Ming-Style Round-Backed Armchair Using Bamboo-Integrated Material with the Finite Element Method 279
Jinglong Li, Qisen Zhu, Zhuoran Li

ICDTDE_876: The Impact of Corporate Governance on Investment Decisions: International Experiences and Implications for Vietnamese Industrial Enterprises 280
Pham Mai Chi, Ngo Thu Giang, Nguyen Thu Ha

ICDTDE_877: Performance–Energy Efficiency Tradeoff Analysis of Distributed Multi-RIS Systems under Co-Channel Interference 281
Huu Q. Tran, Phan Tran Truong Dien, Ly Nhan Hau
ICDTDE_878: Topology Optimization for Daylight Analysis (T.O.DAY): A Constructability-Driven Methodology for Additively Manufactured Façades. 282
Dimitrios N. Gonidakis, Nikolaos D. Lagaros
ICDTDE_879: Machining Process Design and Quality Evaluation of Freeform Surface in Ultra-Precision Turning Based on Diffsys Software 283
Nguyen Kim Hung, Do Manh Tung, Chu Anh My, Duong Xuan Bien, Bui Kim Hoa, Ngo Viet Hung, Hoang Nghia Duc
ICDTDE_880: Research on Measuring Technique of the Quality Indexes for Diffraction Surface on White Light Interferometer Equipment in Ultra-Precision Turning 284
Bui Kim Hoa, Duong Xuan Bien, Do Manh Tung, Nguyen Kim Hung, Ngo Viet Hung, Hoang Nghia Duc
ICDTDE_881: Multi-objective optimization of quality indicators of Copper alloy sphere surface in ultra-precision turning using MRA technique and biomimetic optimization algorithms 285
Do Manh Tung, Pham Viet Hoang
ICDTDE_882: An Explainable Hybrid Machine Learning Approach for Early Diabetes Prediction: Comprehensive Feature Engineering and Multi-Model Analysis 286
Mohammed Salem, Mohammed Al-Hubaishi and Mohanad Alayedi
ICDTDE_883: Advanced Feature Engineering and Machine Learning for Hybrid Wi-Fi/BLE Indoor Localization: A Comprehensive Study 287
Abdulkader Al-Gailani, Mohammed Al-Hubaishi and Mohanad Alayedi
Global Human Resource Management: Navigating talent Across borders 288
Dr. Bindhu D, K.M. Chethana, Dr. Shashidhara D, Thanuja, Dr Deekshitha Rani, Ashwini, Sowmya
ICDTDE_887: Adaptive Crow Search Algorithm with Dynamic Neighborhood Structures for Flow Shop Scheduling Problem 289
I. Mouangui, S. El Moumen, M. Naimi
ICDTDE_889: Implementation of the Approximate Factorization 2 (AF2) Method in Solving Heat Equation 290
Adinda Pramita, Salmawaty Arif, Rahma Zuhra
ICDTDE_890: Application of the Alternating Direction Implicit (ADI) Method to the Full Potential Equation 291
Humaira Salsabila, Salmawaty Arif, Rahma Zuhra
ICDTDE_891: Algorithm for Generating Signal-Like Interference in a Retransmitter using Autocorrelation Processing 292
The Quan Trong, Nguyen Trong Nhan, Tran Huu Nghi
ICDTDE_892: Scientific Exploration of Extra-Terrestrial planets and Analysis using Quantum Computing 293
Zarif Bin Akhtar, Sauda Musharrat
ICDTDE_893: Multilayered conceptual modeling for the design, implementation and optimization of information security systems 294
Ivan Gaidarski
ICDTDE_894: Development of Graph Neural Network for Predicting Stress Field of Particulate Nanocomposite considering Interphase Region 295
Tien-Thinh Le, Quang-Viet Vu
ICDTDE_895: Lean Six Sigma driven process optimization for sustainable efficiency in small-scale toy manufacturing 296
Lucas Nyakas de Oliveira, Blaha Gregory Correia dos Santos Goussain
ICDTDE_896: Data-driven Lean Six Sigma optimization for sustainable robotic welding in agricultural machinery manufacturing 297
Igor da Silva, Blaha Gregory Correia dos Santos Goussain
ICDTDE_897: Lean Six Sigma based optimization of barley waste management: mapping, root causes, and structured solutions for continuous improvement 298
Gabriela Silva Guimarães, Blaha Gregory Correia dos Santos Goussain
ICDTDE_902: Women at the helm: Analysing their influence in business strategy and culture 299
Dr. Bindhu D, Chandramma M, Ravi Kumar V S, Ashwini, Dr. Vijay Budihal, Misba, Niveditha N, & Princy P F
ICDTDE_903: Dual-Objective B.E.S.O.: Explicit Integration of Annual Daylight Autonomy into Structural Topology Optimization. 300
Dimitrios N. Gonidakis, Nikolaos D. Lagaros
ICDTDE_905: Multi-objective optimization of steel cellular beams using genetic algorithms 301
Tran-Hieu Nguyen
ICDTDE_908: Instructions for Preparing a one Page Abstract for the International Conference 302
Tanguturu sp Madhuri, Dr.G.S. Ragahvendra

ICDTDE_909: Predictive Modeling of Student Academic Performance Using Continuous Assessment Data: A Case Study for Advanced Mathematical Methods Course 303
Hafizah Bahaludin, Nor Amirah Mohd Busul Aklan
ICDTDE_910: Simulation-Based Analysis of Electromagnetic Shielding in Polypyrrole Composites Using the ASTM D4935 Framework 304
Adhurim Hoxha, Aurela Qamili
ICDTDE_911: Structural Reusability of Recycled Aggregate for Sustainable Concrete Development in Small Island Developing States: A Case Study of Mauritius 305
Joshan Sembhoo
ICDTDE_912: Simulation-Based Optimization of Load-Bearing Structures in Ground-Floor Housing for Efficiency and Sustainability: Insights from Small Island Developing States (SIDS) 306
Pauline Jean- Noël Nicolas, Asish Seeboo, Yashwaree Baguant, Zaheer Doomah, Manta nowbuth
ICDTDE_913: Towards Resilient Rooftops in Small Island Developing States (SIDS): Assessing Waterproofing Membranes and Alternatives in Mauritius 307
PHEERUNGGEE Muhammad Arfan, Asish Seeboo, Yashwaree Baguant, Zaheer Doomah, Manta nowbuth
ICDTDE_925: Digital Transformation and Customer Satisfaction: A CIS Framework for Urban Water Utilities 308
Amaliyah, Farhan Dwi Maulana, Erindah Dimisyqiyani, Rizky Amalia Sinulingga, Gagas Gayuh Aji
ICDTDE_926: Hand Hygiene Practices Among University Students: Insights from Hand Scanner Analysis Across Faculties 309
Shavkat Azimov, Sherzod Nematov, Adkham Makhkamov, Temurbek Daminov, Jamoliddin Razzokov
ICDTDE_927: Business-IT alignment in cloud computing using process mining and LLMs tools 310
M. Bouacha, H. Sbai
ICDTDE_929: The Role of Land Use Planning in Disaster Risk Reduction: The Case of Montagne Ory, Mauritius 312
Y. Baguant, A. Seeboo, M. Nowbuth, Z. Doomah4, P. Sitaram
ICDTDE_931: Assessing and Proposing a Resilient City: A Case Study of La Laura Mauritius 313
Y. Baguant, A. Seeboo, M. Nowbuth, Z. Doomah, Rowinsen Dholah
ICDTDE_932: Environmental Management in Cities Case Study of Central Flacq, Mauritius 314
Y. Baguant, A. Seeboo, M. Nowbuth, Z. Doomah, P. Sookharee
ICDTDE_934: The Role of Financial Technology in Enhancing Social and Financial Outcomes in Microfinance 315
Dr Catherine Nirmala J, Dr Bindhu D, Chethanraj & Diya Keerthan Shetty
ICDTDE_935: Integrating Machine Learning and GIS Techniques for Optimal Siting of Utility-Scale Solar Photovoltaic Systems in Maricopa County 316
Prince Chukwuemeka, Endurance Onyenweuwa Nwadoziokwu, Becky P. Bamiekumo, Meremu Dogiye Amos, Omabuwa O Mene-Ejegi, Charles U. Akajiaku, Okes Imoni
ICDTDE_936: Challenges and Opportunities of adopting the Agile Methodology in the banking sector for enhancing project management efficiency. 317
Hurpaul, S., Nowbuth, M. D., Doomah, Z., Baguant, Y. and Seeboo, A.
ICDTDE_937: Project Intelligence: When AI is the project Manager in IT and communication services in Mauritius. 318
Chundy, P, Nowbuth, M. D., Seeboo, A., Doomah, Z & Baguant, Y.
ICDTDE_938: Enhancing safety and productivity in the constructions sector through effective project management practices. 319
Cabri, J. A. T. A., Nowbuth, M. D., Baguant Y., Seeboo, A. and Doomah, Z.
ICDTDE_943: Artificial intelligence in Smart Cities and IoT: Edge and Cloud Symphony of Urban Intelligence 320
Aakash Sunil Chaudhari
ICDTDE_944: The Impact of University–Industry–Research Collaboration on Corporate Financial Health in the Digital Era—Empirical Evidence from an AI-Based Financial Diagnosis Database 321
X. Xiong, X. Jia
ICDTDE_945: Effects of timeseries length in early warning tsunami systems using a spatio-temporal transformer 322
Ilias Chamatidis, Denis Istratia, Katsuichiro Goda, Nikos D. Lagaros
ICDTDE_946: Investigating physics-based transformers in tsunami prediction 323
Ilias Chamatidisa, Denis Istratia, Katsuichiro Goda, Nikos D. Lagaros
ICDTDE_948: Neurodidactic and Cognitive Bases of Competency Clustering in Engineering Education: Mapping Trajectories and Interference Zones 324
Alimov Azam Anvarovich, Bakhriddinova Nasiba Muradovna, Savrieva Ikbol Bakhodirovna, Hafizov Akmal Rustamovich, Miralieva Aziza Kayumovna
ICDTDE_949: UTAUT2 and Online Shopping Anxiety: Evidence from Electronic Purchase Decisions in Indonesian Marketplaces 325
Efenly, and Princes, Elfindah
ICDTDE_951: A Hybrid Approach Based on Machine Learning and Multicriteria Decision Analysis for Budget-Aware Chronic Kidney Disease Analytics 326

O. Abdellaoui, M. Naimi
ICDTDE_952: Design Optimization of a Washing Machine Spider Arm Considering Manufacturing Constraints 327
Onur Çolak, Kübra Polat, Musa Uzun, Cahit Atagün, Mehmet Murat Topaç
ICDTDE_958: Intelligent triage of patients based on medical specialty in telemedicine: a Systematic Literature Review 328
H. Oueslati, Z. Maalej, K. Nouira
ICDTDE_960: Simulation of Intelligent Fire Protection System for Buildings and Spatial Visual Evacuation Design 329
Beibei Li, Yunyi Wu, Julan Lai, Weiqi Zhang
ICDTDE_963: Comparative Analysis of 3D-Printed Smart Orthoses for the Dominant Upper Limb: Materials, Components, and Standards 330
Portilla David, Castillo Samuel, Avella-Rodríguez Edna and Plazas-Rosas Ramiro
ICDTDE_965: Preventing The Obsolescence Of Residential Buildings Through The Integration Of Photovoltaic Solar Modules 331
Khotamov Asadulla Toshtemirovich, Urinov Murodjon Zayni ugli, Abdurakhmonov Abdubosit Abdukhakim ugli
ICDTDE_967: The Role and Development of Business Intelligence in the Banking Sector and Its Implications for AI Project Management Practices: A Systematic Literature Review 332
Melsiora Saniba Fernandes, Teguh Raharjo, Ni Wayan Trisnawaty
ICDTDE_969: Mechanism Analysis of Digital Infrastructure in Promoting Digital Finance Development 333
Shuai Cui, Zihao Wang, Qing Han, Xuewei Zhang, Jiaxi Tian, and Bo Shen
ICDTDE_970: Digital economy, market size and urban-rural income gap 334
Zihao Wang, Qing Han, Xuewei Zhang, Shuai Cui, and Donghan Meng
ICDTDE_971: Ukrainian Regions in the Process of Entrepreneurial Virtualization: From Global Economic Turbulence to Benchmarking 335
Inna Irtyshcheva, Iryna Kramarenko, Yevgeniya Boiko, Natalia Hryshyna, Natalia Tubaltseva, Oleksiy Horovy
ICDTDE_972: Active distribution network voltage coordination control strategy based on multi-agent reinforcement learning 337
Chengkai Kang and Liuyang Tao and Yilin Zhu and Haoyu Wang and Cong Ding
ICDTDE_973: Modular robot self-assembly interaction paradigm design for non-professional users 338
Jiahao Yang, Zimo Song, Chengkai Kang, Yu Zhang, Shang Wu, and Zhendong Ma
ICDTDE_974: Design and Motion Accuracy Compensation of Variable Curvature Continuum Robot Mechanisms Based on Conformal Geometry 339
Xiaolin Wang, Yuwen Su and Yunfei Jiang and Nuo Xu
ICDTDE_975: Data-driven prediction and uncertainty quantification of bearing remaining service life 340
Yongzhuang Li, Hongfang Shan, Yu Zhang, Junyi Li, Wenjing Zhou and Xinyu Bu
ICDTDE_976: Multimodal perception-based robotic flexible assembly force control process and digital twin verification 341
Hongfang Shan, Jiahao Yang, Yu Zhang, Wenkai Shi, Xuyin Han and Chengkai Kang
ICDTDE_977: Adaptive gripper design and grasping mechanics simulation based on variable stiffness soft robot 342
Xiaolin Wang, Yongzhuang Li, Yu Zhang, Zichen Tang and Yuxiang Hu
ICDTDE_979: Transforming the Construction Industry: Evolution of Building Information Modelling Towards Modular Construction 343
Hashem Al-Mattarneh, Rabah Ismail, Mei-Zhen Lim, Syed Ahmad Farhan, Marwa Al Jamal
ICDTDE_980: Attenuating Heat Transfer through Residential Roof Assemblies: Evaluation of Bulk Insulation based on 6-Dimensional Building Information Modelling 344
Rabah Ismail, Hashem Al-Mattarneh, Christopher Tan Earn Soon, Syed Ahmad Farhan, Marwa Al-Jamal
ICDTDE_982: Closing the Loop: Circularity in Modular Construction Research 345
Syed Ahmad Farhan, Rabah Ismail, Hashem Al-Mattarneh, Nadzhratul Husna, Marwa Al-Jamal
ICDTDE_983: Improved Technology For Producing Fine-Grained Concrete Using Marble Waste: A Comprehensive Study 346
Askarov Bakhtiyor Askarovich, Sobirova Mukaddas Khamidullaeva
ICDTDE_984: Research on the Impact of Digital Finance on Green Technology Innovation: A Quasi-Natural Experiment Based on the Pilot Program of Financial Technology Innovation Supervision 347
Xuewei Zhang, Qing Han, Zihao Wang, Jiaxi Tian, Qi Wang
ICDTDE_985: The Impact of Digital Economy on Enterprise Core Technological Innovation 348
Mingyang Li, and Chenhuan Kou
ICDTDE_986: Can Digital Village Construction Enhance Financial Inclusion? ——A Quasi-Natural Experiment Based on the Digital Village Pilot Program 349
Qing Han, Xuewei Zhang, Zihao Wang, Jiaxi Tian, and Chenhuan Kou
ICDTDE_987: Copyright Protection of FDM Products via Controlled Line Deviations 350
Pavel Tomashaytis, Victor Fedoseev, David Shapiro, Alexey Maximov

ICDTDE_988: Digital economy, industrial restructuring and consumption upgrading 351
Haodi Lv, Jingxi Yan, and Donghan Meng
ICDTDE_989: Can Artificial Intelligence Enhance Financial Inclusion? Evidence from a Quasi-Natural Experiment of China's New Generation AI Innovation and Development Pilot Zone 352
Zhifei Li, Shuai Chui, Yumo Zou, Bo Shen
ICDTDE_990: Research on the Effect of Digital Technology Promoting Agricultural Development — Based on Spatial Panel Regression Analysis 353
Jingxi Yan, Haodi Lv, and Zixian Zhang
ICDTDE_993: Graph-Based Modeling of Corrugated Boards for Local Stress Analysis During Compression 354
Ricardo Fitas
ICDTDE_994: A Machine Learning Supported AHP–GIS Framework for Flood Risk Mapping in the Central Niger Delta 355
Charles Ugochukwu Akajiaku, Ifunanya Osondu, Anslem O Otutu, Meremu Dogiye Amos, Tarinabo William, Omabuwa O Mene-Ejegi, Ebingiye Nelvin Agbozu
ICDTDE_996: Core Outcomes of Artificial Intelligence for Product Design and Development: A Systematic Literature Review and Future Research 356
Agung Purnomo, Ahmad Syamil, Bhekti Setyowibowo, Mulyani Karmagatri, Halbana Tarmizi, Fairuz Iqbal Maulana
ICDTDE_997: Towards recycling and promoting susttasinable nature-based solution for storm water capture using pervious pavement 357
Reshma Rughooputh and Fadeela Khadeejah Dulloo
ICDTDE_998: Stakeholders' perspective on sustainability, planning, restoration and management of the coastline of Mauritius: a thematic analysis approach 358
(Reshma Rughooputh) and (Myrna Jharittay)
ICDTDE_999: Construction and demolition wastes (CDW) management in Mauritius for circularity in construction materials towards resilient cities 359
(Reshma Rughooputh) and (Zakiyyah Jugon)
ICDTDE_1000: An Optimization led Design Framework and Global Case Studies for Post Disaster Recovery Shelters 360
Aditya Singh
ICDTDE_1001: Predictive Modeling of a Vacuum-Tube Solar Thermal System Using an LSTM Neural Network for Enhanced Energy Efficiency 361
Zhelyazko Terziyski, Margarita Terziyska, Nikolay Komitov
ICDTDE_1002: Real-Time Controlled 3D-Printed Robotic Manipulator for Digital Engineering Training 362
Nikolay Komitov, Veselin Mengov, Zhelyazko Terziyski, Margarita Terziyska, Aleksandar Gonev
ICDTDE_1003: Thin-Layer Drying Modeling of Red Beet Using Experimental Data, Page Kinetics, and Digital Monitoring 363
Nikolay Komitov, Margarita Terziyska, Zhelyazko Terziyski, Petya Tranenska, Aleksandar Gonev
ICDTDE_1004: Shear Force in a Beam-Column Connection from a Linearly Distributed Load Occupying Various Possible Positions on a Cantilever Beam - Asymmetric Cross Section 364
Albena Doicheva
ICDTDE_1005: Reflection from the Type of Load on the Beam and Other Factors Significantly Influencing the Magnitude of the Horizontal Shear Force 365
Albena Doicheva
ICDTDE_1006: The Necessity of Bioengineered and Microbial Materials in the Field of Construction 366
Aditya Singh
ICDTDE_1007: Temporal Refinement and ML-Driven Uncertainty Assessment of GEBCO Bathymetry in the Nigerian EEZ 367
Desmond Rowland Eteh, Ifunanya Osondu, Anslem O Otutu, Ebingiye Nelvin Agbozu, Tarinabo William, Ayebawanaemi G Winston
ICDTDE_1008: Machine-Learning-Based Evaluation of Freeze–Thaw Durability in Lime-, Cement-, and ZT-Stabilized Expansive Soils 368
Haitham Saleh, Samer R. Rababah, Abdulla A. Sharo
ICDTDE_1009: Systematic Review of Artificial Intelligence Roles for Product Design and Development: From Accelerating Innovation to Amplifying Sustainability 369
Agung Purnomo, Fairuz Iqbal Maulana, Mulyani Karmagatri, Halbana Tarmizi, Bhekti Setyowibowo, Ahmad Syamil
ICDTDE_1011: Comparative Evaluation of SQP, GA, and PSO in Constrained Truss Design Optimization using MATLAB 370
Faizan Masood and Vagelis Plevris
ICDTDE_1014: Consumer Preference Modelling for Electric Vehicles in Indonesia: A Conjoint Analysis Approach 371

Hendri Bhirowo, Indrawati, Indra Ardhanayudha Aditya, Handrea Bernando Tambunan, Refi Rifaldi Windya Giri, Fasa Maulidan Hakim, and Fayza Najeela Pakutandang
ICDTDE_1015: Three-Dimensional FLAC3D Modeling and Support System Optimization for Irregular Foundation Pit Excavations 372
Chang Wei Che, Hao-Yun Chi, Chiu Chiang Chung
ICDTDE_1016: Cross-Device Perception of LiDAR-Based Digital Twin Virtual Tourism: A Comparative Study Using a Heritage Fort Environment 374
Ting Lu Chiang, Hao-Yun Chi
ICDTDE_1017: Applying Digital Twin and XR in a Real-World Residential Renovation: A Workflow for Spatial Understanding and On-Site Decision Support 376
Hao-Yun Chi
ICDTDE_1018: Pilot Assessment of Digital Health Communication via WhatsApp Business and Its Impact on Purchase Intention at Edelweiss Hospital Indonesia 378
Iman Sulaeman and Indrawati
ICDTDE_1019: The Role of Virtual Influencers in Building Brand Trust Through Consumer Engagement: A Cultural and Consumer Trust Perspective 379
Sylvia Putri Setiawan and Indrawati
ICDTDE_1021: The effect of correlations among random member properties on structural design: Investigation based on Robust Design Optimization 380
Dimos C. Charmpis
ICDTDE_1023: Modeling Smart Furniture Publication Dynamics: A Design-Driven Management Approach Using a Weighted Multi-Model Ensemble 381
Agung Purnomo, Bambang Kartono Kurniawan, Fairuz Iqbal Maulana, Muhamad Ezran Bin Zainal Abdulah, Andi Pramono
ICDTDE_1027: A Hybrid Systematic Review and Delphi Study on the Internet of Medical Things in Entrepreneurship: Roles, Challenges, and Future Directions 382
Calista Kalleya, Agung Purnomo
ICDTDE_1028: Entrepreneurship Enablers in Civil Infrastructure: A Systematic Review and Delphi-Validated Synthesis 383
Casilda Aulia Rahmadina, Agung Purnomo
ICDTDE_1029: A Systematic Literature Review and Delphi Study on Entrepreneurship Roles in Civil Infrastructure: Toward a Future Research Agenda 384
Ajeng Pramesti Setia Wibowo, Agung Purnomo
ICDTDE_1031: Design and Optimization of a Multiband Patch Antenna for Mobile Communication Devices 385
S. Kannadhasan, Nor Asilah Wati Abdul Hamid, Dafik, R. Sunder, Arun S, S N Kumar
ICDTDE_1032: The Impact of Financial Inclusion on Economic Growth: Case of Tunisia 386
Kaies SAMET
ICDTDE_1033: Success Factors of IoT-Enabled Digital Tools in Entrepreneurship: A Systematic Review Integrated with Delphi Validation 387
Imeliana Jopi, Shandy Aulia Jaya, Hizkya Raka Priananda, Agung Purnomo, Yulia Magdalena
ICDTDE_1034: Neural Network Constitutive Modeling of Soil for Resilient and Sustainable Design 388
Stefanos Voulgaris, Nikos D Lagaros
ICDTDE_1039: Cellular Manufacturing's Impact on JIT and Lean Outcomes: A Literature-Driven Analysis 389
Wei Weng, Meimei Zheng
ICDTDE_1040: An Enhanced MILP Model for Efficiently Solving the Reentrant Flexible Job Shop Problem 390
Wei Weng, Cheng Chen
ICDTDE_1050: Quantum Microprocessor Architectures: Scalability and Error Correction Benchmark 391
Gabriel Silva Atencio
ICDTDE_1051: Comparative analysis of quantum technology and classical computing: advantages and drawbacks 392
Gabriel Silva Atencio
ICDTDE_1052: Formation Control Design for Multi-UAV Systems under Linear Disturbance Estimation 393
Linh My Dao, Thiem V. Pham, Nam Hoai Nguyen
ICDTDE_1053: Attack Design on Consensus of Second-Order Multi-Agent System 394
Dao Minh Thanh, Khanh Huy Tran, Linh My Dao
ICDTDE_1054: Unknown Input Observer–Based Estimation of Steering Rack Force in Steer-by-Wire Systems 395
Tuan Vu Ba, Cuong Duong Chinh, Quynh T. Thanh Nguyen
ICDTDE_1055: Compact Dual-Circularly Polarized Patch Antenna for Drone Communication Systems 396
Hoang Nguyen-Huy, Anh Tran-Tuan, Noi Truong-Quang, and Nguyen Tran
ICDTDE_1056: Design of a Compact Wideband 8-Port MIMO Antenna using Dual-Polarized Radiators for C-Band Applications 397
Thai Dinh Nguyen, Cuong Do-Manh, Trang Hoang-Thu, and Nguyen Tran

ICDTDE_1057: Compact Sub-6 GHz Patch MIMO Antenna with High Isolation for Handheld Devices 398
Tu Chu-Anh, Tan Dao-Duc, Dat Tran-Huy, and Hung Tran-Huy
ICDTDE_1058: Integrating Digital Tools and Business Intelligence to Overcome Data Fragmentation in SMEs Manual Recording Processes 399
Christine N. Mulyo, Meilinda Trisilia
ICDTDE_1064: A review of Goals of sustainable economic growth, creativity, and infrastructure aligned with SDG 9 400
CA Priti Sharma, Dr. Rupa Khanna Malhotra, Himani Upreti
ICDTDE_1065: Industry 5.0 as a Catalyst for Resilient Poverty Reduction Policies 401
Priti Sharma, Rupa Khanna Malhotra, Himani Upreti
ICDTDE_1068: Eco-Friendly Tourism and Hospitality: Balancing Growth with Environmental Responsibility 402
Priti Sharma, Rupa Khanna Malhotra, Himani Upreti, Sangeeta Bagga
ICDTDE_1071: Building Sustainable Communities: CSR Contributions to Affordable Housing, Mobility, and Resilience under SDG 11 in India 403
Himani Upreti, Rupa Khanna Malhotra, Priti Sharma
ICDTDE_1073: Artificial Intelligence Tools Driving Innovation and Advancements in Audit and Assurance: Towards Intelligent Risk Management and Transparency 404
Himani Upreti, Rupa Khanna Malhotra, Priti Sharma
ICDTDE_1074: Decadal Trends and Comparative Dynamics of CSR Spending by PSUs and Non-PSUs in India: Statistical Insights and Forecasts for Sustainable Development 405
Himani Upreti, Rupa Khanna Malhotra, Priti Sharma
ICDTDE_1077: Structural credentials of Wire-arc Additive Manufacturing fabricated 406
Nano-reinforced Aluminum Alloys
Charalampos Gkountas, Gavriil Dimoulas, Evangelos Efthymiou
ICDTDE_1078: Synergistic Wear–Corrosion Interaction in Al–Si/Al_2O_3 Composites: Microstructural, Electrochemical, and Tribological Assessment 407
Farah Ammar Ibrahim, Zeyad D. Kadhim, Mohammed A. Abdulrazzaq
ICDTDE_1080: Dynamic Characterization of Layered ground from Vibration Measurements 408
Hana Y. Shamayleh, Jamil Renno, Mohammed F. Hussein
ICDTDE_1087: AI-Driven Project Performance Management System for Engineering and Infrastructure Projects 409
Dr. Nisha Nandal
ICDTDE_1088: Optimization-Based Decision Framework for Resource Planning and Operations Management in Engineering Projects 410
Dr. Naveen Nandal
ICDTDE_1089: Digital Twin–Enabled Risk and Productivity Management for Construction and Industrial Operations 411
Dr. Naveen Nandal
ICDTDE_1093: Comparative Feasibility Analysis Of Hyperloop Technology Versus Conventional Ferry Operations For Cross-Lake Freight Transport: A Case Study Of Lake Van (Eastern Turkey) 412
Furkan Alperen SAKIN, Serdar DİNDAR
ICDTDE_1095: Data-Driven Torque and Temperature Estimation in PMSM Drives Using NARX Neural Networks 413
Ghiorghita Dan Ionut, Marian Gaiceanu, Razvan Buhosu
ICDTDE_1098: A blockchain-enabled deep learning framework for privacy-preserving cloud forensics in healthcare 414
Kavyashree J and Dr.Vikas Reddy S
ICDTDE_1099: Adaptive and real-time intrusion detection system using lightweight deep learning and optimized feature engineering 415
Deepti N N and Dr. Dhanalakshmi B K
ICDTDE_1100: Trajectory Tracking of an Ackermann-Driven Unmanned Ground Vehicle Using Lyapunov-Based Nonlinear Kinematic Control 416
Razvan Buhosu, Marian Gaiceanu, Ghiorghita Dan Ionut
ICDTDE_1110: What neural networks may be used to analyze trend lines for management decision-making? 417
W. Okulicz-Kozaryn
ICDTDE_1112: Integrating Artificial Intelligence into medical imaging to enhance diagnostic accuracy through multi-stream attention-based CNNs while effectively addressing multi-modal data challenges to improve overall clinical outcomes 418
Dr. T.C. Manjunath
ICDTDE_1114: Characterization and Anisotropy of 3D Printed Mycelium 419
Minas Karagiannis, Nikos D. Lagaros

ICDTDE_1117: Implementation of a Prediction Model Based on Naïve Bayes and Bag of Words (BoW) in Assessing ESG as a Supporting Factor for the Green Economy 420
Fernando, Kevin Deniswara
ICDTDE_1122: 5G-enabled digital twins: A governance framework for equitable smart urban transformation 421
Gabriel Silva Atencio
ICDTDE_1124: Optimizing the Strengthening Efficiency of Double Skin Tubular Beams using Sustainable Hybrid LRS FRP System 422
Bara'a R. Alnemrawi, Rajai Z. Al-Rousan, and Osama K. Nusier, Nikos Lagaros, Stelios K. Georgantzinos
ICDTDE_1125: NLFEA Study on the Flexural Behavior of Double Skin Tubular Beams Strengthened with LRS FRP System: Inner Steel Tube Eccentricity Effect 423
Bara'a R. Alnemrawi, Rajai Z. Al-Rousan, and Osama K. Nusier, Nikos Lagaros, Stelios K. Georgantzinos
ICDTDE_1126: The Extent Effect of Concrete Material on the Flexural Performance of Solid and Hollow Double Skin Tubular Beam 424
Bara'a R. Alnemrawi, Rajai Z. Al-Rousan, and Osama K. Nusier, Nikos Lagaros, Stelios K. Georgantzinos
ICDTDE_1130: Parametric statistical scheme for tracing the transmission of total harmonic distortion between a power network analyzer and an oscilloscope 425
Francisco Espín, Carlos Velásquez, Byron Silva, Paola Andrade
ICDTDE_1132: Evaluation of Success Factors in Determining the Impact of Biomedical Engineering on Neurosurgical Operations 426
Elif Bilge Akinci, Ali Karasan, Elifnaz Olgac
ICDTDE_1134: A Study of Fully Soft Fuzzy Assignment Model involving Soft More General Class of Linear Octagonal Fuzzy Numbers 427
Arul Roselet Meryline S, Amalore Arumica, Benazir Obilia X A
ICDTDE_1138: A Study of Fully Fuzzy Transportation Model involving More General Class of Linear Octagonal Fuzzy Numbers 428
Amalore Arumica, Arul Roselet Meryline S, Benazir Obilia X A
ICDTDE_1139: A Study of Fuzzy Correlation Coefficient in a Soft Fuzzy Environment 429
Vidya M, Arul Roselet Meryline, Felbin C Kennedy
ICDTDE_1156: Multiscale Stress Based Topology Optimization using local constraint enforcement 430
George Kazakis, Nikos D. Lagaros
ICDTDE_1157: Automated quantification of pronuclear dynamics and embryo ploidy 431
Panteleimon Tsakalis, Nikolaos Lagaros

Preface

International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025): ADDOPT2025, OPTARCH2025, OPT-iii2025, and DiGiCES2025 are endorsed by the European Council of Civil Engineers (ECCE), Scientific Technical Chamber of Cyprus (ETEK), Association of Civil Engineers of Greece (ACEG), and Cyprus Architects Association (CAA).

ADDOPTML2025, OPTARCH2025, OPT-iii2025, and DiGiCES2025 conferences are indexed in Scopus, and all presentations will be published by Springer.

The National Technical University of Athens (Greece), Jordan University of Science and Technology (Jordan), National and Kapodistrian University of Athens (Greece), Politecnico di Torino (Italy), University of Cyprus (Cyprus), and Al-Albayt University (Jordan) are organizing the 2nd International Conference on ADDitively Manufactured OPTimized Structures (ADDOPT2025), 3nd International Conference on Optimization Driven Architectural Design (OPTARCH2025), 3nd International Conference on Engineering and Applied Sciences Optimization (OPT-iii2025), and 1st International Conference on Digital Tools in Construction for Efficiency and Sustainability (DiGiCES2025) to be held in Jordan in an ONLINE format from December 18th- 20th, 2025. The conferences are supported by the MSCA RISE project ADAPT4CE with No: 101182768.

The ADDOPT2025, OPTARCH2025, OPT-iii2025, and DiGiCES2025 conferences aim to bring together a global, multidisciplinary community of researchers, practitioners, and innovators from a diverse range of disciplines. Topics of interest include, but are not limited to: Optimization and computational mechanics, Architectural and structural design, Additive manufacturing and advanced materials, Civil and structural engineering, Artificial intelligence and data science, Digital construction/manufacturing technologies, and Environmental and sustainability sciences. These thematic areas are indicative rather than restrictive, and the conferences actively, encourage contributions from adjacent and emerging fields that intersect with the broader domains of digital, computational, and sustainable engineering.

The conferences seek to advance a holistic, machine learning–assisted, optimization-driven design-to-manufacturing framework for civil and architectural structures. Through interdisciplinary collaboration, the events will explore challenges and opportunities in areas such as: Engineering problem formulation across domains, Advanced computational methods and digital tools, Cross-platform software and workflow integration, Data-informed decision-making across the construction lifecycle. A key focus is the integration of theory, methods, and application, linking mathematical programming, bio- and nature-inspired algorithms, simulation-driven design, and AI-enhanced sustainability with practical implementations in construction and manufacturing.

A flagship goal of the ICDTDE2025 conference cluster is the development of an integrated structural design and construction framework leveraging additively manufactured, optimization-enhanced components. Potential applications include: Transitional healthcare units for rapid response in public health emergencies and Post-disaster recovery shelters tailored for resilience and sustainability. These initiatives exemplify how cutting-edge, multidisciplinary research can translate into concrete societal impact, fostering innovation at the intersection of technology, engineering, architecture, and sustainability..

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International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

Jordan, December 18th - 20th 2025

6D Printing: Exploiting Full Programmability of Smart Structures through Additive Manufacturing

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ABSTRACT

The rapid evolution of additive manufacturing (AM) has transformed how we design and fabricate structures, moving from static 3D prints to dynamic, shape-morphing constructs enabled by 4D printing. Yet, existing paradigms remain constrained — either by geometric limitations, lack of intelligence, or narrow responsiveness to environmental stimuli.

The concept of 6D Printing represents a transformative evolution in additive manufacturing (AM), combining the geometric freedom of 5D printing—which allows material deposition in any spatial direction—with the time-dependent responsiveness of smart materials. This integration enables the full programmability of structural behavior by controlling not only where and how material is placed, but also how the resulting object will respond dynamically to external stimuli such as temperature, stress, magnetic fields, or pH.

Unlike 3D and 4D printing, which are limited by planar layer deposition and predefined, often simplistic, stimulus-response behaviors, 6D Printing introduces a new design paradigm where behavior is encoded directly into the deposition path. The multi-axis control of 5D printing enables alignment of functional domains and reinforcement fibers along stress trajectories or actuation directions. This precise control over spatial orientation and material composition allows structures to deform, morph, or function predictably and programmably over time.

This work explores the foundational principles of 6D Printing, presents early case studies demonstrating directional stimulus-responsiveness, and highlights its disruptive potential across sectors such as biomedicine, soft robotics, and aerospace. By embedding behavior during fabrication, 6D Printing unlocks new possibilities in adaptive, intelligent, and functionally reprogrammable structures.

* The asterisk denotes the presenting author.

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A Systematic Review of Protective Shelters for Archaeological Sites: Design, Environmental Control, and Sustainability

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ABSTRACT

Protective shelters are widely-used protection method in archaeological sites, especially in the Mediterranean basin. Shelters are constructed to protect interior design elements vulnerable to deterioration, such as mosaics, wall paintings, or fragile building materials. Studies often explore the decision-making and design processes of protective shelters, focusing on their visual and structural features or post-construction evaluations, yet few assess their energy performance through before-and-after measurements of temperature, humidity, radiant heat, and climate adaptability to determine their effectiveness [1–4]. This study reviews the effectiveness of protective shelters for archaeological sites, focusing on their impact on environmental control, design features, and long-term performance. The purpose is to evaluate the ability of different shelter types to regulate temperature, humidity, and pollutants, and to assess their sustainability and adaptability to diverse climatic conditions. A systematic search was conducted across Web of Science and Scopus databases. The studies were categorized into three groups: Environmental Control, Shelter Design, and Shelter Performance Evaluation. Data extraction involved screening and organizing the findings using Rayyan, Mendeley, and Excel. The results reveal that while shelters provide essential protection, moisture management and long-term monitoring remain key challenges. The study concludes with practical recommendations for improving shelter design, including better moisture management, passive environmental control, and modular designs tailored to specific site conditions. These gaps should be addressed in future research.

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Towards Automated Summarization of Cybersecurity Reports Using Fine-Tuned Large Language Models

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ABSTRACT

Cybercrime has been a growing global issue [1], with nations, businesses, and individuals facing increasingly sophisticated cyber threats. This necessitates the development of advanced tools for cyber threat intelligence and incident response. Small businesses are impacted mainly by continuous cyberattacks, as they often lack the necessary resources and tools to implement comprehensive cybersecurity measures. According to the Annual Cyber Threat Report [2], the average cost per cybercrime for small businesses increased by 8%, decreased by 35% for medium-sized companies, and decreased by 11% for large businesses. Large Language Models (LLMs) have been shown to be powerful tools for processing and analyzing vast amounts of unstructured data. These models are able to automate complex tasks such as summarization, pattern recognition, and information extraction. Several studies have shown that LLMs can help cybersecurity operations by automating intelligence gathering and threat analysis [3,4]. While LLMs have been helpful in cybersecurity applications, existing models are designed for general-purpose language tasks and lack fine-tuning for cybersecurity-specific contexts. Furthermore, traditional methods of cyber threat intelligence analysis require significant manual effort, making them inefficient and prone to human error [5]. One of the key challenges is ensuring that LLMs can effectively process, extract, and interpret threat intelligence from unstructured data, as traditional methods struggle to keep pace with the dynamic nature of cyber threats [6]. To address the problem mentioned, this study aims to fine-tune LLMs using historical cybersecurity reports to enhance their ability to extract and summarize threat intelligence reports and thus automate the cybercrime investigation process to some extent. This study also evaluates the effectiveness of LoRA in optimizing model training while minimizing computational overhead.

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International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

Jordan, December 18th - 20th 2025

Investigating Tribological Performance of Si_3N_4-hBN Ceramic Composite using BHARAT Approach

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ABSTRACT

Silicon nitride (Si_3N_4) is widely used in industrial applications due to its high fracture toughness, strength, and wear resistance. Its suitability has also been demonstrated in biomedical applications, particularly in orthopaedics.

This study presents an experimental investigation, combined with the Taguchi-based Best Holistic Adaptable Ranking of Attributes Technique (BHARAT) approach to evaluate the tribological behaviour of Si_3N_4–hBN ceramic composites sliding against ASTM 316L steel under dry conditions. Wear tests were performed with hBN weight fractions of 0, 4, 8, 12, and 16% in Si_3N_4. Loads ranged from 5 N to 25 N in 5 N increments, using a Pin-on-Disc (PoD) tribometer.

The experiments were planned using DoE-Taguchi method and recently proposed Best Holistic Adaptable Ranking of Attributes Technique (BHARAT) is implemented to minimize both the volumetric wear rate and the coefficient of friction, with the goal of enhancing the tribological performance of Si_3N_4–hBN composites for industrial and biomedical applications. The optimization considered two key factors: applied load and hBN volume fraction. The analysis presented that 15N load with 12 % Wt. of hBN addition is optimum to improve the tribological performance of silicon nitride through minimizing volumetric wear rate and coefficient of friction.

Keywords: Taguchi-BHARAT Approach, Silicon Nitride (Si_3N_4), hexagonal Boron Nitride (hBN), Wear, Coefficient of Friction (CoF).

Quantile Regression Modeling of Unit Gompertz–Poisson Distributions for Digital Optimization of Urban Water Leakage Reduction

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ABSTRACT

Urban water distribution networks face significant leakage, leading to economic losses and inefficient resource use. This work introduces a quantile regression framework based on the Unit Gompertz–Poisson (UGP) distribution for bounded response variables in leakage reduction projects. By linking explanatory variables directly to conditional quantiles, the model provides robust estimation in the presence of skewed data and outliers.

Model parameters are estimated via maximum likelihood, and diagnostics are carried out using randomized quantile residuals and Cox–Snell plots. A synthetic dataset designed to mimic real-world district metered area (DMA) interventions is analyzed. Results show that the UGP quantile regression outperforms conventional bounded models such as Beta and Kumaraswamy distributions in flexibility and predictive accuracy. The analysis also highlights operational and infrastructural factors affecting leakage reduction efficiency.

Overall, the study demonstrates the potential of UGP quantile regression as a digital engineering tool for smart water management. Its integration into data-driven optimization frameworks supports decision-making in sustainable urban infrastructure.

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International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

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Applications of Physics-Informed Neural Networks for Static Analysis of Plates

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ABSTRACT

This study employs Physics-Informed Neural Networks (PINNs) to predict the deflection and stress distributions in plates under in-plane loads. A PINN framework called the Deep Energy Method is developed, which utilizes a deep energy-based model to approximate displacement fields and minimizes the total potential energy as its loss function. The displacement and stress distributions predicted by the PINN framework for the plates under uniform and sinusoidal distributed loads are validated against numerical models based on a custom FEM code and simulations in ABAQUS. The findings illustrate that the deep energy-based model accurately predicts the displacement and stress fields of the plates, demonstrating good agreement with numerical models. Furthermore, the deep energy-based model shows significant potential as a superior alternative to traditional computational methods for solving complex problems in structural mechanics.

Keywords: Physics-Informed Neural Networks (PINNs), Static Behavior Prediction, Computational Mechanics, Deep Energy Method.

Design and Implementation of an Intelligent Question-Answering System for Low-Carbon Technologies in Green Buildings

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ABSTRACT

This paper presents an intelligent QA system for low-carbon technologies in green buildings, aligned with China's dual-carbon targets and large-scale infrastructure delivery. We curate a domain corpus by translating and structuring 33 building-related items from the national list of 103 promoted low-carbon technologies and 56 criteria from the Green Building Evaluation Standard (2024). The knowledge base is stored in an OpenAI Vector Store; retrieval uses file_search with hybrid search. A two-stage routing is adopted: first, semantic retrieval over the internal corpus (top-k=5 with a similarity threshold); second, it falls back to web search when confidence is low. Reasoning relies on GPT-5 Responses API (non-streaming) with constrained max_output_tokens (e.g., 256) to balance latency and cost. Multi-tenant isolation is enforced via per-tenant vector stores and access control.

Experimental results show that on a 300-question domain-specific benchmark the system attains ~88% accuracy with an average response time of <8 s (P95 ≈ 7.5 s). The system combines traceable, policy-aware retrieval with robust generation. Each answer explicitly indicates the building lifecycle stage (e.g., design, construction, operation) applicable to each referenced low-carbon technology or green building criterion, providing context-specific support for technology selection and compliance checks across all lifecycle phases. Its design is informed by prior work on green building rating systems [1], low-carbon design using BIM [2], and BIM-centric QA [3].

International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

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Application of negative pressure assisted filling method in contour control of soluble microneedle array

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ABSTRACT

Applying controllable negative pressure to the bottom of the mold to assist filling is a new technology with potential in the field of mold-based preparation of soluble microneedle patches. However, the mechanism of the influence of its process parameters on the precise molding of microneedles remains to be studied. In this study, the actual action range of negative pressure at the bottom of the PDMS mold was defined by designing through holes with different geometric features, and the actual action range of negative pressure, the expansion effect, and the relationship between it and the final microneedle molding area were systematically analyzed. On this basis, based on the grid structure through holes, the synergistic effect of negative pressure intensity, loading time and grid geometric parameters was further systematically investigated, and how these factors jointly regulated the expansion behavior of negative pressure in the mold was deeply revealed. Based on the above research conclusions, we successfully applied the optimized grid structure to large-aperture through holes, effectively overcoming the problem of collapse in the central area of the PDMS mold caused by negative pressure, and achieved uniform microneedle molding in the entire target area including the non-through hole area. Finally, a microneedle array with the expected heart-shaped contour was prepared, and its effective puncture depth of about 400 μm was verified in an in vitro pig ear skin model, confirming the feasibility and application value of this optimization strategy in the development of customized, high-performance microneedle patches.

Analysis of Fluid Dynamics and Gas Flow Characteristics of Compressed Gas Ejection System for UAV

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ABSTRACT

With the rapid development of UAV technology, especially its wide application in military, agriculture, disaster monitoring and other fields, the demand for UAV take-off performance is increasing. Traditional take-off methods have limitations such as poor flexibility and the need for a long runway, while compressed gas ejection systems provide a solution for fast take-off without a runway. This paper studies the gas flow characteristics of the compressed gas ejection system of UAV and its impact on system performance through fluid dynamics analysis. By numerically simulating the expansion process of different gases (such as helium, nitrogen and air) in the compression ratio range of 3 to 6, it is found that helium can improve the energy conversion efficiency by about 15% compared with nitrogen and air. The study also shows that an increase in compression ratio can increase the airflow velocity, thereby enhancing thrust, but too high a compression ratio will lead to energy loss. By optimizing the pipeline design (such as reducing the roughness and curvature of the inner wall of the pipeline), the airflow resistance can be reduced by about 10%. These research results provide an important theoretical basis for the design and optimization of compressed gas ejection systems for UAVs, and improve the take-off efficiency and application capabilities of UAVs in various complex environments.

Cross-embodied reinforcement learning control method for quadruped robots on complex terrain

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ABSTRACT

With the widespread application of quadruped robots in complex terrains, achieving efficient and stable motion control in these changing environments has become a key issue. Traditional control methods often rely on pre-set control rules or models, which struggle to maintain consistency across different platforms and complex terrain conditions. This paper proposes a control method for quadruped robots based on cross-embodied reinforcement learning (C-ERL), aiming to address the robot's adaptability to diverse challenges in complex terrain. By introducing a reinforcement learning framework and an adaptive reward function, this method not only optimizes the robot's motion control on flat terrain, slopes, rocky areas, and loose gravel, but also enables cross-platform transfer of control strategies. Experimental results show that using this method, the quadruped robot achieves an 8% increase in average speed, a 15% improvement in posture stability, a 12% reduction in specific energy consumption, and a task completion rate exceeding 90% across various complex terrains. In terms of cross-platform transfer, the robot's overall score varies less than 5% between platforms, demonstrating strong cross-embodied adaptability. This study provides a new solution for the efficient control of quadruped robots in dynamic and complex environments and lays a foundation for the further development of cross-embodied control technology.

Design of high-energy cathode materials for lithium-ion batteries based on first principles

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ABSTRACT

In order to meet the urgent demand for high-energy-density lithium-ion batteries in the fields of electric transportation and high-end energy storage, this paper systematically designs and screens a variety of new cathode materials based on first-principles calculation methods. Density functional theory (DFT) is used to simulate the crystal structure, electronic structure, lithium-ion migration behavior and thermal stability of candidate materials, and a theoretical research framework combining performance prediction with microscopic mechanism is constructed. In the study, a total of 8 types of transition metal oxide/fluoride materials were evaluated, and representative M3 and M6 systems were selected. The theoretical specific capacity reached 280mAh/g and 302mAh/g respectively, and the average working voltage was 4.05V and 4.28V respectively, corresponding to a theoretical energy density of more than 1100Wh/kg. The migration energy barrier calculation shows that the lithium-ion diffusion barrier of the M6 material doped with Ti^{4+} is reduced to 0.28eV, which is about 35% lower than the original structure, effectively improving its fast charge and discharge performance. At the same time, the formation energy and phonon spectrum analysis show that the optimized material has good stability in both thermodynamics and kinetics. The study also proposed a structural optimization strategy of "doping + defect coordinated regulation", successfully established a quantitative correlation between atomic-scale structural modulation and macroscopic performance improvement, and verified the predictive value and guiding significance of the first-principles method in material design. This research result provides a quantitative basis and engineering path for the theoretical development of a new generation of high-energy lithium-ion battery cathode materials.

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International Hydrogen Energy Trade Flow Forecast and Transaction Optimization Model Based on 5G and Blockchain

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ABSTRACT

With the acceleration of global energy transformation, hydrogen energy, as an important clean energy, has gradually become a key component of the energy strategy of various countries. In order to improve the efficiency and security of hydrogen energy trade, this paper proposes an international hydrogen energy trade flow forecast and transaction optimization model based on 5G and blockchain technology. By taking advantage of the low latency and high bandwidth of 5G technology, real-time data transmission and accurate prediction of hydrogen energy production, demand and trade flow on a global scale can be achieved; at the same time, combined with the decentralization and immutability of blockchain technology, the transparency and automation of the trade transaction process can be achieved. Experimental results show that the prediction accuracy of hydrogen energy trade flow based on this model is about 12% higher than that of traditional methods, and the transaction optimization effect is significant, the transaction cost is reduced by about 15%, and the transaction time is reduced by about 20%. The application of this model provides an innovative technical path for the efficient, safe and transparent operation of international hydrogen energy trade, and has broad application prospects and practical value.

Research on the Application of Blockchain Smart Contracts Driven by Generative Large Language Models in Industrial Automation

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ABSTRACT

With the continuous development of industrial automation technology, traditional automation systems face great challenges in efficiency and flexibility. The combination of generative large language models and blockchain technology provides a new solution for improving the intelligence, accuracy and transparency of industrial automation systems. This paper quantitatively analyzes the application of blockchain smart contracts driven by generative large language models in industrial automation, focusing on its performance in equipment management, production scheduling, data sharing and decision support. In the experiment, compared with the traditional system, the smart contract system based on the generative large language model reduced the contract generation time by 40%, increased the system response time by 33.3%, increased the production efficiency by 18%, and reduced the equipment maintenance cost by 25%. The research results show that the system not only significantly improves the automation level, but also improves the security and reliability of the system. Finally, this paper also explores the application prospects of this technology in industrial automation and the technical challenges it faces, and puts forward the direction of future research.

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Jordan, December 18th - 20th 2025

Strength improvement of poured concrete in bridges in high-cold areas based on integration of vibration mixing and non-destructive testing

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ABSTRACT

This study explores the application of integrated vibration mixing and non-destructive testing technology in bridge concrete construction in high-cold areas, aiming to improve concrete strength and ensure construction quality. The experiment selected 60 groups of concrete samples, divided into vibration mixing + non-destructive testing group and traditional mixing group, and poured and cured them under low temperature conditions such as -10℃, -15℃, and -20℃. The results show that the compressive strength of concrete using vibration mixing and non-destructive testing technology at 28 days of age is an average of 30.6% higher than that of traditional construction methods. Under extreme low temperature conditions, the compressive strength is increased by 47.9%. In addition, the use of ultrasonic non-destructive testing technology can monitor the change of concrete strength in real time to ensure the controllability of concrete quality during construction. The research results show that the integrated technology of vibration mixing and non-destructive testing can effectively overcome the influence of high-cold environment on the improvement of concrete strength, significantly improve the density and durability of concrete, and provide a new technical solution for bridge construction in high-cold areas.

Compact and Smart: An IoT-Integrated Smartwatch for Gas Hazard Detection and Safety Alerts

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ABSTRACT

This paper presents the design and implementation of an IoT smartwatch using the ESP8266 microcontroller, integrated with an MQ-2 sensor for gas detection, a DHT22 sensor for temperature and humidity measurement, and a 20x04 LCD screen for real-time information display. The system incorporates an NTP Client for precise time synchronization and the Blynk platform for remote control. Key functionalities include displaying time, temperature, humidity, gas concentration, and issuing alerts when gas levels exceed safe thresholds. Users can adjust the time zone via a push button or the Blynk app. Experimental results show stable operation, with response times of 8.5–10.2 seconds, sensor accuracy of ±5–8%, and a false alarm rate below 7%, outperforming some comparable systems. The device, costing under 15 USD, offers a compact (100mm x 80mm x 40mm) and portable solution suitable for household and small-scale industrial safety monitoring.

* The asterisk denotes the presenting author.

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A High-Performance Gradient Descent MPPT Algorithm for Fast and Stable Power Extraction in PV Systems

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ABSTRACT

This study introduces an enhanced maximum power point tracking (MPPT) algorithm for photovoltaic (PV) systems, utilizing a novel gradient descent (GD) strategy. Traditional MPPT methods, such as Perturb and Observe (P&O) and Incremental Conductance (InC), often struggle to balance between fast convergence and minimizing power oscillations. The proposed GD-based technique overcomes these drawbacks by adaptively adjusting the duty cycle based on the power–voltage gradient, enabling both rapid convergence and stable tracking of the maximum power point (MPP). Simulations conducted on a boost converter integrated with three PV modules in series demonstrate that the proposed method achieves MPP convergence within 0.108 to 0.201 seconds—substantially faster than conventional InC techniques. Furthermore, steady-state power oscillations are significantly suppressed, leading to improved system efficiency and operational stability. Owing to its simplicity and robust performance, the proposed algorithm is well-suited for real-time PV applications operating under dynamic environmental conditions.

* The asterisk denotes the presenting author.

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Unsupervised Anomaly Detection Using Segmentation and Object Localization for Real-Time Surveillance Applications

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ABSTRACT

Anomaly detection is vital across domains such as surveillance, healthcare and manufacturing. Conventional systems, often based on manual monitoring or rule-based algorithms, are limited by human fatigue, delayed response, and sensitivity to environmental changes. To overcome these challenges, we propose an unsupervised anomaly detection framework for real-time deployment with minimal technical complexity. The system leverages computer vision and artificial intelligence techniques to detect and localize abnormal events within video streams. Foreground segmentation and object detection are employed to highlight critical objects and activities, with bounding boxes and mask-based segmentation supporting accurate localization and interpretation. Unlike conventional supervised methods, the model learns normal and abnormal activity patterns with limited supervision, ensuring adaptability across varied environments without extensive retraining.

Performance is evaluated using complementary benchmarks: mean Intersection over Union (mIoU) for segmentation accuracy and mean Average Precision (mAP) for object detection quality. These metrics together provide a comprehensive assessment of the system's ability to identify anomalies in both spatial and semantic contexts. The proposed framework demonstrates scalability, and user-friendliness, making it suitable for real-world anomaly detection in diverse applications.

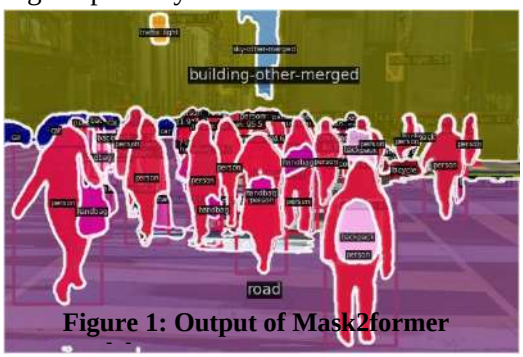


Figure 1: Output of Mask2former

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International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

Jordan, December 18th - 20th 2025

Product Classification by Weight Using Computer Vision and YOLO11n on Jetson Nano

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ABSTRACT

In the era of rapid industrial automation, accurate and cost-effective product classification systems are increasingly essential. This paper presents a computer vision-based solution for product classification by weight, integrating the YOLO11n deep learning model on the Jetson Nano platform. The proposed system comprises an electronic scale, camera, conveyor belt, robotic arm, and a central controller to recognize weight readings and product attributes such as shape and color for automatic sorting. Experimental results demonstrate that the optimized YOLO11n-RP model significantly reduces model size and computational resources while maintaining high accuracy, achieving an average precision (mAP50) of approximately 0.993. The system ensures stability, fast processing speed, and feasibility for real-world manufacturing environments. This work highlights the potential of combining computer vision and AI for intelligent product classification, offering an efficient, scalable, and cost-effective solution for industrial applications.

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Efficient CNN-Based Maize Leaf Disease Detection for Embedded Agricultural Applications

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ABSTRACT

Advances in computer vision are transforming precision agriculture, particularly in crop disease monitoring. This work presents a lightweight corn (maize) leaf classification system to support plantation development through efficient and deployable deep learning. The system classifies corn leaves into four categories: healthy, blight, common rust, and gray leaf spot. A transfer learning approach using ResNet-18 was adopted, where the model was fine-tuned on a corn leaf dataset with multiple training-validation splits (90:10, 80:20, 70:30, 60:40). Transfer learning accelerated model development and improved performance even with limited data. To enable lightweight deployment, two strategies were explored: (i) fine-tuning pre-trained models and (ii) fine-tuning quantized pre-trained models using feature extractors. In the latter, feature extractor layers were frozen and a new classifier trained with Quantization-Aware Training (QAT) to reduce model size while maintaining accuracy. Results showed that the unquantized model achieved 90.15% peak validation accuracy, while the quantized model achieved 97.01%, outperforming the baseline while being more efficient. The optimized model is further implemented on an NVIDIA Jetson Nano for real-time testing, demonstrating practical applicability for embedded agricultural systems. This work highlights the potential of lightweight transfer learning with quantization for reliable and scalable crop disease detection. The proposed approach offers a cost-effective and accessible tool for real-world agricultural applications, advancing the integration of AI in sustainable farming practices.

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Real-Time Zero-Shot Object Grounding on Edge Devices with Vision-Language Models

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ABSTRACT

Real-time object grounding using zero-shot visual tracking has gained significant attention due to its ability to recognize and track objects based on natural language descriptions without the need for retraining on new object categories. In this work, we present a real-time interactive object grounding system deployed on the NVIDIA Jetson Nano platform to perform object localization through referring expressions. The core zero-shot grounding model, CRIS.pytorch, processes both image inputs and user-supplied text queries to accurately localize target objects. To further support the grounding process, an optional BLIP model is integrated to generate descriptive captions. To improve usability and accessibility, the system integrates multiple components into a unified real-time application, including a camera interface, graphical user interface (GUI), grounding visualization, confidence scoring, and feedback mechanisms such as LED indicators and audio outputs. System performance is evaluated in terms of grounding accuracy, inference speed, user interaction experience, and responsiveness. Benchmarking is conducted using referring expression grounding datasets such as RefCOCO and RefCOCO+, which assess the system's ability to identify objects based on natural language queries. Experimental results demonstrate that the proposed system achieves precise object grounding with low inference latency, making it well-suited for real-time deployment on edge devices. This work highlights the feasibility of combining vision-language models with low-power hardware to deliver practical, adaptive, and interactive visual tracking solutions.

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International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

Jordan, December 18th - 20th 2025

Identifying Systemic Super-Spreaders Using Triangulated Maximally Filtered Graphs

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ABSTRACT

The increasing interconnectedness of financial systems amplifies contagion risks, particularly in emerging markets where structural vulnerabilities remain underexplored. This study addresses the limitations of conventional network filtering methods such as Minimum Spanning Tree (MST) and Planar Maximally Filtered Graph (PMFG), which often fail to capture higher-order dependencies, by applying the Triangulated Maximally Filtered Graph (TMFG) to Bursa Malaysia [1]. Using daily returns of 28 firms listed in the PRIBUMI Bursa Malaysia Zakat Index,we constructed a TMFG-based dependency network, identified systemically important firms via degree centrality, and modeled contagion dynamics through probabilistic shock cascade simulations parameterized by seed-failure probability (δ), exposure fraction (α), and tolerance threshold (θ). The analysis is based on the year 2018 until 2023. Results reveal that CIMB and MBSB companies as central hubs, with MBSB acting as a "super-spreader" capable of triggering full-scale systemic collapse under high exposure ($\alpha \geq 0.7$) and low buffers ($\theta = 0.01$), while increasing buffers to $\theta = 0.03$ substantially mitigates contagion. The findings demonstrate the utility of TMFG in uncovering hidden interdependencies, quantifying systemic vulnerabilities, and highlighting the disproportionate impact of hub institutions in propagating shocks. This framework improves the use of network filtering and cascade modeling in financial engineering, providing a data-driven approach to monitor systemic risk and build stronger resilience strategies in emerging markets.

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Jordan, December 18th - 20th 2025

Comparison of Credential Management Systems Based on the Standards of IEEE, ETSI, and YD/T 3957-2021

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ABSTRACT

As V2X (Vehicle-to-Everything) technology becomes increasingly prevalent, the security of V2X networks has garnered growing attention worldwide. In North America, the IEEE 1609 series standards are primarily used, while Europe adopts the ETSI series standards, and China has also established its industry standard, YD/T 3957-2021, among others. Although these standards share some commonalities, they also exhibit differences. To achieve compatibility across these standards, analyzing their similarities and differences is a crucial issue. Therefore, this study focuses on analyzing the three major standards mentioned above, discussing aspects such as certificate formats, signed message formats, and certificate request processes. Additionally, this research evaluates the efficiency of different cryptographic methods, including NIST P-256 and SM2-256, SHA-256 and SM3-256, as well as AES-128 and SM4-128. Finally, the study implements these three major standards on V2X devices and compares the efficiency of message signing and signature verification in V2X systems, providing a reference for the development of a secure certificate management system for V2X networks.

* The asterisk denotes the presenting author.

International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

Jordan, December 18th - 20th 2025

Implementing Management Accounting in Small and Medium-Sized Enterprises: Opportunities, Challenges, Constraints, and Development Strategies

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ABSTRACT

Small and medium-sized enterprises (SMEs) are the backbone of most economies but often lack systematic management accounting (MA) practices. While MA has proven to enhance decision-making, cost control, and strategic alignment, its implementation in SMEs remains limited due to financial constraints, lack of expertise, and cultural resistance. At the same time, digital technologies and sustainability imperatives are creating new opportunities for SMEs to adopt more advanced MA systems.

This paper reviews existing ISI/Scopus literature and case studies to analyze both opportunities and constraints for MA adoption in SMEs. It then proposes a five-phase strategic framework, moving from awareness and capacity building to sustainability-oriented management accounting (SMAc). The framework emphasizes incremental adoption, digital integration, and alignment with environmental and social performance metrics.

The study contributes by consolidating fragmented evidence, offering a structured roadmap for SMEs, and highlighting the role of digitalization and sustainability in shaping the future of MA practices.

Keywords: management accounting, SMEs, opportunities, challenges, framework, sustainability.

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Aerodynamic Design and Structural Evaluation of a TPMS-Core, Composite-Reinforced Nose Cone

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ABSTRACT

This work presents the design rationale and multi-physics assessment of a nose cone that combines a low-drag Haack-series external profile with an additively manufactured triply periodic minimal surface (TPMS) lattice core and composite laminate skins. The selected LD-Haack (von Kármán) geometry targets reduced wave-drag in the transonic regime for slender finned vehicles, while the TPMS core enables high specific stiffness and tunable energy absorption relative to conventional foam or honeycomb cores.

The structure is realized by 3D-printing a polymeric TPMS core and co-bonding (or secondary bonding) carbon- or glass-fiber reinforced polymer (CFRP/GFRP) skins to obtain a smooth aerodynamic surface and laminate tailoring for bending and buckling resistance. The evaluation methodology integrates (i) computational fluid dynamics (Mach 0.3–1.2) to quantify pressure distribution, drag coefficient, and flow features near the shoulder; (ii) finite-element analysis to assess global stiffness, local buckling, and failure modes (core shear, facesheet wrinkling, and delamination hot-spots); and (iii) aero-thermal checks using stagnation-line heating correlations to bound surface temperature rise during flight. The analyses are organized in a design–test feedback loop to reduce modeling uncertainty and converge on a weight-efficient lay-up and core topology.

Results indicate that the TPMS-core sandwich with composite skins can achieve a favorable stiffness-to-mass ratio while maintaining low external drag, with damage-tolerant failure modes and straightforward repair strategies (facesheet patching, localized core replacement). The workflow generalizes to fairings and small-vehicle nose cones, providing a scalable path from model-rocket scales to more demanding mission profiles.

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Integrated Aerodynamic and Structural Design with Experimental Evaluation of a Solid-Propellant Model Rocket

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ABSTRACT

This work reports the end-to-end design, integration, and experimental evaluation of a solid-propellant model rocket. The vehicle architecture integrates propulsion, aerodynamic shaping, structural design, avionics, and a two-stage recovery system into a flight-ready configuration. Initial sizing and stability assessment follow established analytical models for slender finned vehicles, coupled with mass-property estimates and static-margin targets. The propulsion selection and sizing are informed by standard rocket-propulsion performance relations.

The methodology combines numerical simulation with targeted testing. Finite-element analysis (FEA) is used to verify structural integrity under combined thrust and aerodynamic loading, while computational fluid dynamics (CFD) supports aerodynamic refinement and stability analysis in the relevant subsonic regime. Ground testing includes static motor firings to characterize delivered thrust and burn time, avionics-in-the-loop checks, and deployment tests for the recovery sequence. These activities establish a design–test feedback loop that reduces model uncertainty and closes the gap between predicted and observed behavior.

The outcome is a flight-ready system that meets structural and stability requirements and demonstrates reliable subsystem operation prior to launch. The presented workflow—integrating analytical models, finite-element and CFD analyses, and subsystem validation—offers a transferable template for small-scale rocketry projects and can be extended to higher-performance vehicles and mission profiles.

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Traceroo: An Innovative Educational Game for Teaching Primary School Children English Writing Skills

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ABSTRACT

Teaching primary school pupils is a crucial responsibility that lays the groundwork for their academic success and holistic development. At this formative stage, children are undergoing significant cognitive growth, continuously acquiring new knowledge and skills. However, teaching this age group presents important challenges that educators must navigate. The learning problems encountered by primary school pupils can manifest in the most important and difficult subjects, including Mathematics, Reading, and Writing.

Educators need to understand these obstacles and develop effective tools and strategies to help pupils overcome them, thereby fostering success both in school and in their personal lives. Recent studies highlight the effectiveness of Game-based learning in enhancing academic performance among primary school children, specifically in English language acquisition. Our contribution examines the development of an educational game called Traceroo. The main goal of the developed game is to teach primary school children English writing skills. Traceroo is based on its design on learning second language theories. Specifically, the game aligns with **Communicative Language Teaching (CLT)** theory in several key ways: Interactive Activities, focus on meaningful Communication, motivation through play, immediate feedback, collaborative learning, and cultural Context.

By designing games that align with learning second language theories, children engage with language skills dynamically and enjoyably. Incorporating these methodologies into game-based activities not only improves motivation and enthusiasm but also ensures that children receive appropriate linguistic input adapted to their developmental levels. The interplay between cognitive engagement and interactive learning environments promotes a deeper understanding and retention of English language skills, advocating for the integration of playful learning strategies in primary education.

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EduSpeakAI: An AI-Powered Real-Time Speech Evaluation and Coaching System for Elocution and Public Speaking

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ABSTRACT

Public speaking and elocution are essential competencies in both educational and professional settings. It shapes an individual's capacity to persuade, inform and inspire audiences. Despite their importance, consistent evaluation and personalized feedback remain challenging, mainly because human judgement can be inherently subjective, varying among evaluators, and may require considerable time and effort. To address these challenges, this paper introduces EduSpeakAI, an AI-powered, dual-purpose mobile application that functions both as a real-time speech trainer and as an automated judge for elocution competitions. EduSpeakAI is an advanced tool that offers objective scoring and actionable feedback by integrating speech-to-text, natural language processing (NLP), and acoustic analysis to provide holistic feedback on speaking performance. Key features evaluated include pitch variation, loudness, pacing, filler density, and grammatical accuracy.This integrated approach sets it apart from existing tools that are limited to pronunciation training or automated scoring. The system provides learners instant, practical feedback on fluency, clarity, pacing, and disfluencies such as filler words, while also providing scores suitable to competition settings. Evaluation was conducted on a dataset of 1,200 student speech samples using multiple machine learning models. The results reveals that Gradient Boosting achieves the highest prediction accuracy (R^2 = 0.915, RMSE = 0.043). This paper outlines the system design, implementation, and comparative performance with traditional models, while emphasizing key feature contributions. The proposed solution offers a scalable framework for educators, competition organizers, and students, supporting an objective assessment, personalized coaching, and tracking improvement over time.

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Generative IA for Cybersecurity Learning in Higher Education: A literature review

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ABSTRACT

Due to the rapid evolution of cybersecurity threats, traditional learning methods are no longer adequate to achieve and ensure an effective and efficient education for cybersecurity learners. Particularly, with the growth of E-learning, which uses the "one size fits all" approach **i.e.,** employs uniform teaching strategies and curricula for all students without taking a consideration learners' diverse preferences and learning styles.

Recently, Generative artificial intelligence (AI) technologies have gained momentum in higher education, and several generative AI approaches are provided in the literature that use different techniques to enhance learning in higher education.

This paper presents a literature review on the use of Generative AI and personalized learning for enhancing cybersecurity training in higher education, focusing on studies published between 2020 and 2026.Finally, the problems of current e-learning recommendation methods are outlined, and views on future research opportunities are proposed.

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Uncharted Models for Dropout Prediction: A Comparative Benchmark in Online Learning

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ABSTRACT

Predicting student dropout in online learning remains a pressing challenge in the field of Educational Data Mining (EDM). While numerous studies have applied traditional classifiers and deep learning models, several promising approaches remain underexplored. This study presents a comparative investigation of models that are rarely used in dropout prediction, including Learn++NSE for handling concept drift, rare logit models for imbalanced data, density-based methods for anomaly detection, graph neural networks for relational learning, and survival analysis techniques that reframe dropout as a time-to-event problem. We further explore hyperparameter optimization methods to assess their influence on model performance, examining whether fine-tuning provides a meaningful improvement that justifies the added complexity in implementation.

Alongside these models, we systematically evaluate feature engineering strategies that go beyond standard filter methods, incorporating wrapper techniques, ensemble-based feature selection, and embedded approaches. Our evaluation considers a wide range of performance metrics rather than relying solely on accuracy or AUC, allowing us to capture trade-offs across models and data conditions.

The findings provide a clearer understanding of which underutilized methods are most effective for dropout prediction and under what circumstances.

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Survey On Quantum Light And Its Applications

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ABSTRACT

Quantum light, a field at the intersection of quantum mechanics and photonics, has garnered significant attention due to its potential to revolutionize various technologies. This abstract explores the fundamental principles of quantum light, including phenomena such as entanglement and superposition, which challenge classical understandings of light behavior. The applications of quantum light are vast, ranging from quantum computing and cryptography to advanced imaging techniques in medicine. These technologies promise enhanced security, increased computational power, and improved diagnostic capabilities. However, the development of quantum light applications faces challenges, including technical limitations, the need for substantial investment, and public understanding. This survey aims to assess current perceptions of quantum light and its applications, gathering insights from individuals across various demographics and fields of study. By analyzing the responses, we hope to identify key areas of interest and concern, as well as the perceived impact of these technologies on society. Ultimately, this research seeks to contribute to the ongoing dialogue surrounding quantum light, fostering greater awareness and encouraging further exploration in this exciting domain.

* The asterisk denotes the presenting author.

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Using Thermoelectric Generators to Power Pipeline Monitoring Devices from Waste Heat

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ABSTRACT

Recovering waste heat from industrial systems is an effective way to improve energy efficiency and support sustainable operations. In this work, thermoelectric generators (TEGs) are proposed as a compact solution for powering monitoring devices directly from the heat of pipelines. The system makes use of commercial bismuth telluride (Bi_2Te_3) modules, where the p-type and n-type legs have Seebeck coefficients of about +200 µV/K and −200 µV/K, respectively. By mounting rectangular TEG modules (40 × 20 mm) on a hot pipe surface operating near 120 °C, and providing cooling through a finned heat sink exposed to ambient air at roughly 45 °C, a practical temperature difference of 30–40 K can be maintained across each module. This temperature gradient enables stable electrical output that can drive sensors and wireless transmitters without relying on batteries. The distributed arrangement of TEGs along the pipeline ensures efficient coverage and maximizes the harvested energy. The concept demonstrates how waste-heat recovery can be combined with autonomous sensing, offering a low-maintenance approach to continuous pipeline health monitoring.

Stochastic Modeling of Corrugated Board Compression Using Random and Brownian Node Perturbations

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ABSTRACT

The compressive performance of corrugated boards is highly sensitive to imperfections [1], yet traditional deterministic models often overlook the variability that governs real-world behavior. This study introduces a stochastic framework to quantify uncertainty in the stress–strain response under out-of-plane compression. Time-series data of node displacements from laboratory tests are analyzed to characterize temporal correlations in deformation. Based on this analysis, two perturbation strategies are proposed: independent random walks to represent uncorrelated fluctuations, and Brownian-type correlated walks informed by the autocorrelation structure of the data. These perturbations are applied to nodal displacements in numerical models, enabling the generation of ensembles of perturbed geometries. Stress–strain curves computed from these ensembles yield probabilistic envelopes that capture the influence of displacement variability on compressive strength. The results demonstrate the importance of correlation structure in uncertainty propagation and provide a pathway toward more robust prediction of corrugated board performance.

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Discussion on Structural Facade Using Perforated Structural Wall Panel for Multi-Storey Buildings

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ABSTRACT

This study is based on the four-year research on innovative structural systems techniques in multi-storey buildings, research supervised by the Department of Scientific Research at Polis University and the Department of Architecture at University of Ferrara.

In multi-storey buildings the positions of the structural walls are usually dictated by functional requirements. Often these requirements may not suit structural planning. The purpose of a building and the consequent allocation of floor space may dictate arrangements of concrete walls that can often be readily utilized for lateral force resistance. Building sites, architectural interests, or clients desires may lead, on the other hand, to positions of walls that are undesirable from a structural point of view.

In this context it should be appreciated that to accommodate any kind of wall arrangement, is very difficult to ensure satisfactory overall building response to large earthquakes when wall locations deviate considerably from those dictated by seismic considerations. In this regard, as an optimal solution, in order to fulfil the above requirement, it is being clearly stated and suggested, the using of perforated structural wall panel as an aesthetic element with a significant architectural performance to be an integral part of facade of multi-storey buildings.

This study offers a novel method for exploiting perforated structural walls to achieve architectural performance in multi-story buildings. The Triangle 3B panel layout, which is classified as a "Frame Braced Wall" architecturally, is a noteworthy example. This multi-story building's perimeter features a perforated structural wall element that improves structural behavior while at the same time can be seen as an architectural element. The element, in addition to the aspect of structural stability, offers the opportunity to be used in the creation of various architectural designs for multi-storey buildings.

KEYWORDS multi-storey buildings, structural façade, perforated structural wall panel, architectural performance, structural rigidity.

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Efficient Intrusion Detection with RNA Encoding and Random Forest Classifier on CIDDS-001 Dataset

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ABSTRACT

Intrusion detection system is a main part of network security and is responsible for spotting any unapproved or malicious activity. Since there are now serious threats and complex attacks on networks, it is crucial to have detection systems that are reliable and efficient. The proposed method in this paper combines RNA encoding with a Random Forest (RF) classifier to improve the representation of patterns and the reliability of classifying them. The methodology is tested using the Coburg Intrusion Detection Data Sets (CIDDS-001) dataset, which simulates realistic network traffic scenarios and also includes various attack types and normal user behavior. The proposed method consists of six steps: Raw network traffic of CIDDS-001, data pre-processing, RNA encoding, feature vector construction, Random Forest training and testing, and prediction & evaluation. Experimental results demonstrate that the system achieves high detection accuracy and low false alarm rates, and can used with real-world network environments.

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Unveiling the Latest Trends in Recommender Systems for MOOCs: A Review

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ABSTRACT

Recommender systems (RSs) emerged in the mid-1990s to help users manage information overload, gradually becoming advanced tools widely used across various online platforms to assist users in discovering relevant items, products, services, or content from a vast array of options based on their preferences and interests. They are broadly adopted across different domains, including e-commerce, streaming platforms, social networking, healthcare, and education. The education field has undergone a significant transformation due to technological advancements, especially through the development of Massive Open Online Courses (MOOCs). MOOCs leverage Internet technology to facilitate learning objectives, offering a flexible and effective alternative to traditional classroom education. However, the proliferation of MOOCs has introduced challenges, such as effectively navigating the options, where helping students find online courses that align with their interests and needs is essential.

A recommender system for MOOCs aims to deliver personalized learning experiences, suggest relevant educational resources, and assist in matching students with suitable courses or materials. It plays a vital role in addressing students' individual needs and optimizing their educational journeys based on their interests, career aspirations, and skill development goals. This paper reviews Recommender Systems in MOOCs, highlighting recent trends that aim to improve the quality and effectiveness of recommendations.

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The Effect of Superplasticizers on the Strength and Elastic Properties of B30 Concrete

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ABSTRACT

The article studies the effect of superplasticizers (Mixplast, PKAN-55) on the compressive and flexural strength as well as the elastic modulus of B30 concrete. According to the research results, superplasticizers improved the strength and deformation properties of concrete by 10–15% and enhanced the density of its microstructure. Consequently, such concrete has been found to be effective for use in structures subjected to high loads.

The experimental and theoretical studies demonstrated the increase in compressive strength, flexural strength, and elastic modulus of B30 concrete, as well as the effectiveness of adding superplasticizers (Mixplast and PKAN-55). The effect of superplasticizers was also clearly observed in flexural strength: with Mixplast, the 28-day Rbt was approximately 3.76 MPa, and with PKAN-55 it reached about 3.84 MPa. This represents a 10–15% increase compared to the reference concrete, proving that superplasticizers enhance the density of the concrete microstructure, reduce capillary pores, and improve adhesion between the binder and aggregates. The addition of superplasticizers reliably improves the strength and elasticity characteristics of concrete both theoretically and practically, which expands the practical application scope of B30 concrete and represents an important factor in the development of sustainable and energy-efficient construction materials.

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The Evaluation Climate-Resilient Infrastructure Projects to Encourage Digital and Optimization led Engineering

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ABSTRACT

Climate Change, which has been a pressing matter in the world and with the passing time, the countermeasures to human development have become paramount. This means climate-resilient infrastructure is also essential in order to protect societies against the mounting risks of climate change. It is noteworthy that advanced computational models in addition to optimization techniques are developing, but the projects built across the globe provide important lessons to proceed on this path. This paper will cover climate-resilient infrastructure projects, connecting their practical design strategies with digital as well as optimization powered engineering's broader vision. Some selected important case studies comprise of Maeslantering storm surge barrier present in the Netherlands, Singapore's adaptive water management system, Japan's tsunami defenses along with earthquake resilient base isolated buildings, followed by multipurpose cyclone shelters present in India and Bangladesh. Such projects show interaction between digital monitoring, engineering innovations, in addition to optimization principles, either through adaptive design, multifunctional construction, predictive simulations, and modular construction. The examination of these projects highlights known reliance attributes like adaptability, redundancy, real-time responsiveness, and sustainability. The insights gained from these projects will then be plotted against the developing frameworks in digital engineering as well as AI improved optimization; to show the ways the existed experience could aid the succeeding generation design processes. This paper will also mention the current gaps in the literature to show the path to progress in this direction. This paper will claim that the merging of the best practices worldwide with ML aided frameworks could lead future civil as well as architectural structures in the direction of sustainability in addition to resilience. Finally, the insights from these projects will help in establishing a practical bridge amid field tested infrastructure strategies and visionary digital construction frameworks, to pave the road for highly adaptive as well as robust engineering in the 21st century. Then, some graphical analysis will be done based on available sources to understand the future of digital and advanced technologies in the context of climate-resilient infrastructure projects, to support the study.

Keywords: Climate-Resilient Infrastructure, Digital Construction, Disaster Mitigation, Resilient Cities, Sustainable Engineering

Basketball Pose Coach: An AI-Powered Real-Time System for Shooting Form Analysis and Biomechanical Feedback

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ABSTRACT

Basketball training and performance evaluation have conventionally utilized human observation, tending to be subjective and variable. This paper presents an end-to-end smart system—Basketball Pose Coach—that combines pose estimation, joint angle calculation, and real-time feedback through an interactive web interface to objectively evaluate and improve shooting mechanics. With Open Pose-based detection and trigonometric computation, the system determines critical joint angles and compares them to biomechanical norms to analyze player posture. Visual overlay and multilingual audio cues help players correct form in real-time. Supported by a proprietary Basketball Shooting Pose Dataset, the system enables personalized training, session recording, and progress visualization. The platform shows great pose detection accuracy (93.8%), low angular error (±2.1°), and stable user satisfaction, which makes scalable, data-driven training possible for athletes as well as trainers.

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Fortification of Iris Images: A Combined Approach using Pixel Transposition and Modified Logistic Map based Substitution

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ABSTRACT

This work suggests a scheme for encryption and decryption using a combined transformation and chaotic substitution method. For the purpose of achieving high security levels appropriate for protection of multimedia images, a two-phase process is used per round. A 256-bit secret key is used to propel the encryption. For each round, a Modified Pseudo-Hadamard Transformation (MPHT) is done in the first phase of shuffling pixel positions effectively. The second step incorporates a Modified Logistic Chaotic Map, which produces random sequences by utilizing initial conditions from the secret key. Encryption and decryption both utilize ten iterations for each of the two rounds of stages. Security and strength are tested employing a dataset of 100 normal iris images from The Chinese University of Hong Kong (CUHK). Security level can further be increased by adjusting parameters in the Modified Logistic Map, leading to better randomness and unpredictability in the encryption process.

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Bank Customer Churn Analysis: Leveraging Power BI, Python & SQL Workbench for Predictive Insights

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ABSTRACT

Customer churn prediction is important in banking, given that maintaining existing customers is normally cheaper than acquiring new customers. This project provides an integrated solution with SQL, Python, and XG Boost in predictive modeling, supported by Power BI for decision-making and visualization. SQL is utilized for efficient data extraction and integrity checking, while Python handles preprocessing, exploratory data analysis (EDA), and machine learning implementation. XG Boost, a fast gradient boosting algorithm, is used to achieve high prediction accuracy. Power BI dashboards provide interactive and actionable insights, which enable banks to identify risky customers and implement proactive retention strategies. The proposed solution not only offers accurate churn predictions but also helps banks enhance customer loyalty, reduce attrition, and enhance long-term profitability.

Research on Comprehensive Error of Digital Image Correlation Methods

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ABSTRACT

Digital Image Correlation (DIC) is a widely adopted experimental technique for deformation measurement. Further enhancement of its measurement accuracy remains a central focus of current DIC research. Establishing an error-theoretic model that comprehensively accounts for multiple error sources is essential for quantifying the individual contributions and mutual coupling of various error components inherent to DIC. In this work, a unified error-theoretic model for DIC is proposed within a frequency-domain framework. Adopting a systems-theoretic perspective, interpolation and image noise are treated as two linear shift-invariant subsystems whose transfer functions are derived explicitly, thereby furnishing a quantitative relationship between interpolation- or noise-induced perturbations and the resulting DIC errors. The proposed model enables a priori prediction of systematic error arising from sub-pixel interpolation, stochastic error attributable to image-intensity noise, and their nonlinear coupling. Extensive numerical simulations demonstrate excellent agreement between theoretically predicted and experimentally observed error statistics. Both theoretical analyses and numerical results reveal that: systematic error increases monotonically with decreasing speckle radius under all parameter combinations; random error scales linearly with noise magnitude; and elevated noise levels amplify the coupled error component.

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Knowledge Base-driven RAG System for Additive Manufacturing Standards

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ABSTRACT

Additive manufacturing (AM) for construction is advancing rapidly, yet practitioners struggle to navigate dense and evolving standards. ISO/ASTM 52939:2023 codifies quality‑assurance requirements for structural and infrastructure elements in additive construction[1], and an identical Chinese adoption is underway, underscoring the need for timely, trustworthy access to normative guidance[2]. This paper outlines a knowledge-base–driven web application that leverages Retrieval-Augmented Generation (RAG) to deliver concise, cited answers from authoritative standards. Building on insights from "digital concrete" and AM construction literature[3], the system couples a semantic retrieval layer—using neural ranking and embeddings for intent-level search[4]—with large-language-model prompting that constrains generation to retrieved clauses and emits verifiable citations. The reference architecture comprises an ASP.NET MVC front end, a SQLite repository for standards (chunked by clauses with vector indices), an OpenAI-based embedding and answer engine, and an admin console for auto-syncing updates from official sources and managing versions. Role-based access, answer traceability to clause IDs, and audit logs support compliance and drafting workflows. Evaluated qualitatively on use cases such as QA planning and cross-standard consistency checks, the approach reduces lookup time, improves answer provenance, and maintains currency as standards evolve. The result is a pragmatic, enterprise-ready pathway to operationalize AM construction standards with AI while preserving rigor and trust.

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A Value-Focused Thinking approach for teacher-course assignment and school timetabling under personnel scarcity

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ABSTRACT

The school timetabling problem is mathematically complex, leading various research groups to use it for testing advanced optimization algorithms, such as ant swarming, genetic algorithms, or simulated annealing. These reports assume that the objective function to be optimized is fixed in advance, without including a procedure for how it can be elicited from the preferences of the scheduler.

In practice, however, the construction of class schedules is preceded by assigning subjects to teachers. Since teachers differ in their training, some assignments are more desirable than others, and it is crucial to have an adequate metric for this preference so to ensure the quality of the education provided. This is particularly important in situations where there is no ideal candidate teacher for all subjects and in which some candidates are available only at certain time slots. Thus, class timetables should be decided subject to these additional restrictions.

According to R. Keeney's Value-Focused Thinking, a metric for the relative preference of the teacher-subject pairings must consider relevant characteristics of the subjects and candidates, but also the width of the variation of these characteristics among the prospects. This paper shows how a metric that fulfills these requisites can be constructed, which is used to solve a linear programming problem that yields the most appropriate subject-teacher assignment consistent with the preferences of the schedule maker. The metric found is inherently subjective, in the sense that it depends on the person making the decision. A method for eliciting the preference metric is presented, which involves the decision-maker placing a series of values in specified arrays.

Once the assignments between teachers and subjects are set, a method is proposed to construct the group schedules. The method uses random variables and can be adjusted to look for schedules with two-hour blocks per subject.

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Reconstructing RAG Systems for Green Buildings and Additive Manufacturing from Economic and Sustainable Development Perspectives: A GPTCache-Enabled Semantic Caching Approach

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ABSTRACT

Frequent repeated queries in green building and additive manufacturing domains lead to excessive costs and wasted computation when using large language model services for knowledge-based Q&A. This inefficiency runs counter to the principles of "Green AI," which advocates making efficiency a first-class metric alongside accuracy[1]. Building on this perspective, we reconstruct a Retrieval-Augmented Generation (RAG) question-answering system using GPTCache semantic caching to cut redundant LLM API calls and their environmental externalities. Our three-layer architecture (Figure 1)—front-end interface, application logic, and data/knowledge—integrates a GPTCache module that embeds user queries and performs similarity matching to reuse prior answers when appropriate. We provide a module-function table and a cross-industry comparison (green building vs. healthcare, e-commerce, legal) that shows how TTL policies, LRU eviction, and similarity thresholds should be tuned by domain risk and freshness requirements. In our target setting (green building + additive manufacturing), GPTCache reduced LLM calls by ~60–70% and cut mean latency by 2–5×, improving cost efficiency while lowering energy use and associated carbon emissions—consistent with recent evidence that the environmental footprint of AI inference dominates at scale and benefits from efficiency interventions[2][3]. Overall, semantic caching offers a practical path to balance economic cost and sustainability when deploying large-model RAG in architecture and additive manufacturing.

International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

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Machine Learning Driven Streamflow Prediction Using Vegetation and Soil Indices for Sustainable Water Management: A Texas Case Study

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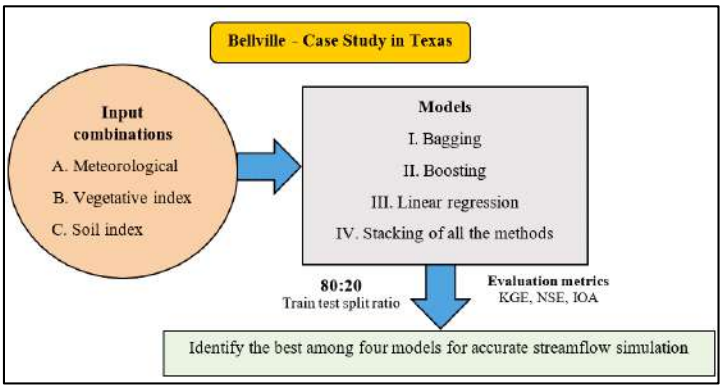
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ABSTRACT

Streamflow prediction is of paramount importance in sustainable water management under variable hydrologic conditions. The present study evaluates the impact of incorporating vegetation and soil indices in addition to meteorological variables for streamflow prediction in Bellville, Texas, USA. Daily time series data is obtained for a time stamp of 1991-2020. Four input combinations were tested: (i) rainfall only, (ii) rainfall with maximum and minimum temperature, (iii) rainfall, temperature, and a vegetation index, and (iv) rainfall, temperature, vegetation, and soil indices. These input combinations were considered for estimating streamflow by applying Random Forest (Bagging), Gradient Boosting (Boosting), Linear Regression along with a stacked ensemble of the three. These models were trained and tested using an 80:20 split ratio and were diagnosed using KGE, NSE and IOA. Results show that while rainfall is the dominant predictor, adding temperature improves the representation of streamflow variability, and further inclusion of vegetation and soil indices enhances predictive skill by capturing watershed storage and ecohydrologic feedbacks. The stacked ensemble consistently provided the most reliable performance, balancing accuracy and stability across all input combinations. Overall, the findings highlight the importance of incorporation of vegetation and soil indices along with meteorological inputs, demonstrating that even simple indices can yield tangible improvements in streamflow prediction.

GRAPHICAL ABSTRACT



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Analysis with Index Matrices Harvesting Energy from Vibration

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ABSTRACT

One substance is built of different components. It's purpose – if it has to be stretched or replaced in different directions according to different conditions, defines how the particles that it is constructed are connected to each other. Moreover, for the calculation of the deformation in space and time, coordinates of the constructive particles of an element should be defined. In this article with the Theory of Index Matrices the influence of the vibrations to the way membranes, plates and energy that are transformed in microphones. This can help for defining parameters of batteries, which would store generated electricity from a sound waves. In addition, with the Theory of probabilities, the displacement nodes can be predicted.

* The asterisk denotes the presenting author.

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Integrating Embedded Control and Machine Vision in a 5-DOF Robotic Arm for Automated Sorting

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ABSTRACT

This paper presents the design and implementation of a low-cost five-degree-of-freedom (5-DOF) robotic arm for automated color-based product sorting. The system integrates an STM32F407 microcontroller, MG996R servos, and a webcam with a Python/OpenCV vision pipeline. Motion planning is achieved using forward and inverse kinematics, while timer-based PWM ensures accurate actuation. A PC-based interface supports both manual control and autonomous operation. Experiments demonstrated stable pick-and-place performance with 94.4% sorting accuracy, ±3.5 mm positioning error, and a throughput of ~14 items/min. The prototype highlights an accessible platform for STEM education and a foundation for further research in robotic manipulation.

* The asterisk denotes the presenting author.

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Hardness Behaviour of FDM-Printed PLA-CF under Varying Process Parameters

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ABSTRACT

Fused Deposition Modelling (FDM) using carbon fibre-reinforced polylactic acid (PLA-CF) has gained prominence for producing lightweight, high-strength parts with complex geometries. This study explores how four key FDM parameters layer thickness, nozzle temperature, printing speed, and raster orientation affect the mechanical performance of printed components, particularly Shore D hardness. Experiments were designed using the Taguchi L9 orthogonal array, and hardness values were evaluated in line with the "larger is better" criterion. Results revealed that raster orientation and layer thickness were the most influential parameters, significantly impacting surface hardness. The optimal combination 0.2 mm layer thickness, 210 °C nozzle temperature, 60 mm/s printing speed, and ±45° raster orientation achieved a maximum Shore D hardness of 71. Signal-to-noise ratio analysis confirmed that this setting not only maximised hardness but also improved process stability. These findings provide valuable insights for enhancing the surface quality of PLA-CF parts while maintaining material efficiency and printability.

Key words: FDM / Parameter's optimisation / PLA CF / Hardness measurements

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Effect of Precursor Composition and Oxide Ratios on the Performance of Geopolymer Mortars

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ABSTRACT

This study explores a novel ternary geopolymer mortar system engineered by synergistic incorporation of metakaolin (MK), ground granulated blast furnace slag (GGBFS), and fly ash (FA), with a focus on achieving ultra-high mechanical properties. Ten groups of geopolymer mortars were designed with varying combinations and proportions of these precursors. The fresh properties, including setting time and flowability, along with hardened properties such as compressive and flexural strength, were evaluated. The effects of raw material composition and oxide ratios on mechanical performance were systematically investigated. Results indicated that the incorporation of GGBFS or metakaolin markedly reduced the flowability of fresh mixtures. The setting time decreased significantly with higher GGBFS content but remained largely unaffected by metakaolin content. Mortars incorporating all three precursors exhibited superior compressive and flexural strength compared to those with one or two components. Specifically, the mix comprising 30% MK, 30% GGBFS, and 40% FA achieved the highest 28-day compressive and flexural strengths of 123.6 MPa and 10.4 MPa, respectively, demonstrating great potential for producing ultra-high performance concrete. Furthermore, geopolymer mortars with SiO_2/Al_2O_3 ratios between 0.72–0.79 and CaO/SiO_2 ratios between 0.4–0.5 attained compressive strengths exceeding 97.8 MPa, with a maximum value of 121.2 MPa.

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Unified Pathways: Enhancing Communication and Collaboration for Accelerated Innovation

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ABSTRACT

In the current world where the business environment changes constantly and intensively, as in today's world creating and promoting an innovative culture within a fast-paced and diverse team has become crucial. This paper, "Unified Pathways: The paper "Towards Integrated Communication and Collaboration for More Rapid Innovation: Progressing the Development and Adoption of Integrated Communication Systems" looks at the approaches towards creating compound comprehensive frameworks for boosting communication and collaboration at all levels and departments. Innovation is better done as a team; it cannot be a centrally top-driven and implemented procedure but rather it requires ideas to be shared across different organizational levels and functions.

This work presents an analysis of the different approaches that can be adopted on the organization to enhance the structural communication links that enhance information sharing across organizational departments, and also facilitate use of collaborative technologies. Change agents can work with people from different modes of thinking and level of experience to coalesce everyone's efforts towards achieving organisational innovation goals. Based on the examination and comparison of various and very different cases ranging from technological, healthcare, and educational industries, this work detects several key issues that define the culture of constant innovation.

These are varied and distinctive communication interfaces for addressing different team requirements, easily accessible databases for storing and sharing pertinent information, and team integration that allows everyone's input to be considered pertinent and valuable. The research outcomes show that those organizations that define the information sharing and

collaborative problem-solving trajectories, not only foster the increasing speed of innovation but also improve its quality and relevance to the emerging market needs.Finally, based on the literature reviewed in this paper, the following practical suggestions are proffered for the consideration of organizational leaders: There is the need for the promotion of agile, cross-functional work engagement. Thus, the strategies identified allow organizations to approach the management of change both in terms of continuous gradual enhancement of existing solutions and in terms of radical breakthroughs that enable the concept of establishing organizations as leaders in their respective industries.

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Nonlinear Associations Between Streetscape Visual Features and Perceived Safety in Historic Districts: An Interpretable Machine Learning Empirical Study

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ABSTRACT

Understanding how semantic-level visual features shape urban perception requires both scalable image metrics and interpretable models. Focusing on two UNESCO heritage towns in Malaysia, this paper develops a reproducible pipeline that couples 13 streetscape semantic features metrics with Perceived Safety scores derived from Place Pulse 2.0 via a ResNet-50 architecture. A Random Forest model (5-fold CV) provides a reliable in-sample fit and, when interpreted with SHAP and Partial Dependence Plots, reveals nonlinear and interacting effects, where moderate Motorized vehicle presence, sufficient yet not excessive Greenery, Building proportion above a threshold, and intermediate Pedestrian flow are associated with higher perceived safety. These findings challenge the "more is better" heuristic, indicating that calibrated heterogeneity and contrast yield the greatest perceptual benefits. The study contributes (1) a validated, interpretable modelling pipeline for urban perception research; (2) empirically derived, actionable thresholds for heritage district design and conservation; and (3) evidence that Semantic categories and Streetscape composition jointly shape perceived safety. We conclude with recommendations for conservationists and planners and propose field experiments to test causal effects.

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Optimizing Demand Forecasting in Supply Chains through Machine Learning: Practical Implications for Business Performance

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ABSTRACT

The efficiency of a supply chain depends on the demand forecasting, which affects inventory, production, and competitiveness levels. Traditional methods such as ARIMA fail to provide good accuracy for volatile demand. However, machine learning techniques such as Random Forest, XGBoost, and LSTM, offer greater accuracy owing to their capability to handle non-linear demand and seasonal fluctuations. This paper evaluates these ML techniques where Random Forest performed better as per lower error metrics and better adaptability. Additionally, it provides an exclusive exploration of business intelligence tools that link predictive analytics to decision-making. The findings highlight that there are very useful gains such as better inventory, rising costs, and more flexibility in operations. Yet, there are challenges from data quality, computational demand, and interpretability. In the future, researchers should look to conduct real-time forecasting and coupling with explainable AI for further use case in business.

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Experimental Investigation of the Effectiveness of Dynamic Fenestration Insulation in Canadian Climate

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ABSTRACT

The current work investigates the effectiveness of adding an extra layer of insulation over a window system that could be removed when building occupants desire to make use of the window. This dynamic insulation takes the form of an exterior insulated window shutter that would be shut from sunset to sunrise. Using an experimentally constructed wall panel, this paper analyzes the thermal effectiveness of the dynamic fenestration insulation in a building located in Ottawa, Ontario, Canada. Temperature data was recorded and analyzed from various locations within the physical wall system during the winter season. The experimental data have shown the effectiveness of the window shutters integration. It maintained indoor comfort temperature for a longer time compared to no shutter case. The indoor temperature fluctuation was much less even with adverse outdoor temperature variation. The shutter was able to reduce the building heating load by 12.9 % in the considered period.

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Enhancing Network Performance through Service, Memory, and Access Monitoring

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ABSTRACT

Network monitoring enables the administrators to monitor a computer network for slow or failing components. A design process centered on the needs, behaviors, and expectations of security analysts can greatly influence and impact the usability and practicality of such systems. For best results, security experts and visual designers must thereby collaborate to complement each other's skills and expertise to innovate informative, interactive, and exploratory systems that are technically accurate and aesthetically pleasing. In this survey, we begin by looking into different categories of data sources incorporated in the design of security visualizations and provide an informative list of sources accessible to the research community. By expressing our main contribution in the classification of network security visualization systems. We provide a detailed description of the proposed taxonomy together with an analysis of the derived use-case classes. We follow by giving a thorough description of each system as we outline its strengths and weaknesses. An overall assessment of systems in each use-case class in addition to guidelines and directions for future systems is also provided. We summarize the multiple attributes of recent network security visualization systems in a table for better future references. By outlining issues and concerns surrounding security visualization by elaborating on seven potential pitfalls. By summarizing our findings.

Controlling Localized Potential to Govern Soliton Dynamics in Optical Communication Systems

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ABSTRACT

The propagation of nonlinear soliton waves in optical communication systems has attracted considerable attention due to their unique ability to maintain shape and stability over long distances, a property that makes them promising candidates for high-capacity data transmission. Solitons emerge from a delicate balance between group velocity dispersion and Kerr nonlinearity, allowing them to carry information robustly against perturbations. To gain deeper insight into their behaviour, the variational approximation (VA) method provides a powerful analytical framework for studying soliton dynamics under external influences which are potentials. When solitons interact with localized potentials, such as the Pöschl–Teller potential, their propagation characteristics can be significantly altered. Through VA, one can effectively capture complex features such as velocity amplification, center-of-mass acceleration, and stability preservation during transmission. Identifying the critical parameters where solitons undergo controlled acceleration without pulse distortion is of great importance, as it suggests practical strategies for enhancing transmission speed and efficiency in fiber-based networks. This approach not only advances the theoretical understanding of soliton–potential interactions but also opens pathways for the design of all-optical devices that exploit soliton capabilities for high-speed signal processing, switching, and next-generation communication systems.

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The Importance of Improving Methods for Determining the Load-Bearing Capacity of Reinforced Concrete Bridges in Operation Based on Technical Diagnostics

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ABSTRACT

Improving calculation methods for the strength, durability, and service life extension of transport facilities, as well as enhancing the strength and quality indicators of transport structures, requires the advancement of methods for determining the load-bearing capacity of reinforced concrete railway bridges in operation based on technical diagnostics.

Based on the improved method, separate technical diagnostics and the established point-based evaluation for each reinforced concrete span structure and support are summarized, with the overall results classified as good, satisfactory, or unsatisfactory according to the "≤" condition. The results obtained serve as an initial basis for determining the technical condition of railway bridge spans and supports, recalculating them, and preliminarily assessing their load-bearing capacity.

An improved method has been developed for determining the class of load-bearing capacity of bridge spans and supports, taking seismic effects into account, based on technical diagnostics results. In the method for determining the load-bearing capacity of spans and supports, an expression was proposed for determining the permissible temporary loads k, considering seismic effects, through the factor k_c.

A Cloud Container Workflow Scheduling Algorithm Based on Multi-Agent Reinforcement Learning with Affinity Constraints

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ABSTRACT

In container cloud environments, workflow scheduling needs to take into account new characteristics such as affinity constraints, dynamic resource allocation, and large-scale scheduling. Traditional heuristic methods or reinforcement learning algorithms either struggle to adapt to these new characteristics or heavily rely on manual experience; to address this issue, this paper proposes a multi-agent reinforcement learning-based cloud container workflow scheduling algorithm integrated with genetic programming. The study first incorporates container affinity constraints into the workflow model, selects execution time, cost, and load balancing as optimization objectives, and constructs a workflow model for container cloud environments; Second, it designs a chunked training strategy and a dynamic parameter strategy to improve the quality of heuristic rules generated by genetic programming, which are then used as the action space for multi-agents; Finally, multi-agents collaboratively make decisions on resource allocation and node selection, and a multi-agent counterfactual reward distribution strategy is proposed to reduce training difficulty. Experimental results on test datasets in comparison with other baseline algorithms show that the proposed method significantly enhances scheduling rationality and outperforms other baseline algorithms across multiple performance metrics, verifying its superiority.

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High-Performance Failure Prediction in Industrial Engines: A Random Forest Approach with Advanced Feature Engineering and SHAP Interpretability

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ABSTRACT

This paper, we propose the machine learning framework of predictive maintenance in industrial engines, where we concentrate on engine failure prediction. Based on synthetic data, Random Forest classifier and various advanced feature engineering strategies are used in order to improve the accuracy of the models. The synthetic engine dataset simulates real-life parameters of engine RPM, temperature, oil pressure, vibration and load together with failure probability that are computed on the basis of real life variables. The preprocessing of data prepares these data to be used with the model, which also means imputation of the missing values by KNN imputation to ensure high-quality input data to the model, outliers that are detected using Isolation Forest, as well as feature scaling performed by RobustScaler. Such relationships within the dataset are captured by a series of engineered features: interaction, polynomial functions, lag-based features. Results indicate that the model has an outstanding predictive ability with an accuracy of 97.34%, a ROC-AUC of 0.9966, PR-AUC 0.9970. To achieve model transparency and interpretability, SHAP values are achieved to offer insights on how individual features contribute to the predictions. These findings point to the usefulness of machine learning methods in industrial predictive maintenance and the need of interpretability when implementing the models in life-critical systems. The limitations of the use of synthetic data and possible future work of the research are also discussed in the paper. The model tested on actual datasets should be proven to be more practical and used in the industrial workings.

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Hussein Search Algorithm Mathematical Model and its application on Inverted Indexes for Efficient Information Retrieval

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ABSTRACT

Introduction: Information retrieval system does not tell the user about the subject of the query, it only informs the user if the document is found in databases or not. Most of the data or documents collected from web sites are unstructured data, information retrieval system must process it in a manner to store and retrieve it efficiently based on the user's query. Then, the role of information retrieval system is to locate and return all the documents that contain or related to the keywords of the query. An information retrieval system cannot be efficient unless it maintains an efficient index structure to be used for query processing.

Methods: This paper presents a comprehensive experimental evaluation of the Hussein Search Algorithm (HSA) as applied to inverted indexes, comparing it against binary search, a standard baseline for sorted dictionaries in information retrieval (IR) systems. Hussein search algorithm is designed to efficiently locate an element in a sorted array. It achieves this by utilizing a prediction table structure and a sequential search algorithm. This approach reduces the time complexity from O (n) in sequential search or O (log n) in binary search to O (1) (Omer H Abu El Haijia, Arwa H. Zabian, 2023) **.**

Results: HSA achieves speedups up to 80% over binary search, aligning with theoretical expectations. For small datasets (5K terms), speedups are pronounced: ~80% for existing queries (1.016s vs. 0.206s) and ~29% for non-existence (0.197s vs. 0.139s), due to minimal bucket scans (E[arrb[l]] ≈ 1). As datasets scale to 50K and 500K, speedups stabilize at 13–44% for existing queries and 44–6% for non-existing, reflecting HSA's efficiency in handling misses without full logarithmic comparisons. For the largest dataset (2M terms), HSA excels in non-existing queries with a ~56% speedup (227.7s vs. 100.6s), as bucket identification avoids unnecessary probes. Existing queries show ~30% improvement (105.8s vs. 73.6s). Overall, average speedups are higher for non-existing queries (up to 80%), critical in IR where many terms are rare or absent.

Conclusion: This work provides the mathematical model of HSA and is application on inverted index search to improve the query lookup time in efficient information retrieval. Our results show that the application of HSA on synthetic datasets with different sizes gives the same results obtained by binary search algorithm in terms of finding the queries and HSA outperforms binary search algorithm in the searching time for both existing and not existing queries. The application of HSA on inverted index has produced a reliable, robust, scalable and efficient information retrieval system.

International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

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Global trade flow prediction based on spatiotemporal graph neural network (ST-GNN)

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ABSTRACT

Forecasting global trade flows is crucial for macroeconomic analysis, building supply chain resilience, and formulating international trade policies. However, traditional time series models and mainstream deep learning models struggle to effectively capture the complex nonlinear spatiotemporal dependencies in trade networks. To address this challenge, this study proposes a novel ST-GNN framework. This framework models the global trade system as a dynamic, heterogeneous graph, where nodes represent countries or regions and edges represent weighted trade relationships. By integrating a graph attention network (GAT) with a gated temporal convolution (TCN), the model collaboratively learns the spatial structural dependencies and multi-scale temporal dynamics of trade flows. Experiments are conducted on real trade and macroeconomic data from UN Comtrade and the World Bank for the period 2000-2022. Results show that the proposed ST-GNN model significantly outperforms a range of baseline models in forecasting trade flows six months into the future. Specifically, the model reduced the global mean absolute percentage error (MAPE) to 6.9%, the root means square error (RMSE) to $108.5 billion, and the coefficient of determination (R^2) to 0.89. Detailed ablation experiments further confirmed the effectiveness of the model's core components (Spatial modeling, temporal modeling, and multiscale fusion), which contributed approximately 13.9%, 8%, and 8%, respectively. This research provides a powerful and interpretable tool for accurately forecasting complex global trade systems.

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Cross-border e-commerce logistics demand forecasting based on XGBoost and GRU integration model

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ABSTRACT

This paper addresses the challenges of nonlinearity, high-dimensional temporal dependencies, and external interference in cross-border e-commerce logistics demand forecasting. We propose a residual compensation ensemble forecasting model based on XGBoost and GRU. This model combines XGBoost's strengths in structured feature modeling with GRU's ability to capture temporal dynamics. By introducing a weighted residual learning mechanism, it significantly improves forecasting accuracy and generalization performance. Experiments on a real-world dataset consisting of approximately 500,000 orders spanning two years demonstrate that the proposed model achieves RMSE of 149.6, MAE of 98.7, MAPE of 7.92%, and R^2 of 0.92 on the test set. Compared to single XGBoost, GRU, and ARIMA models, the RMSE is reduced by 18.4%, 10.1%, and 50.5%, respectively. Multi-step forecast analysis further demonstrates that the model maintains optimal performance and exhibits the most gradual error growth across forecast steps ranging from 7 to 56 days. The results show that the integrated method proposed in this paper can not only effectively capture the complex patterns in cross-border logistics demand but also provide a scalable solution for high-precision time series forecasting and has strong practical application value.

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Study on the optimal path of emergency material distribution in 5G network environment for delivery vehicles and UAV

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ABSTRACT

Delivery vehicles and UAV under the 5G network have gradually become a new distribution method for parcels and food delivery. However, there is little research on the efficient distribution mode of emergency supplies by delivery vehicles and UAV in some major emergencies. This study is based on the data of question B of the 2022 Chinese College Students' Electrical Mathematical Contest in Modeling. The researchers first preprocess and visualize the original data. Then minimize the weighted distance cost as the objective function, establish a graph theory-based heuristic TSP and a graph theory-based heuristic VRP model to determine whether the delivery vehicle goes through the path from point i to point j, and whether the UAV pass from point i The path from i to point j and whether point i is delivered by the delivery vehicle are the constraints, and the self-loop and sub-loop are removed to form the optimal Hamilton loop respectively. Finally, through empirical analysis and comparison, it is concluded that under the heuristic VRP model based on graph theory The shortest time required to complete the optimal route of 14 delivery locations under the delivery vehicle and UAV is 5.76 hours. This study provides new research ideas and methods for emergency material distribution in the 5G network environment.

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Design and implementation of an autonomous four-wheel drive Mecanum wheel robot system for infrared thermal anomaly inspection of refinery pipelines

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ABSTRACT

This study aimed to design and implement an autonomous four-wheel-drive Mecanum-wheeled robot system for automated infrared thermal anomaly inspection of refinery pipelines, overcoming the low efficiency, poor safety, and high subjectivity inherent in traditional manual inspections. The system integrates an omnidirectional mobile platform, a high-resolution infrared thermal imaging sensor, a multimodal perception fusion navigation algorithm, and an online thermal anomaly diagnosis module. The robot achieves precise motion control through an inverse kinematics model, enabling omnidirectional mobility in complex pipeline environments with a maximum speed of 0.3 m/s. The infrared thermal imaging system captures high-precision thermal images with a temperature resolution of 0.05°C. It then uses a Gaussian filter and adaptive threshold segmentation algorithm to identify thermal anomalies, achieving a detection accuracy of 90% and a false alarm rate of less than 4%. Experimental results in a simulated refinery pipeline environment demonstrate that the system achieves 92% inspection path coverage accuracy, an average inspection time of 360 seconds for a single 50 m² inspection, and a 45-second response time from anomaly identification to alarm, surpassing the traditional manual inspection (response time of 120 seconds and accuracy of 75%). Furthermore, the system demonstrates strong robustness across various test environments, with a navigation success rate exceeding 90%. This study verified the advantages of the system in improving inspection efficiency, reducing labor costs and safety risks, and provided a complete technical solution for intelligent operation and maintenance of industrial pipelines with high engineering application value.

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Optimization of autonomous grasping strategy for warehouse robots based on vision-language large model

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ABSTRACT

This paper proposes an optimization method for autonomous grasping strategies in warehouse robots based on a large-scale vision-language model. By constructing a multimodal fusion framework, it achieves a deep fusion of visual information and language commands, significantly improving the robot's perception and decision-making capabilities in complex warehouse environments. To address the limited adaptability of traditional methods in dynamic environments, this study designed a multi-objective optimization algorithm that comprehensively considers key metrics such as grasping success rate, path efficiency, stability, and semantic matching. Experimental results show that the proposed method achieves a 96.4% success rate on the test set, a 4.3 percentage point improvement over a baseline strategy that only optimizes success rate. The average path length is shortened to 3.0 meters, a 37.5% reduction compared to traditional methods. Energy consumption is reduced to 182 J, and the failure rate is controlled at 3.2%. This method also demonstrates significant advantages in grasping stability index (0.85) and semantic command matching rate (93.8%). Furthermore, by combining reinforcement learning with contrastive learning for training, the model convergence cycle is reduced to 10, improving training efficiency by 44.4% compared to supervised learning methods. These quantitative results fully demonstrate the effectiveness and superiority of the proposed method in improving the autonomous grasping performance of warehouse robots and provide important technical support for the development of intelligent warehousing systems.

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Metaheuristic Landscape Analysis for Multi-Objective Structural Design in Complex Environments

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ABSTRACT

These days, optimization in structural engineering sometimes involves juggling competing goals, such as reducing the weight and cost of materials while enhancing their strength, resilience, and sustainability. Metaheuristic algorithms, such as hybrid heuristics, swarm intelligence, and evolutionary techniques, have become potent resources for delving into intricate and expansive design domains. There is a lack of understanding regarding the multi-objective problem's underlying landscape, which greatly affects their efficiency and convergence behavior. This is particularly true in complex environmental conditions with stochastic loads, material uncertainties, and dynamic operational scenarios. [1] With the goal of enhancing civil and architectural engineering's multi-objective structure design, this research gives a thorough metaheuristic framework for landscape analysis.

The methodology assesses the efficacy of various metaheuristic approaches according to robustness, solution variety, and convergence speed, and it defines the fitness landscape using measures like neutrality, roughness, and modality. The use of surrogate models based on machine learning is also being investigated as a means to speed up optimization for more realistic games. Under dynamic and unpredictable loading situations, the technique is shown to work on benchmark structural design challenges, such as topology optimization of trusses and additive-manufactured modular components. Insightful information for choosing or tailoring metaheuristics for particular structural design problems is provided by the findings, which emphasize the connection between landscape characteristics and algorithm performance. Providing a way forward for sustainable, efficient, and robust structural design in ever-increasingly complex engineering contexts, the research adds to theoretical knowledge as well as practical application. [2]

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A Hybrid Loss Function Approach with Diverse Backbones for Robust Waste Segmentation

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ABSTRACT

Semantic segmentation of waste is a fundamental task for automating recycling processes and advancing sustainable environmental management. However, real-world waste datasets present significant challenges, namely high visual diversity and severe class imbalance. This research proposes a robust deep convolutional neural network (DCNN) framework to address these issues. To assess its efficacy and flexibility, we implement and benchmark the performance of two distinct backbone architectures: the high-capacity EfficientNet-B7 for maximum accuracy and the lightweight MobileNetV3, designed for real-time, resource-constrained applications.

A core contribution of this work lies in the synergistic combination of two powerful loss functions: Advanced Focal Loss and Dice Loss. The Dice Loss directly optimizes the Intersection over Union (IoU) metric, making it highly effective at mitigating global pixel-level imbalance. Concurrently, the Advanced Focal Loss concentrates the model's learning on hard-to-classify examples and under-represented classes, thereby enhancing performance on rare waste categories. This hybrid objective function is engineered to simultaneously tackle severe data imbalance while improving segmentation accuracy at object boundaries.

The proposed models are trained and evaluated on the Deep Solid Waste Dataset (DSWD), employing standard data normalization techniques, including image resizing and pixel value normalization. Experimental results are expected to demonstrate that our approach significantly outperforms baseline methods, particularly in the accurate identification of minority waste classes. This work paves the way for the deployment of more intelligent, efficient, and robust automated waste sorting systems.

* The asterisk denotes the presenting author.

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Hybrid Semantic-Web Architecture for Context-Aware Agricultural Decision Support

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ABSTRACT

Agriculture in developing nations faces critical challenges in knowledge dissemination, resource optimization, and decision-making processes. Traditional farming practices rely on fragmented information sources and historical patterns, leading to suboptimal crop selection and reduced productivity. This research presents a novel hybrid semantic-web recommendation system that combines Ontology Web Language (OWL) modeling with MERN stack implementation to deliver context-aware agricultural decision support.

The proposed three-tier architecture integrates semantic web technologies with scalable web development frameworks. The core semantic model utilizes OWL ontology to represent complex agricultural domain knowledge, incorporating over 25 inference rules developed through expert consultations. These rules cover critical decision-making scenarios for wheat, rice, cotton, and sugarcane, enabling automated reasoning for crop selection, fertilizer application, and pest management based on specific growing conditions and stages.

The technical implementation leverages MongoDB for flexible data storage, Express.js and Node.js for server-side processing, and React.js for dynamic client interfaces. The semantic processing layer integrates SPARQL query capabilities with the web application, enabling real-time inference and recommendation generation. A key innovation is the two-tier query resolution mechanism that bridges automated semantic processing with human expertise. When farmers submit queries, the semantic inference engine first attempts to provide recommendations using the rule-based knowledge base. Unresolved queries are forwarded to agricultural experts, whose responses are systematically integrated back into the knowledge base, creating a continuous learning cycle.

The system addresses critical agricultural domains including fertilizer optimization based on soil nutrient analysis and crop growth stages, pest and disease management with chemical and cultural treatment recommendations, and crop selection guidance considering local conditions. The semantic model captures

complex relationships between agricultural parameters, enabling sophisticated reasoning about optimal farming practices under varying environmental conditions.

Comprehensive testing validates functionality across user interface responsiveness, authentication security, query processing accuracy, and expert integration effectiveness. The multi-stakeholder design accommodates farmers, agricultural advisors, fertilizer companies, government departments, and pesticide representatives through specialized interfaces. This collaborative ecosystem facilitates knowledge sharing and coordination among agricultural value chain participants.

Implementation results demonstrate significant advantages over existing systems through effective combination of automated reasoning consistency with human expertise adaptability. The semantic web foundation handles data heterogeneity challenges while supporting interoperability with external services. Real-time recommendation generation provides immediate decision support during critical agricultural periods, while the adaptive knowledge base ensures continued relevance as practices evolve.

Current limitations include geographic specificity to Pakistan agricultural contexts, coverage limited to four major crops, and dependency on expert availability for complex queries. Future research directions encompass mobile application development, crop coverage expansion, IoT sensor integration for real-time environmental monitoring, and large-scale deployment for national-level digital agricultural services.

This research contributes to agricultural informatics by demonstrating practical semantic web implementation for agricultural decision support, providing a scalable framework for hybrid human-machine knowledge systems, and establishing methodologies for continuous knowledge base evolution through expert feedback integration. The system offers a replicable model for developing context-aware agricultural recommendation systems that maintain local relevance while supporting broader deployment across diverse agricultural contexts.

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Steel Fiber-Reinforced Concrete and Features of Calculating the Strength and Crack Width of SFRC Structures

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ABSTRACT

This article presents information on steel fiber reinforced concrete and the fundamentals of its calculation. Steel fiber reinforced concrete is a variation of concrete distinguished by the use of dispersed fibers within the concrete mixture. These fibers act as an additional reinforcing and, in some cases, decorative component. Steel fiber reinforced concrete is produced from either heavy or fine-grained concrete. In such elements, steel fibers are used as reinforcement, uniformly distributed throughout the volume of the concrete. The joint performance of concrete and fibers is ensured by the adhesion of their surfaces and the presence of anchors on the fibers. Steel fiber reinforced concrete is mainly applied in structures that require the following properties: maximum impact strength, enhanced crack resistance, frost resistance, reduced concrete shrinkage, and more efficient use compared to traditional reinforced concrete

The spatial behavior of precast elements and of the building structure as a whole, confirmed by the conducted research, ensures high economic efficiency and makes it possible to recommend the use of pavilion-type buildings assembled from thin-walled, fiber-reinforced elements in construction, including in seismic regions and in areas with dry and hot climates.

The results of experimental and theoretical studies have been applied in the adjustment of working drawings, in the production of a set of precast elements, and in the experimental construction of a pavilion-type building with walls and roofing made of thin-walled, fiber-reinforced concrete elements.

4D Printing of complex ABS Structures

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ABSTRACT

Additive manufacturing (AM), commonly known as 3D printing, has revolutionized the way complex geometries are designed and fabricated. Building upon this foundation, the emergence of 4D printing—the integration of time as a functional dimension—enables printed structures to change shape or function in response to external stimuli such as heat, moisture, or light. This dynamic behavior has opened new avenues in fields ranging from biomedical devices to aerospace systems.

This paper explores the development and implementation of 4D printing techniques using acrylonitrile butadiene styrene (ABS) to fabricate complex, stimuli-responsive structures. By leveraging the intrinsic thermomechanical properties of ABS and carefully programming the printing path, we demonstrate the ability to induce time-dependent shape transformations in static 3D-printed geometries. The study presents a detailed analysis of design strategies, process parameters, and post-processing techniques that enable controlled deformation in response to thermal stimuli. Several prototypes with intricate geometries are fabricated and tested, showcasing reversible and irreversible transformations. The results highlight the feasibility of using conventional FDM-based 3D printers and ABS filaments for creating cost-effective, functional 4D-printed components, opening new possibilities for applications in soft robotics, deployable systems, and adaptive structures.

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Shape Recovery Behavior of PETG Structures in 4D Printing

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ABSTRACT

Four-dimensional (4D) printing combines additive manufacturing with stimuli-responsive behavior, enabling structures to recover their original geometry under external activation. This work investigates the shape recovery of polyethylene terephthalate glycol-modified (PETG) structures fabricated by fused deposition modeling (FDM). To evaluate the influence of printing conditions, an orthogonal Taguchi design was employed considering key parameters such as layer height, extrusion width, and nozzle temperature. The specimens underwent a thermomechanical cycle comprising deformation, fixation, and thermal recovery. Shape recovery was quantified through the shape-recovery ratio (R_r) and maximum shape-recovery rate (V_m), providing a systematic framework for assessing how process parameters govern recovery performance. The study establishes a methodological basis for understanding PETG as a shape-memory material in 4D printing, with potential applications in adaptive structures, biomedical devices, and aerospace systems.

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The Effect of Technology Transformational Leadership on Human Resource Employees performance and job satisfaction in Insurance Companies in Palestine

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ABSTRACT

The integration of digital technologies is reshaping organizational leadership practices, especially within human resource management. This study examines the effect of technology-oriented transformational leadership on employees working in insurance companies in Palestine. The objective was to determine how leaders' ability to leverage digital tools, encourage innovation, and promote adaptability influences employee performance, and satisfaction.

A quantitative cross-sectional design was adopted, and data were collected from 318 human resource employees across three major insurance companies in Palestine using a validated questionnaire. Statistical analysis was conducted through SPSS, applying correlation and multiple regression tests to measure the association between transformational leadership dimensions and employee outcomes.

The results revealed that technology-driven transformational leadership had a significant positive effect on employee performance ($\beta = 0.42$, $p < 0.001$), and job satisfaction ($\beta = 0.37$, $p < 0.001$). Employees reported higher engagement and adaptability when leaders demonstrated digital competence, provided individualized consideration, and fostered intellectual stimulation.

The study concludes that insurance companies in Palestine can enhance HR effectiveness and organizational sustainability by embedding technological competencies into transformational leadership strategies. These findings emphasize the importance of leadership training programs focused on digital transformation to strengthen the competitiveness of the Palestinian insurance sector.

Keywords: Transformational leadership, technology, human resource management, employee performance, job satisfaction , insurance companies, Palestine

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Experimental Investigation on the CFRP Strengthening Efficiency of Flexural-Deficient RC Slabs

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ABSTRACT

The flexural behavior of reinforced concrete (RC) slabs is subject to degradation during their service life. Therefore, the necessity for upgrading their overall performance becomes essential using suitable, efficient, and easily applied material, such as the carbon fiber reinforced sheets (CFRP). This study examines the CFRP strengthening efficiency applied to one-way RC slabs using an experimental procedure of six specimens. Slabs were of 1100 mm length, 500 mm width, and 100 mm depth, and strengthened with different numbers of CFRP sheets (0, 1, 2, 3, 4, and 5), where their flexural behavior was examined. Results were reported in terms of the failure mode, ultimate load, ultimate deflection, stiffness, and toughness. It was found that increasing the number of utilized CFRP strips resulted in increasing the flexural capacity by 110.25%, reducing the mid-span deflection, and improving the toughness and stiffness behaviors by 76.57% and 90.03%, respectively. Besides, it was observed that the CFRP delamination was the dominant failure mode exhibited by the strengthened RC slabs.

* The asterisk denotes the presenting author.

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Jordan, December 18th - 20th 2025

The Flexural Behavior of Thin RC slabs Strengthened with Different CFRP Ratios

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ABSTRACT

This study introduces the effect of the carbon fiber reinforced polymers (CFRP) strengthening ratio on the flexural behavior of thin reinforced concrete (RC) slabs. The RC slabs were tested experimentally using a simply supported boundary condition with (1100×500) mm geometrical dimensions for the length and width, respectively. The tested slabs have two depth values (60 and 80) mm and are strengthened with different ratios obtained using (0 (without), 2, and 4) sheets applied at the bottom of the slabs. The behavior of the slabs was introduced in terms of multiple mechanical characteristics related to strength and serviceability. In addition, the profitability of utilizing different amounts of strengthening material was also addressed and compared. It was noticed that the CFRP debonding failure was dominant for strengthened specimens compared to a ductile failure recorded for the unstrengthened ones.

* The asterisk denotes the presenting author.

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The Extent Depth Effect on the Behavior of Strengthened and Unstrengthened One-Way RC Slabs: Experimental Study

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ABSTRACT

Improving the flexural behavior of structural members and analyzing their failure consequences are essential in some cases where deficiencies appear in their design due to sudden overloading or environmental action. In addition, several ways and materials were introduced to upgrade the strength of flexural-deficient members that vary in their efficiency and ease of application. This paper investigates the structural performance of strengthened one-way reinforced concrete (RC) solid slabs using carbon fiber-reinforced polymer (CFRP). Nine RC slabs with dimensions (1100 × 500) mm with three different thicknesses (60,80,100) mm were fabricated, tested using a four-point loading test, and analyzed, while maximum load, deflection, and modes of failure were recorded. Slabs were strengthened with different numbers of CFRP strips as follows: 0, 3, and 5. It was found that the flexural strength could be improved up to 110% compared to the control specimen. On the other hand, the result indicated that a small a/d ratio significantly improved overall structural behavior in terms of strength capacity and stiffness by about 120.18% and 442.42%, respectively.

* The asterisk denotes the presenting author.

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Smart Mapping and Decision Tools for Localized Material Reuse in Circular Construction

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ABSTRACT

Accelerating the transition to a circular economy in the built environment requires robust methodologies for identifying, assessing, and managing reusable materials. Localized Material Banks (LMBs) have emerged as a promising strategy for organizing material flows at the urban scale by serving as spatially defined inventories of construction elements recovered from demolition, renovation, or surplus. To enable their effective implementation, a digital framework combining Geographic Information Systems (GIS), Multi-Criteria Decision Analysis (MCDA), and sustainability metrics is proposed.

GIS provides the spatial foundation for mapping material stock, integrating data from remote sensing, BIM models, LiDAR scans, and pre-demolition audits. MCDA methods such as AHP and TOPSIS allow for systematic prioritization of reuse options based on material condition, accessibility, quantity, environmental benefit, and transport logistics. Complementary sustainability tools—including Life Cycle Assessment (LCA), Life Cycle Costing (LCC), and circularity indicators—offer deeper insight into the environmental and economic value of reuse strategies.

The approach is further strengthened through integration with real-time and emerging technologies such as IoT sensors, blockchain for material traceability, and digital twins for scenario simulation and planning. Together, these tools support data-driven, traceable, and scalable reuse workflows aligned with climate-neutral and resource-efficient construction goals.

* Online presenter

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Digital Twin for Fused Filament Fabrication (FFF)

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ABSTRACT

Fused Filament Fabrication (FFF) is one of the most accessible and cost-effective additive manufacturing (AM) techniques; however, it is frequently hindered by process instability, print defects, and reliance on heuristic parameter tuning. This study presents the development and implementation of a Digital Twin framework for FFF, designed to provide real-time process insight, predictive control, and automated decision support. The proposed architecture integrates a sensorized physical FFF printer with a virtual environment comprising physics-based simulation modules—including thermal, structural, and fluid flow models—as well as machine learning algorithms for defect prediction and process optimization. Data acquisition is achieved through thermal, mechanical, and visual sensors, while control feedback is enabled via dynamic G-code adaptation and predictive maintenance mechanisms. The framework is validated through representative use cases demonstrating enhanced print quality, reduced failure rates, and improved repeatability across different geometries and process conditions. Furthermore, future extensions are proposed, including integration with blockchain for secure material passports, support for multi-material and 5D printing processes, and compliance with ISO/ASTM 52900 standards to ensure cross-platform interoperability. The Digital Twin paradigm introduced here establishes a foundational step toward autonomous, intelligent, and traceable FFF manufacturing systems.

* Online presenter

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Research Of Energy Consumers And Consumption Of Fuel And Energy Resources In The Construction Of Small-Story Residential Buildings In The Conditions Of Uzbekistan

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ABSTRACT

The scientific novelty lies in the development of a scientific and methodological approach to integrated accounting of fuel and energy resources consumption in the construction of low-rise residential buildings. The goal is to improve organizational and technological models for the construction of low-rise residential buildings, taking into account the integral consumption of fuel and energy resources by all types of energy consumers at all stages of construction. The methodology is based on the work of domestic and foreign scientists, specialists in the field of technology and organization of energy-efficient construction production, the principles of organizational and technological modeling, federal and regional programs aimed at providing citizens of the country with affordable and comfortable housing, as well as increasing energy saving and energy efficiency.

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Developing Competency Clusters For Future Engineers: A New Educational Taxonomy Approach

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ABSTRACT

This research presents a comprehensive framework for developing competency clusters for petroleum engineering technology students through an enhanced educational taxonomy. The proposed approach extends Bloom's classical taxonomy by incorporating "Representation" and "Attitude" categories, aligning with ABET, CDIO, and OBE principles. The framework structures learning outcomes across A-B-C proficiency levels (basic-intermediate-advanced) and integrates assessment indicators with diagnostic tools. This augmented taxonomy, featuring anticipation mechanisms and metacognitive development, ensures coherent integration of academic knowledge, practical skills, ethical-social competencies, and digital environment interaction capabilities for petroleum engineering professionals [1].

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ABSTRACT

The article presents the results of theoretical and experimental full-scale thermophysical studies on models of external walls made of aerated concrete. The research includes the determination of thermal resistance, thermal conductivity coefficient, temperature distribution within the thickness of experimental samples, moisture regime, and thermal stability of external walls.
Keywords. thermal resistance**, thermal conductivity coefficient, temperature distribution, thermophysical studies, moisture regime, experimental sample**

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Digital Spatial Analysis of Historic District Renewal: A Space Syntax and GIS Approach

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ABSTRACT

In contemporary historic district regeneration, residential neighborhoods are frequently marginalized, whereas commercialized districts are often prioritized due to their greater capacity to generate immediate economic benefits. This tendency has raised increasing concerns regarding spatial inequity and the mismatch between spatial configuration and community needs. To investigate this issue, this study adopts Space Syntax, a methodology for analyzing the topological relationships of street networks, and integrates it with GIS-based heatmaps of population density and facility distribution, complemented by resident surveys and semi-structured interviews.

The Shuanglong Alley historic district in Kaifeng, China, serves as a representative case: it preserves architectural heritage from the Ming and Qing dynasties while functioning as a dense residential neighborhood, where tensions between commercialization and community needs are particularly pronounced. Results indicate that densely inhabited residential sectors exhibit significantly lower accessibility and intelligibility (the degree to which residents can understand and navigate spatial configurations) compared to commercialized areas, while also facing shortages of public facilities. These findings reveal a structural mismatch between spatial configuration and social demand, constituting systemic spatial inequity..

To address these challenges, the study proposes strategic interventions including street network optimization, the provision of community facilities, and the enhancement of wayfinding and spatial legibility. By combining computational spatial analysis with participatory inquiry, this research underscores the value of digital and interdisciplinary approaches in advancing equitable and sustainable historic district renewal.

Keywords: Historic district regeneration, Spatial inequity, Space syntax, GIS, Sustainability

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Automated Seismic Detection Algorithm applied for Iraq's Mesopotamian Seismological Network

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ABSTRACT

The tectonic location of Iraq, due to its position on the border of the Arabian Plate and Eurasian Plate, is unique in terms of seismic environment, owing to moderate to high seismic activity in general, and especially along the Zagros Fold Thrust Belt. Although the seismicity of the neighboring Mesopotamia Flat is relatively low, a series of low-seismic events and covered fault networks indicate the necessity of close and consistent local control. As a reaction, the Mesopotamian Seismological Network (MPSN) was introduced to increase the detection of earthquakes in central and southeast Iraq. The design and implementation of a C# coded automated seismic event detection algorithm with a specific design adopted to be integrated with the MPSN stations in a real-time manner are presented. In this paper, an efficient method of signal preprocessing is utilized. The process begins with offset compensation to remove DC offsets and noise from seismic signals, ensuring baseline stability. Next, signal energy monitoring calculates instantaneous and average energy levels, using an adaptive threshold to identify potential seismic activity. High-average energy signals are prioritized to reduce irrelevant data. Finally, earthquake detection occurs by filtering out transient signals or noise using predefined time window sizes. The algorithm was tested on seismic stations across Iraq and on various seismic events, demonstrating high accuracy in determining the arrival times of seismic waves. The results obtained closely matched those from international programs, such as Hermann, and aligned with expert manual analyses. This confirms the method's effectiveness in enhancing the seismological network and response times. Key innovations include adaptive thresholding and a sliding window mechanism that increases sensitivity to weak events and reduces false alarms. Using actual MPSN data, the algorithm was highly accurate and required no extra resources, making it suitable for large-scale deployment. This development improves automated waveform detection in Iraqi seismic data, aiding earthquake monitoring and hazard mitigation.

Keywords
Seismic event detection, P- and S-wave picking, Seismology, Mesopotamian Seismological Network (MPSN), Real-time monitoring, Iraq tectonics

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Digital Transformation to Improve Government Performance in Bangka Belitung Province Indonesia

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ABSTRACT

Digital transformation has become an essential driver of public sector reform to enhance efficiency, transparency, and citizen participation. This study analyzes how digital transformation influences government performance in Bangka Belitung Province, an archipelagic region with unique governance challenges. Using the dynamic capability framework—sensing, seizing, and transforming—partnering agility was tested as a mediating variable. A sequential mixed-methods approach was applied, combining quantitative analysis with SmartPLS and qualitative validation through NVivo. The findings indicate that sensing, seizing, and transforming capabilities positively affect government performance, while partnering agility strengthens these relationships by enabling collaboration across sectors. Quantitative results show significant path coefficients supporting the hypotheses, whereas qualitative coding highlights infrastructure readiness, digital literacy, and inter-agency collaboration as critical factors. The integration of both analyses suggests that dynamic capabilities, reinforced by partnering agility, provide a robust mechanism for improving administrative efficiency, public satisfaction, and digital governance maturity in Bangka Belitung. This research contributes theoretically by bridging digital transformation and dynamic capability literature in the public sector, while practically offering policy recommendations for accelerating electronic-based government (SPBE) implementation in Indonesia's archipelagic regions.

Keywords: digital transformation, dynamic capability, partnering agility, government performance, Bangka Belitung

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Food Prediction and Alert Automation Using Stacking Ensemble Machine Learning Model

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ABSTRACT

Flood is the severe natural catastrophes, impacting millions of people and causing significant economic and infrastructural damage. To address the growing need for timely flood risk assessment, this project proposes an intelligent flood prediction and alert system based on ensemble machine learning techniques. The system leverages a stacking ensemble model, combining Random Forest and Logistic Regression as base learners, with K-Nearest Neighbors (KNN) as the meta-model to enhance prediction accuracy and generalization. The proposed work focuses on a multidimensional data incorporating more than 20 features related to urbanization, drainage, deforestation, climate change, and topographical vulnerability. Preprocessing includes missing value imputation, feature scaling, and SMOTE for class balancing. A responsive web application is developed using Streamlit, allowing users to input data, view predictions, and interact with visual components like gauge charts and comparison plots. When the predicted flood risk exceeds a defined threshold, the system triggers automated email alerts via Brevo API and sends real-time notifications to a Node.js backend. Recipient email addresses are dynamically loaded from an Excel file, making the alert system adaptable and scalable. Overall, the system offers a complete solution that integrates accurate prediction, real-time alerting, and intuitive visualization to support proactive flood response and disaster preparedness.

Enhancing E-Content Development for Engineering Courses with Machine Learning: A Graph Neural Network Approach

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ABSTRACT

Incorporating cutting-edge machine learning methodologies, including Graph Neural Networks (GNNs) and Hierarchical Conceptual Clustering, holds immense potential for revolutionizing the analysis of students' interactions with educational materials to discern their learning preferences. GNNs offer a robust framework for modeling intricate relationships within graph-structured data, facilitating a comprehensive understanding of the complex interplay between students and learning objects. Meanwhile, Hierarchical Conceptual Clustering provides a sophisticated approach to identifying overlapping hierarchical concepts, thereby enabling a more nuanced exploration of students' individual learning styles. Our study proposes a novel integration of GNNs and Hierarchical Conceptual Clustering to develop personalized learning recommendation systems for online education platforms. By harnessing the complementary strengths of these methodologies, we aim to create intelligent agents capable of tailoring learning tasks and materials to suit each student's unique preferences and academic abilities. Leveraging students' interaction data and advanced clustering techniques, our approach seeks to extract meaningful insights into learning behaviors while respecting individual differences. Furthermore, our methodology adopts a literature-based approach, leveraging existing research findings to inform the training process of the GNN model and enhance its predictive capabilities. Through the synergistic combination of GNNs, Hierarchical Conceptual Clustering, and domain-specific knowledge, our research endeavors to advance the field of intelligent educational technologies, paving the way for more personalized and effective online learning experiences tailored to the diverse needs of students.

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Shear Force in a Beam-Column Connection from a Linearly Distributed Load Occupying Various Possible Positions on a Cantilever Beam

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ABSTRACT

The beam-column connection is an important but vulnerable element in frame structures under seismic actions. The shear force at the joint is cited as a major cause in the occurrence of failures. Research over the last few decades has not led to the establishment of a uniform procedure in different countries for the determination of shear strength. One reason is the difficulty in calculating the forces that are transmitted from the beams to the columns. In the current Eurocode 2, the shear force is defined capacitively [1]. In this paper, a mathematical model of the beam is considered that allows taking into account all the dimensions of the beam in height as well as the material characteristics of the beam while calculating the magnitudes of the forces transferred from the beam to the column as a result of a specific load. This model allows to calculate and prove the influence of each material characteristic, as well as of each specific geometric dimension, on the magnitude of the shear force [2-4]. In the present study, a cantilever beam loaded with a linearly distributed transverse load occupying different possible positions is considered. A solution is performed and the beam lateral edge support reactions along the height are determined. The results for a selected beam and the variation of magnitudes of forces entering the joint from the load and a given characteristic are demonstrated. The shear force is calculated with the exact forces determined with the newly derived formulas. To validate the results, the new shear force was compared with that determined by the approximate method recommended in the literature. The difference is up to 12%. A comparison was also made with the shear force determined according to Eurocode 2. The difference ranges from -52% to +45%.

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A Lightweight Open-Data QGIS Workflow for Walking Accessibility of Heritage Nodes in Dali Dong Village

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ABSTRACT

Rapid growth in rural tourism and everyday mobility concentrates pressure on culturally significant spaces in traditional villages. This study develops a lightweight, reproducible workflow to quantify pedestrian accessibility for key heritage nodes in Dali Dong Village and to inform low-cost, heritage-sensitive circulation upgrades. High-resolution Tianditu imagery is integrated with OpenStreetMap roads and manually digitized alleys in QGIS (open-source geographic information system software) to construct a pedestrian network. Verified points of interest include the drum tower, flower bridges, main village entrances. Using network analysis tools in QGIS, multi-band walking isochrones are generated and symbolized for visual comparison. A grid-based origin–destination lineset approximates segment usage, and overlay analysis identifies corridors within the catchment as well as nodes that fall outside it. Applied to Dali Dong Village, the workflow produces clear service areas, reveals uneven coverage between hamlets, and highlights valley-aligned corridors as high-pressure links, while several entrances and bridges remain outside the catchment and merit priority upgrades. The approach relies only on openly available data and standard QGIS tools, lowers implementation barriers in data-poor rural contexts, enables transparent replication, and provides actionable guidance for micro-routing, wayfinding, and rest-point placement. It offers a deployable template for heritage-sensitive circulation planning and cross-case evaluation.

Keywords

walking accessibility; traditional villages; QGIS; isochrone analysis; heritage planning

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Helmet and Reflective Vest Recognition System Based on the Improved YOLOv11 Algorithm

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ABSTRACT

To address the current problems of reduced accuracy and missed detections in the target detection of safety helmets and reflective vests due to small target sizes and low actual image resolution,an improved real-time detection algorithm based on YOLOv11 is proposed. First, we compiled a dataset comprising 22,453 images that include both real projects and networks. These images were subsequently annotated utilizing self-supervised learning techniques. Our approach involved the use of a Yolov5 network, which was expediently trained utilizing a limited number of samples, serving as the teacher model.Then,we integrate the CBAM (Convolutional Block Attention Module) into the backbone network to augment the model's feature representation capabilities, enabling it to concentrate more effectively on critical regions of helmets and vests. Next, we replace the original CIoU loss function with the Wise-IoU loss function, which incorporates a dynamic non-monotonic focusing mechanism. This replacement mitigates the detrimental impact of low-quality examples on the model's generalization performance, thereby improving detection accuracy, particularly for small and partially obscured objects. The experimental findings indicate a mean average precision (mAP) of 92.3% for the enhanced model, marking an advancement of 5.0% compared to the initial model.This algorithm ensures a diminutive model size while substantially augmenting the mean average precision (mAP), making it ideally suited for deployment on platforms with limited computational resources.

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Estimating the Potentials for Indoor Thermal Comfort and Electric Vehicle Charging with BIPV in Nigeria

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ABSTRACT

Alongside the power sector, the building and transport sectors are among the largest contributors to greenhouse gas (GHG) emissions, due to heavy reliance on fossil fuels. In Nigeria, rapid population growth and urbanization are further increasing energy demand for heating, ventilation, and air-conditioning (HVAC) and for transport. This study explores the potential of building-integrated photovoltaic (BIPV) to simultaneously support indoor thermal comfort and transport electrification, ultimately reducing GHG emissions. A coordinate-based study was conducted for locations across Nigeria, followed by a case-study consideration of three cities: Abuja (North), Lagos (Southwest), and Anambra (Southeast). A 100 m^2 single-storey residential building with rooftop-type BIPV was modeled in OpenStudio to estimate HVAC loads under realistic occupancy schedules with smart system control. Solar photovoltaic (PV) generation was obtained via the PVGIS tool, and surplus electricity was evaluated for EV charging with the Tesla Model 3 Long Range AWD as the reference vehicle and city-specific maximum travel distances. The simulation results showed that HVAC demand is dominated by cooling loads due to the country's hot climate. Anambra recorded the highest cooling load but also the greatest capacity for EV charging, owing to shorter travel distances. Abuja had the highest PV output potential. GHG savings were most significant in northern Nigeria, with annual reductions of 17.65 tCO2e (BIPV) and 36.08 tCO2e (EV). Overall, cumulative annual reductions of 53.73, 49.86, and 48.43 tCO2e were estimated for Abuja, Anambra, and Lagos, respectively. This study demonstrates the potential for BIPV to enhance indoor comfort, enable low-carbon transport, and reduce emissions, exemplifying its role in sustainable urban development in tropical climates. Future studies should evaluate the economic feasibility to guide adoption by households and policymakers.

International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

Jordan, December 18th - 20th 2025

The Impossibility of Complete Restoration of Buildings Damaged by Warfare

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ABSTRACT

The purpose of this work was to conduct a comparative analysis of a high-rise building (HRB) damaged by a missile strike in Kyiv on April 26, 2022, and its undamaged counterpart. Such analysis is essential for assessing the extent of damage and accurately determining the scale of losses. The study is based on fib Bulletin 59. It demonstrates how the life-cycle curve of an HRB is transformed under a single instance of wartime impact compared to the standard fib Bulletin 59 curve.

The applied methods included visual and instrumental inspections of the HRB using non-destructive testing techniques, as well as geodetic and vibration measurements with IoT-enabled instruments, to refine the initial-boundary conditions for constructing a Digital Shadow of the building. Experimental verification of the Digital Shadow was performed. Structural calculations were carried out using the LIRA – CAD software package.

Results. Measurements and calculations indicate the need to reinforce damaged pylons on the 18th–21st floors of the HRB (Figs. 1.1 and 1.2), since the ratio of cross-sectional load-bearing capacity to longitudinal compressive force on the 20th floor (axes 2/J and 3/J) is not only lacking a safety margin, as observed on the 17th floor (axes 2/E and 2/D), but is actually less than one. Furthermore, on the 17th floor in axis 2/J, the safety margin is only 1.02, which is insufficient for normal operation. Results of vibration-dynamic surveys conducted more than a year after the building's partial restoration show a reduction in the natural frequency of its structural elements compared with the undamaged reference building.

Conclusions. The experimental and computational results confirm our hypothesis regarding the impossibility of fully restoring HRBs damaged by warfare. This must be taken into account in the final assessment of losses. Preliminary estimates suggest that more than 500,000 such buildings in Ukraine have been damaged over nearly four years of war. Under current conditions, the service life of HRBs after a single missile strike is reduced by approximately $\Delta T \approx 30–40$ years and continues to decline at an accelerated rate compared with the fib Bulletin 59 life-cycle curve.

* The asterisk denotes the presenting author.



Fig. 1.1. General view of the HRB at 6A Lobanovsky Avenue, Kyiv, after the missile strike of February 26, 2024

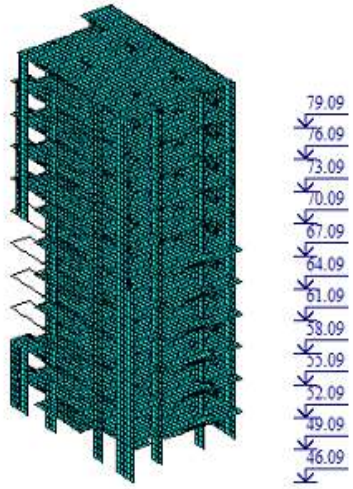


Fig. 1.2. Computer model of the HRB with damage elements within the 18th–21st floors

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Geometric Digital Twin of a Partially Destroyed High-Rise Building

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ABSTRACT

The purpose of this work was to perform engineering and geodetic measurements of the deformed state of high-rise building (HRB) No. 15A, located on Viacheslav Chornovil Street in Chernihiv, Ukraine, and to construct its digital twin. This is an essential step for developing a BIM-based restoration project and enabling the building's re-entry into service.

Applied methods. One of the methods for determining deformations of buildings and structures is leveling relative to a conditional horizontal plane. Measurements of floor slab deviations from the reference horizontal plane using geometric leveling were conducted on the 12th, 13th, and 14th floors with a Sokkia SDL-30 level and a coded staff. The average measurement error did not exceed 0.5–0.8 mm. In locations where geometric leveling was not feasible (Fig. 1), trigonometric leveling was applied using a South Survey NTS-382R10L total station. The accuracy of this method is significantly lower, with an error of ±5 mm.

Results. On the 12th floor, deviations of the floor slabs from the horizontal plane of up to –26 mm were recorded. Trigonometric leveling revealed a maximum deviation of –644 mm from the horizontal. The slab section in axes A–G/8–10 was dismantled and reconstructed. Similar results were observed on the 13th–15th floors. Instrumental monitoring of wall corner vertical deviations showed that as of August 18, 2022, they ranged from 1 mm to 82 mm, and as of November 11, 2022, from 1 mm to 72 mm.

Conclusions. Between September 18 and November 17, 2022, four measurement cycles of floor slab deviations from the reference horizontal plane were conducted. Deviations reached –44 mm for slabs without structural damage and up to –644 mm for slabs with structural failures. A geometric digital twin of the damaged HRB was constructed, its stress–strain state was calculated, and a BIM-based project for its restoration and re-commissioning was developed.

* The asterisk denotes the presenting author.

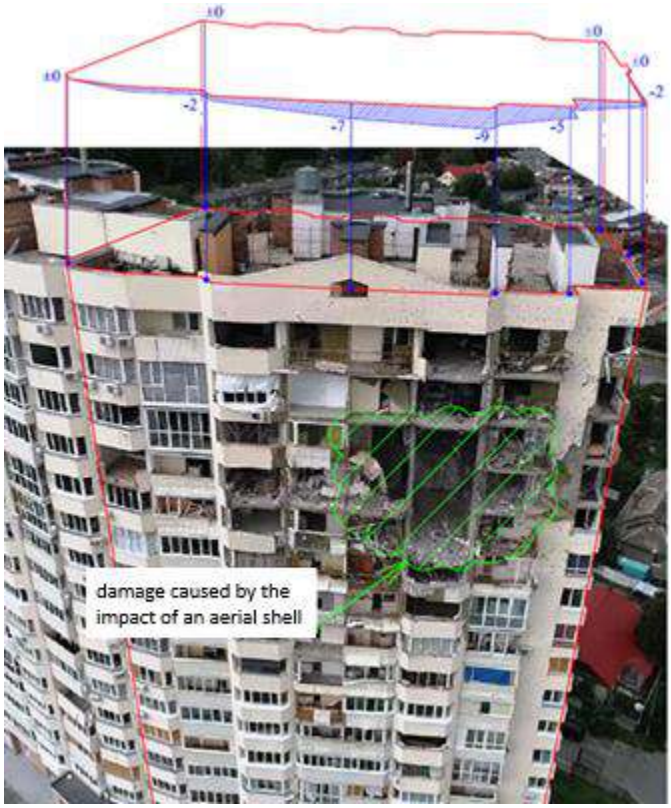


Fig. 1. Damaged HRB No. 15A, Viacheslav Chornovil Street, Chernihiv, Ukraine

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Application of Construction 4.0 Technologies to Detect a Hidden Vibration Source in a High-Rise Residential Building

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ABSTRACT

The purpose of this work was to conduct vibrometric investigations of vibration effects in an apartment of a residential high-rise building at 55 Chyhorina Street, Pecherskyi District, Kyiv, Ukraine. The study was initiated following complaints from residents about the negative impact of vibrations on their health. Vibrations were first detected in January 2023. They persisted continuously throughout the day and night, adversely affecting the residents' health and causing severe discomfort, chest pain, and chronic fatigue. Permanent residence in the apartment became impossible.

Applied methods. Vibration signal recording and processing were carried out using the Seismomonitoring software package. Signal processing employed spectral analysis based on the Fast Fourier Transform. The hardware–software system included a low-frequency vibration measurement module with single-component accelerometers and a laptop with the corresponding software. Communication between the module and the accelerometers was enabled via IoT.

Results. The highest number of valid measurements was obtained in the octave band 31.5–63 Hz, while the lowest number was recorded in the octave bands 4–16 Hz. The building's natural frequencies were determined as follows: along the X-axis, fx = 2.31–2.32 Hz; along the Y-axis, fy = 4.23–4.31 Hz. The recorded excessive vibration levels affected the building's structural elements and had a pronounced negative impact on living conditions.

Conclusions. The elevated vibration level was confirmed. It was established that the source of vibration was internal rather than external, located on the same floor of the building, acting directly on its structures, and creating unfavorable living conditions. Preliminary assumptions suggested that the source might have been hidden high-power cooling fans of a cryptocurrency mining farm or an indoor cultivation facility for narcotic plants in an adjacent locked apartment, which was inaccessible at the time of the investigation (Fig. 1).

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Yield-Stress Rheology, Fluid Mechanics and Machine Learning for Predictive Concrete Pumping

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ABSTRACT

Accurate prediction of concrete pumping requires models that capture both nonlinear yield-stress rheology and the formation of a low-viscosity lubrication layer at the wall. Concrete pumping is the primary method for placing large volumes of material in modern construction, and unexpected pressure losses or blockages can lead to costly delays. Reliable predictive models are therefore essential for the safe and efficient planning of long-distance pumping operations. We develop a physics-based framework that integrates unified yield-stress rheology with the principles of non-Newtonian fluid mechanics. The constitutive model generalizes widely used formulations, including Bingham, Casson, Herschel–Bulkley, and modified Bingham, within a single unified expression. Based on this unified rheology, we derive analytical relations between flow rate and pressure drop for long-distance concrete pumping. To capture the effect of the lubrication layer, we extend the analysis with an explicit decomposition for coaxial dual-fluid flow, where bulk concrete and the lubrication layer are treated as fluids with distinct properties [1]. This combined formulation yields a transparent and predictive model for pumping pressures with direct relevance to engineering practice, particularly for long-distance and large-scale pumping operations. While the forward model enables accurate predictions when material parameters are known, in practice many rheological and lubrication-layer properties are difficult to measure directly. To address this limitation, we frame an inverse problem: inferring constitutive parameters and lubrication-layer characteristics from pumping data. We investigate a range of machine learning approaches to address this problem and assess their suitability for parameter identification. This integration of analytical rheology, fluid mechanics, and AI provides a clear demonstration of how physics-based modelling and data-driven methods can be combined to advance predictive tools for concrete pumping within the framework of digital technology driven engineering.

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Experimental Study on the Compressive Strength and Ultrasonic Pulse Velocity of Seaweed-Modified Geopolymer Concrete

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ABSTRACT

Concrete remains a critical material for infrastructure development, however, its dependence on Portland cement contributes 5–7% of global CO_2 emissions. To support sustainable infrastructure and maintain structural performance, geopolymer concrete, based on alkali-activated pozzolanic materials, has emerged as a promising alternative. Agricultural wastes such as palm oil fuel ash, rice husk ash, and sugarcane bagasse ash have been shown to improve compressive strength when partially substituting fly ash. Beyond these materials, seaweed biomass presents a promising alternative due to its high silica and alumina content. Indonesia, as the world's second-largest seaweed producer, generates substantial amounts of seaweed waste, of which only 15–30% is currently utilized. This study investigates the potential of *Gracilaria sp.* seaweed as a supplementary material in fly ash-based geopolymer concrete. An alkaline treatment using sodium hydroxide (NaOH) was applied to enhance silica extraction and remove non-cellulosic components without high-temperature calcination. The treated seaweed was incorporated into the geopolymer mixture at substitution levels of 0 and 5%, by mass of fly ash. XRF analysis revealed that *Gracilaria sp.* contained 69.03% SiO_2 and 14.07% Al_2O_3, highlighting its suitability as pozzolanic precursor. At 7 days, the average compressive strength increased from 13.79 MPa in control specimens to 15.57 MPa with 5% seaweed substitution, representing a 12.29% increase. However, Ultrasonic Pulse Velocity (UPV) test indicated a slight reduction in density and internal compactness in seaweed-modified specimens. Further studies with substitution levels above 5 % are recommended to evaluate performance on compressive strength, density, and internal compactness of geopolymer concrete.

Keywords: Sustainable Infrastructure, Seaweed, Compressive Strength, Green Material, Extraction

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Jordan, December 18th - 20th 2025

From Smoke to Fire: Improving Early Detection with Pre-trained CNNs

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ABSTRACT

This study examines whether treating smoke as a distinct class enhances the robustness of image-based fire classification systems. We used the hypothesis that smoke detection provides an earlier and more sensitive signal of fires. To evaluate the impact of smoke, two datasets were used: (i) a binary dataset (fire + smoke, non-fire); (ii) a multiclass dataset (fire, smoke, non-fire). Feature extraction is done by pre-trained neural networks (VGG16, ResNet50, EfficientNetB7), and SoftMax and Random Forest models were used for classification. Performance evaluation is conducted using Accuracy, F1-score, the Matthews correlation coefficient (MCC), and the confusion matrix. In the binary classification scenario, EfficientNetB7 with SoftMax achieved the best performance (Accuracy = 0.990, F1-score = 0.990, MCC = 0.973). Conversely, ResNet50 with SoftMax demonstrated superior performance in the multiclass scenario (Accuracy = 0.8633, F1-score = 0.8396, MCC = 0.7596). VGG16 yielded lower values in both the binary (Accuracy = 0.7641 with SoftMax, MCC = 0.1757) and multiclass scenarios (Accuracy = 0.7300 with SoftMax, MCC = 0.5386). Notably, VGG16 with Random Forest showed improvements in accuracy (0.900) and MCC (0.7231) in the binary classification scenario. However, these results were outperformed by ResNet50 and EfficientNetB7 with SoftMax. We pointed out that categorizing smoke as a separate class does not hinder classification, but removing smoke images from the dataset reduces accuracy.

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A Predictive Machine Learning Framework for Proactive Customer Satisfaction Management in Electricity

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ABSTRACT

The deregulation of electricity markets has created new competitive dynamics, requiring utilities to move beyond descriptive surveys toward predictive, actionable intelligence on customer satisfaction[1]. This paper presents a comprehensive machine learning framework designed for electricity service providers, addressing the shortcomings of linear regression–based methods that often obscure individual-level dissatisfaction [2]. Using a Random Forest classifier trained on granular survey responses and consumption metrics, the framework achieves 98.79% accuracy with near-perfect precision (1.00) and recall (0.97), enabling utilities to detect at-risk customers with high reliability.

Building on this foundation, K-Means clustering uncovers hidden customer archetypes, providing nuanced insights that transcend traditional billing categories. A Gradient Boosting–based early-warning system further operationalizes these insights, generating real-time dissatisfaction risk scores to trigger proactive interventions. To scale this framework in enterprise settings, we propose a modular **Customer Intelligence Platform**, integrating robust data ingestion pipelines, advanced machine learning services, and application-layer tools such as CRM integration and targeted intervention platforms.

The results demonstrate that dissatisfaction drivers—particularly customer service and communication effectiveness—are often masked by aggregated SERVPERF-style analyses, underscoring the value of granular, non-linear modeling. By combining predictive accuracy, segmentation, and automated early warning, the proposed framework offers both methodological innovation and practical significance. It provides utilities with a scientifically grounded roadmap to enhance customer loyalty, optimize operational resources, and sustain competitiveness in increasingly deregulated and customer-centric electricity markets.

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Revealing the Visual Cues: How YOLO-Nano Learns to Detect Objects in Adverse Weather

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ABSTRACT

The reliability of object detection models in safety-critical applications like autonomous driving is severely compromised by adverse weather, while their 'black box' nature erodes trust. This research moves beyond simple performance benchmarking to investigate why and how these models fail under visual degradation, dissecting their internal reasoning to engineer more robust and transparent systems.

Our technical approach enhances two lightweight architectures, YOLOv5n and YOLOv8n, by systematically integrating four distinct attention mechanisms: Global Attention Module (GAM), Convolutional Block Attention Module (CBAM), Efficient Channel Attention (ECA), and Shuffle Attention (SA). To reveal the models' reasoning, we employ Gradient-weighted Class Activation Mapping (Grad-CAM) to visualize the precise visual cues guiding the predictions of both baseline and attention-augmented models. Models are trained on a PASCAL VOC 2007 + 2012 subset and then rigorously evaluated in a zero-shot setting on the diverse DAWN dataset, covering fog, rain, snow, and sandstorms.

Our analysis reveals distinct reasoning patterns: YOLOv8n learns holistic object shapes while YOLOv5n relies on localized textures, a critical vulnerability in heavy rain. Crucially, we demonstrate how specific attention modules can mitigate these failures by redirecting the model's focus toward more robust features. These findings provide a clear pathway toward developing more effective and ultimately trustworthy AI systems for all-weather autonomous perception.

Keywords: Explainable AI (XAI), YOLO, Attention Mechanism, Object Detection, Adverse Weather, Grad-CAM, Computer Vision.

International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

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Valorizing Olive Pomace Lignin as a Sustainable Chemical Admixture for Cement Paste: A Mechanistic and Performance Appraisal

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ABSTRACT

The global construction industry is under increasing pressure to transition toward more sustainable and circular practices to mitigate its substantial environmental footprint. A critical challenge is the reduction of reliance on resource-intensive materials like Portland cement and the valorization of large-scale agricultural byproducts. Olive pomace, a major waste stream from olive oil production, presents a promising, yet underexplored, opportunity. This study is the third in a series of research efforts focused on developing olive pomace lignin (OPL) as a high-performance bio-based modifier. Previous work successfully established OPL's efficacy as a sustainable modifier for asphalt binders and concrete mixtures, where it significantly enhanced key properties, including Marshall stability and thermal resistance (Alobeidyeen et al., 2025a, 2025b). While prior research on olive waste in cementitious systems has explored the use of Olive Pomace Ash (OPA) as a pozzolanic supplementary cementitious material (SCM) or raw pomace as a physical aggregate, these approaches often result in a reduction of early-age compressive strength and inconsistent performance (Alkheder et al., 2016). A critical knowledge gap remains in understanding the fundamental behavior and potential of OPL as a sophisticated chemical admixture, rather than as a bulk replacement material. Unlike OPA, which functions through a pozzolanic reaction, OPL is a high-purity biopolymer (Ferreiro-Cabello et al., 2022). The objective of this research is to bridge this gap by investigating the fundamental rheological and mechanical behavior of OPL in cement paste. Specifically, this study aims to clarify the dual chemical role of OPL as a water-reducing plasticizer and its influence on cement hydration kinetics. We will also refine the optimal dosage and chemical role of OPL to overcome the challenge of set retardation while maximizing its plasticizing effect. The significance of this research lies in its novel contribution to the field of sustainable materials science by moving beyond conventional waste valorization. This study will provide foundational mechanistic insights into the interaction between a complex biopolymer and cement, paving the way for the development of a new class of bio-based, high-performance superplasticizers. The successful utilization of OPL in this application would not only provide a high-value, non-combustion pathway for a major agricultural waste product but also advance the design of greener, more durable cementitious materials for future infrastructure.

* The asterisk denotes the presenting author.

International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

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Studying On The Basis Of Modeling The "Foundation -Wall-Superstructure" System Operating Under Dynamic Influence

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ABSTRACT

This case study presents the evaluation process of three simplified computational models for the FWSSS system using an improved finite element method model. Among these computational models, the first two are linear models, while the third one is the famous nonlinear Winkler model. To evaluate the performance of these models under earthquake conditions, a comprehensive nonlinear analysis was performed on buildings located on different soils.

Keywords: single-member structure; finite element method; nonlinear Winkler model; computational model; geotechnical properties of soils.

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Integrating University Social Responsibility into Institutional Strategy Amidst Higher Education Autonomy in Vietnam

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ABSTRACT

In the context of higher education governance reform and the expansion of institutional autonomy in Vietnamese universities, University Social Responsibility (USR) has emerged as a strategic lever for sustainable development. This paper clarifies the concept of USR, evaluates its current implementation in autonomous universities, and identifies systemic barriers such as conceptual misunderstandings, resource constraints, and the absence of standardized measurement tools. Based on these insights, the study proposes managerial implications for embedding USR into strategic planning and governance, thereby enhancing institutional reputation, accountability, and societal impact.

Keywords: Corporate Social Responsibility, Opportunities, Sustainable Development Goals, University Social Responsibility, UNESCO.

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Sound Absorption Performance of a Layered Recycled Metamaterial with Machine Learning-Based Acoustic Simulation

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ABSTRACT

The development of sustainable materials for noise control applications is becoming increasingly relevant in the context of environmental protection and circular economy strategies. In this study we present a new layered acoustic metamaterial made entirely from recycled components, specifically cellular polypropylene membanes, combined with a honeycomb structure of aramid paper. The material was manufactured in configurations of varying thicknesses, reaching up to 3 layers, in order to explore the influence of layering and structural complexity on its acoustic performance. The acoustic properties were characterized experimentally using a Kundt tube, focusing on the sound absorption coefficient across a wide frequency range. The results demonstrate that the proposed layered material exhibits significant absorption capabilities, particularly at low-to-mid frequencies, with performance comparable to conventional porous absorbers. The presence of the aramid honeycomb structure further enhanced the absorption by promoting multiple scattering and resonance phenomena within the layered system. To extend the applicability of the experimental findings, a machine learning approach was employed to simulate and predict the acoustic behavior of the material. A supervised learning model was trained using the experimentally obtained absorption data as ground truth. The trained model successfully reproduced the frequency-dependent absorption trends, providing a fast and reliable tool for forecasting the performance of new layered configurations without the need for extensive experimental campaigns. The combination of experimental validation and data-driven modeling highlights the potential of recycled layered composites for sound absorption applications in building acoustics and noise control engineering. Furthermore, the integration of machine learning with material characterization offers a promising methodology for accelerating the design of sustainable acoustic materials.

Keywords: Sound absorption, Recycled materials, Layered composites, Kundt tube measurements, Machine learning simulation

Improvement Of External Insulation Processes Of Residential Buildings

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ABSTRACT

The development of the modern construction industry, like all other sectors of the national economy, is aimed at the rational use of the country's fuel and energy resources.
Their savings led to the adoption of stricter norms on construction heat engineering, which sharply increased the requirements for heat protection of enclosing structures of reconstructed and newly constructed buildings. Compared to previously in effect norms, the required reduced heat transfer resistance increased by an average of 3-3,5 times.
In this regard, traditional single-layer wall constructions, which were typically made of piece materials (ceramic and silicate bricks and blocks), lightweight concrete panels, or monolithic reinforced concrete, and were widely used before, cannot be applied due to the sharp increase in their thickness. The current regulatory requirements can be realistically ensured only when using multilayer structures with a layer of effective thermal insulation.

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Variable Neighbourhood Search for Solving Edge Dynamic Graph Coloring Problem

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ABSTRACT

In many real-world applications, edges between the vertices of graphs may vary with time. If the graph at any given time step is colored, the changes in its edges cause clashes each time. The problem of coloring such graphs is referred to as the Edge Dynamic Graph Coloring Problem (EDGCP), where the objective is to minimize clashes between consecutive time steps and gradually move towards a feasible coloring. This problem arises in diverse domains such as wireless communication networks (to manage interference when connections change dynamically), timetabling and scheduling (where task dependencies evolve over time), and social or communication networks (where relationships among entities may appear or disappear). EDGCP is relatively new and, to the best of our knowledge, has not been widely studied in the literature. In this paper, we propose a Variable Neighborhood Search (VNS) strategy aimed at reducing the number of clashes promptly whenever the edge set of the graph is altered. We have designed and implemented VNS in C++, and conducted experiments on randomly generated dynamic graphs with varying densities. Our results show that VNS is able to reduce the clashes substantially.

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Durability of aerodrome horizontal markings: a literature-based framework linking AI, lifecycle optimization, and sustainability

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ABSTRACT

This study examines the durability of aerodrome horizontal markings through a literature-based analysis that integrates civil infrastructure engineering with digital predictive approaches. Markings are critical for operational safety, yet their service life is strongly influenced by environmental stressors, traffic intensity, material characteristics, and maintenance practices. Recent advances in artificial intelligence, probabilistic modeling, and 3D-printing–enhanced material applications provide new opportunities for optimizing durability assessment and lifecycle planning. Evidence shows that climatic extremes and heavy traffic accelerate deterioration, while innovations such as abrasion-resistant paints, optimized glass bead morphology, and UV absorbers significantly extend retroreflectivity and service performance. Preventive maintenance strategies, when supported by AI-driven predictive modeling and structured inspection indices, consistently outperform reactive repainting, lowering lifecycle costs and reducing environmental burdens. The findings highlight a critical trade-off: although high-performance materials and digital optimization require greater initial investment, they improve safety outcomes, reduce repainting frequency, and contribute to long-term sustainability in infrastructure management. By bridging civil and structural engineering, computational mechanics, and sustainability sciences, this study demonstrates the potential of digital technology–driven approaches to align safety, efficiency, and environmental responsibility in aerodrome operations.

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Early Detection of Parkinson's Disease using a Multi-modal Transformer: A Synergistic Fusion of Audio Spectrograms and Brain MRI

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ABSTRACT

Parkinson's disease (PD) is a progressive neurodegenerative disorder where early and accurate diagnosis is critical for effective patient management. However, conventional diagnostic methods often rely on single data sources, which may overlook subtle pathological signs present across different biological systems. This paper proposes a novel, fully Transformer-based multi-modal framework for the early detection of PD by synergistically integrating vocal biomarkers and neuroimaging data. For the audio modality, we analyze sustained vowels ('a', 'i') using an Audio Spectrogram Transformer (AST), trained with a novel Hybrid Discriminative Loss function. This loss combines Cross-Entropy, Focal Loss, and Center Loss to simultaneously address class imbalance and enhance feature discriminability. Concurrently, a Vision Transformer (ViT), pre-trained on large-scale medical imaging datasets, is fine-tuned to capture global structural patterns and subtle alterations within brain MRI scans, offering superior contextual understanding compared to traditional CNNs. The high-level feature embeddings from both the AST and ViT are then integrated through a co-attention fusion module. This module enables the model to learn inter-modal dependencies, adaptively weighing the most salient features from both speech and imaging data to form a comprehensive and robust diagnostic prediction. Our unified, Transformer-based architecture significantly enhances diagnostic accuracy over single-modality approaches. Furthermore, the framework offers dual-modality interpretability through attention map visualization from both AST and ViT, highlighting critical vocal and neuroanatomical markers. This work presents a powerful, non-invasive tool for clinical decision support, paving the way for earlier interventions and personalized monitoring in Parkinson's care.

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Research on the Mapping Between Visual Semantic Features of AI-Generated Architectural Images to Styles and Typologies

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ABSTRACT

Addressing the insufficient research on visual semantic feature mapping in AI-generated architectural images, this study investigates how visual features effectively communicate specific architectural styles (Classicism, Functionalism, Parametricism) and typologies (Residential, Commercial, Cultural buildings), aiming to resolve ambiguous semantic expression in algorithmic design. A 3×3 experimental matrix was used to generate 81 high-quality AI images. Semantic tags and visual keywords were extracted using WD14 Tagger and DeepSeek. Python scripts processed the data, while Origin 2025 was employed for analyzing distribution frequency, clustering trends, and consistency. Results revealed stable style-typology patterns: Classicism emphasized decorative vocabulary, Functionalism highlighted pragmatic terms, and Parametricism featured innovative terminology. Keyword distributions exhibited long-tail characteristics, with 82 high-frequency terms forming the core semantic framework. Radar charts confirmed the dominance of stylistic features, scatter plots revealed significant clustering of high-frequency terms, and heatmaps verified consistent label mapping despite cross-category noise. The findings confirm a stable visual-semantic mapping principle, demonstrating AI's capacity to convey predetermined architectural styles and functional intentions. This study provides empirical support and methodological frameworks for AI-assisted design, while also highlighting generative models' limitations in comprehending complex functional scenarios—guiding future optimization efforts.

Keywords: AI-generated images; Architectural Styles and Typologies; Visual Semantics; Mapping Relationships; Architectural Design; Visual Communication Design

Sustainable Magnetic Biochar–Alginate Beads for Adsorption and Photocatalytic Degradation of Methylene Blue in Textile Wastewater

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Abstract

Through a dual mechanism of adsorption and photocatalytic degradation, this study investigates the use of sustainable magnetic biochar–alginate beads derived from agricultural residues for textile wastewater treatment [1]. The beads exhibited an adsorption capacity of ~80 mg/g, removing more than 95% of methylene blue while maintaining strong photocatalytic activity under UV-Vis irradiation [2]. Due to their magnetic properties, the beads can be easily recovered and reused across multiple cycles with minimal loss of performance. Validation with real textile wastewater is anticipated to demonstrate significant reductions in COD and TOC, highlighting the robustness and scalability of the system [3]. Overall, the findings establish magnetic biochar–alginate beads as cost-effective, eco-friendly, and reusable materials for industrial wastewater remediation, contributing to cleaner production practices and environmental sustainability.

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Rice Husk Ash-Based Sustainable Foamed Geopolymer Concrete with Eco-Friendly Foaming Agents for Improved Mechanical and Thermal Insulation

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Abstract

This study aims to develop lightweight cellular geopolymer concrete using rice husk ash (RHA) as a sustainable binder and eco-friendly foaming agents to create a controlled porous structure. Three foaming methods were used: natural protein-based preformed foams, aluminum powder (which reacts with the alkaline medium to release hydrogen), and hydrogen peroxide ($H2O_2$), which breaks down to release oxygen. Viscosity-modifying agents, such as hydroxypropyl methylcellulose (HPMC) and xanthan gum, were added to the foam to stabilize it and prevent its collapse. This ensured a consistent pore distribution and improved stability. The density, water absorption, compressive and flexural strengths, and thermal conductivity were used to assess the effects of foaming type and dosage. The findings showed that foamed geopolymer mixtures maintained satisfactory mechanical performance for low-load structural applications while achieving densities in the 600–1000 kg/m³ range with markedly enhanced thermal insulation. The proposed system is a promising option for environmentally and energy-efficient building materials, as it can create sustainable foamed geopolymer concrete with balanced mechanical and thermal properties [1-2].

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Comparative Study on the Impact Resistance and Mechanical Properties of Slag-Based Geopolymer Concrete Modified with Dual Types of SBS Polymer Reinforcements Using Micro- and Macro-Sized Granules

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Abstract

The mechanical performance and impact resistance of slag-based geopolymer concrete modified with micro- and macro-granules of styrene-butadiene-styrene (SBS) polymers were examined in this study. Four mixes were prepared: a control mix devoid of polymer, a micro-SBS mix, a macro-SBS mix, and a dual system combining both particle sizes. According to the ASTM and ACI standards, all specimens were cured under the same conditions and tested for compressive strength, splitting tensile strength, flexural strength, drop-weight impact resistance after 28 d, and discussed the effect of polymer on surface and core of concrete by scanning electron microscope. The findings demonstrated that, compared to the control, polymer modification significantly enhanced the mechanical behaviour of the geopolymer concrete. Whereas macro-sized SBS improved the flexural performance and toughness by redistributing stresses and slowing the spread of cracks, micro-sized SBS improved the compressive and tensile strengths through improved matrix densification and interfacial bonding. With the highest compressive, flexural, and impact resistance values, the dual system demonstrated the best overall performance, indicating a synergistic effect between the reinforcement scales. Energy absorption analysis showed that the dual system offered superior toughness at both stages, macro-SBS postponed the final failure, and micro-SBS enhanced the resistance to crack initiation. These results highlight the potential of SBS-modified slag-based geopolymers as high-performance, environmentally friendly materials for applications subjected to impact and dynamic loading [1-2].

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Spatial Variability of Particle Size, Suction, and Water Content in Flood-Prone Atyrau, Kazakhstan

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ABSTRACT

Climate change has significantly altered global weather patterns, resulting in increased rainfall intensity and reduced frequency, thereby intensifying the risk of flooding. In Kazakhstan, the severe floods experienced during the spring of 2024 highlighted the critical need for effective flood control strategies, including accurate and localized flood mapping. This study focuses on the spatial distribution of soil properties—specifically particle size (sand, silt, and clay fractions), volumetric water content (VWC), and soil suction—in Atyrau City, covering an area of approximately 300 km². The primary aim is to understand the interrelationship between soil texture, water retention characteristics, and depth, thereby contributing to improved flood risk assessment. Data were collected from 60 boreholes distributed across the region, with a representative modeling sample of 30 points. These datasets were processed and analyzed using Kriging analyses in ArcGIS to assess the spatial variability of VWC and soil texture at multiple suction pressures. The results revealed that VWC consistently decreased with increasing suction pressure and soil depth. At higher suction levels, such as 1500 kPa, the soils exhibited reduced water retention and more uniform water distribution. Spatial maps identified distinct zones of higher VWC, particularly near the Caspian Sea and along the S-shaped trajectory of the Ural River. In terms of texture, clay content showed a general increase with depth, while sand and silt proportions fluctuated across various soil layers. The integration of spatial analysis and geostatistical modeling provided critical insights into the behavior of soil under varying hydrological conditions. These findings enhance the understanding of subsurface hydrophysical processes and the spatial heterogeneity of particle size distribution, both of which are essential for soil management and flood mitigation in vulnerable regions like Atyrau. The study demonstrates the value of combining field data with GIS-based modeling for effective environmental and geotechnical assessment.

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Discussion and Research for Inverted Rubber Players to Overcome Long Pimpled Rubber Opponents in Table Tennis

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ABSTRACT

While much of the existing research on table tennis tactics focuses on optimizing the performance of long pimpled rubber players, fewer studies explore the problem of how inverted rubber players can outperform long pimpled rubber players. The present study tries to develop the work of this research line by discussing the problem how the inverted rubber player can overcome the long pimpled rubber opponents.
First, the relevant basic knowledge is briefly introduced. Then, the following terms of work are carried out in turn. 1.The actual situation of inverted rubber players against long rubber players in the past has been shown by the associated statistics data and investigation results, e.g. see the table 6 below, in particular, the practical situation that the Long rubber players did not have an advantage in the high level competitions, but they had a strong advantage in the amateur competitions is shown, which implies the lack of guidance for the amateur players.2. Some strategies for inverted rubber players to fight against long rubber players are proposed. 3. Some training methods are proposed to improve the skills of inverted rubber players against long rubber players, in particular, the associated training methods for professional players and for amateur players are given respectively. 4. Based on the above discussion and observation, some questions worthy of research and important development directions are put forward, in particular, the importance of strengthening the guidance of amateur sports development is emphasized.

What we have done can not only promote the development of table tennis, but also promote the development of national sports.

Table 6 The 2015-2020 World Cup women's singles championships

Year	City	Name	Country	Racket
2015	Sendai	Shiwen Liu	China	Double-sided inverted rubber
2016	Philadelphia	Miu Hirano	Japan	Double-sided inverted rubber
2017	Manjin	Yuling Zhu	China	Double-sided inverted rubber
2018	Chengdu	Ning Ding	China	Double-sided inverted rubber
2019	Chengdu	Shiwen Liu	China	Double-sided inverted rubber
2020	Weihai	Meng Chen	China	Double-sided inverted rubber

Grasp strategies of 3D printed soft robotic actuators: A systematic review of materials, mechanics and mechanisms

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ABSTRACT

Soft actuators have gained wide attention for their ability to mimic the natural grasping abilities of the human hand. This study examines the materials, mechanics, and mechanisms that enable conformal grasping of soft robotic actuators. Temperature-responsive soft actuators undergo stiffness variations based on temperature changes. Integrating tunable elasticity with strong interfacial bonding enables silicon-based soft actuators to mimic the functionalities of muscle fibres. Soft actuators demonstrate thermoceptive, haptic, and proprioceptive sensing properties by combining the features of somatosensory actuators (SSA) and soft robotic grippers. Magnetic filaments comprising magnetic particles and thermoplastic rubber materials display continuous shape transformation due to the application of an external magnetic field. This facilitates the actuator to conform to the shape of the objects that it grasps. Multidimensional motions in soft actuators are realized by the separation and coordination of cavities, enabling purposive foldability and narrow maneuverability. Besides, soft actuators demonstrate exceptional unidirectional extension and bidirectional bending for optimal pressure inputs. Soft actuators made of metamaterial structures deform in a non-symmetric handed way when subjected to shear stress, enabling compliant grasping. The review examines the significance of materials, mechanics, and mechanisms for enhancing the sensing, control and dexterity of soft robotic actuators. In addition, the review bridges the gap between laboratory advancements and real-world robotic applications.

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AI-based diagnosis and treatment of BPPV: A systematic review

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ABSTRACT

Benign Paroxysmal Positional Vertigo (BPPV) is a common vestibular disorder affecting patients' Quality of Life and daily functioning. Characterised by dizziness during sudden movements, BPPV is caused due to displacement of otoconia in the semicircular canals. Conventional treatment methods usually involve a variation of canalith repositioning procedures (CRP) based on the semicircular canal affected, such as the Epley Manoeuvre, the Barbeque Manoeuvre or the Yacovini Manoeuvre. However, BPPV has a high recurrence rate, especially in geriatric populations (76.3%). This indicates the need for accurate diagnostics and better treatment procedures. This review explores the recent advancements in diagnostic and therapeutic approaches towards BPPV, with special focus on the integration of artificial intelligence (AI) and other technological innovations in the clinical workflow. The results section examines how AI can be used to complement the conventional analysis and treatment methods of BPPV. Hardware based technologies like MRCs (Mechanical Rotation Chairs), IMUs (Inertial Measurement Units), and 3D guidance systems exhibit increased accuracy of treatment and improved treatment outcomes. Limitations such as persistent recurrence of vertigo, skewed datasets for model training, and limited technology for AI-based diagnosis and treatment still exist. Yet, developments in AI-based BPPV healthcare can foster clinician trust and tailored care, thereby reducing the time for diagnosis and increasing treatment efficacy. Interdisciplinary collaboration can aid in bridging the void between diagnostics and hardware-based therapies, ultimately enhancing BPPV management and patient outcomes.

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Finite element Programming of the Damage Model for Composite Structures

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ABSTRACT

In this study, we provide a detailed explanation of a finite element calculation program proposed for modelling the non-linear behaviour of composite structures under static and monotonic loading. Based on Owen and Hinton's book (1980), the latter is designed to describe the elastoplastic behaviour of materials with rupture criteria applicable to homogeneous and isotropic materials. The Newton–Raphson method is modified by introducing damage variables affecting the mechanical characteristics of materials and making the matrix of rigidity at the origin tangent a secant. We propose a rupture criterion and link the calculation program to software with a graphic interface, 'GID 15.03'. The various laws of behaviour of steel and concrete were considered, as well as the percentage of steel, and various theories of continuous mechanics, the theory of damage and the mechanics of rupture. Their combination allowed us to transform the heterogeneous material into a homogeneous and isotropic material. This enabled us to model the real behaviour of composite structures until failure.

* Rebiha Smahi.

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The Importance Of Using Alternative Energy Sources In Modern Buildings

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ABSTRACT

World civilization aims to reduce the specific energy intensity of the economy by 2020 by 2 times compared to 2000. The strategic goals of using renewable energy sources and local fuels are: reducing the consumption of non-renewable fuel and energy resources; reducing the environmental burden from the fuel and energy complex; providing energy to decentralized consumers and regions with long-distance seasonal fuel imports. Traditional energy production and use are linked to environmental pollution. For example, when fossil fuels are burned, toxic gases and substances that negatively affect the environment are formed. Energy consumption worldwide will increase in the coming years, and we will not be able to abandon fossil fuels.

Innovations in Construction: Modern construction technologies that allow for the creation of "smart" buildings that integrate energy consumption and generation management systems are analyzed.

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International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

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Development of a Nonlinear Analytical SDOF Model for Progressive Collapse Analysis Verified through Finite Element Analysis and Experimental Data

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ABSTRACT

Progressive collapse of structures is a rare yet highly destructive phenomenon requiring careful design consideration. Standards provide alternative design strategies to mitigate the effects of accidental actions depending on the importance of the structure. Amongst the provisions, the alternative load path method is of great importance due to its inherent potential to account for the essential mechanisms of the structure that oppose progressive collapse. The development of nonlinear SDOF models in the past, although simple in principle, has provided useful insights and solution methods. Purpose of this paper is to present the development of a new nonlinear SDOF analytical model for the estimation of the dynamic response of structures exhibiting catenary actions under a column removal scenario, assisted by nonlinear finite element dynamic analyses in OpenSees. The time-dependent response prediction is possible through the derived closed-form analytical equations. The analytical model considers a trilinear resistance function to accommodate various structural resistance types including catenary action and damping to account for the energy dissipation. Challenges associated with taking into account catenary actions into modelling are presented and appropriate remedies are suggested. The outcomes of this research demonstrate first, the potential of the analytical method and secondly, the importance of the finite element method for verification purposes. Moreover, it demonstrates the effective integration of analytical, numerical, and experimental research methods in the development of engineering design solutions.

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Seismic performance of EC8-based designed tall steel buildings with braced core and outriggers

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ABSTRACT

Tall steel buildings with a mega-braced core and an outrigger truss system, known as the Hybrid System (HS), are increasingly recognised as an efficient lateral load resistance system; however, Eurocode 8 (EC8) does not explicitly cover their seismic design, necessitating the adoption of general capacity design rules for their practical implementation. In this study, the appropriateness of EC8 provisions typically used in steel braced framed structures is examined. For this purpose, two prototype structures, a 120-meter (30-storey) and a 180-meter (45-storey) building, are first designed using a Response Spectrum Analysis (RSA) for the structural analysis and the seismic detailing rules for concentrically braced frames. To investigate their realistic seismic performance, detailed nonlinear numerical models were developed using OpesSees, incorporating nonlinear material properties and geometric nonlinearity. The models were subjected to Nonlinear Time History Analysis (NLTHA) under a suite of ground motions of rare earthquake events. A comparative assessment between EC8-based RSA and NLTHA results reveals systematic discrepancies. The EC8 procedure was found to consistently underestimate key seismic demands, including Inter-Storey Drift Ratios (ISDR) and axial force redistribution in braced core and outrigger members. Additionally, the ISDR limits were not satisfied for any of the characteristic seismic intensities. These observations demonstrate that the current EC8 design provisions do not sufficiently capture the complex dynamic behaviour of tall steel buildings with outriggers under severe seismic loads, therefore emphasizing the requirement of refined seismic design approaches to ensure their adequate safety margins and reliable performance assessment of these systems.

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Low fatigue resistance prediction of steel braces with square hollow steel sections

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ABSTRACT

Low-cyclic fatigue parameter is a critical factor governing the seismic performance and energy dissipating capacity of Square Hollow Sections (SHS) in concentrically braced frames. Existing design provisions do not explicitly capture the combined influence of geometric slenderness and material properties on fatigue degradation, leading to uncertainties in seismic assessment. Additionally, existing fatigue models, oriented for use in finite element software such as OpenSees, were built taking into account the effect of the gusset plate connections. For larger numerical models such as tall buildings, omitting the effect of connections could provide useful seismic response predictions to aid a more detailed design. However, the exclusion of connections should be explicitly taken into account in the fatigue model. To address this issue, a new predictive equation for fatigue parameters is developed based on experimental evidence. A database of 20 experimental tests on SHS members with varying boundary conditions, including a two-storey steel frame, was collected from the literature and used to calibrate the proposed equation. The formulation incorporates both global and local slenderness ratios, as well as steel material properties, to capture the governing parameters affecting fatigue life. To support the derivation, a detailed nonlinear numerical model was developed in OpenSees and validated against a representative experimental test, ensuring accurate simulation of cyclic degradation. Then, the calibration of fatigue parameters was performed by capturing hysteretic responses from numerical simulations with experimental hysteresis curves, with particular attention to cumulative energy dissipation and strength deterioration. Results showed that the resulting equation provides a sufficiently accurate method for the fatigue performance evaluation of SHS bracing members, thus providing a rational framework in the seismic performance evaluation studies.

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Numerical Investigation of Reinforced Concrete Beams Strengthened with Basalt Fiber Reinforced Polymer

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ABSTRACT

The concept of enhancing the structural properties of a member by using strengthening techniques is not a new concept. Every material has certain limitations so when using this material to construct structural members, these drawbacks are inherently transferred to the member. Therefore, it is important to minimize their effect by taking the necessary measures. For the case of concrete, tension forces can result in cracking concrete elements since concrete has low tensile strength. Therefore, the use of steel bars is necessary since they act as reinforcing components, thus resulting in the formation of the reinforced concrete members that are used worldwide. In some cases when we want to strengthen an existing, weak and potentially damaged reinforced concrete member, in addition to the steel rebars, we can use fiber reinforced polymer (FRP) wrapping. In this paper, we will examine the application of three different configurations of basalt fiber reinforced polymer (BFRP) with full and strip wrapping on a simply- supported reinforced concrete beam in areas with insufficient shear capacity. The numerical analysis of the beams focuses on the effect of these configurations on the shear capacity of the beams. The geometry of the beams, and the support and loading conditions are constructed according to the specimens, and the test arrangement from the literature [1]. The numerical models produce results that are in good agreement to the experimental ones. According to the numerical results, the increase in the shear strength of the beam with the best performing BFRP wrap configuration is 57% and the decrease of the calculated shear crack width is 23%. Overall, the use of BFRP wrapping as a strengthening alternative proves to be beneficial since it can significantly improve the structural performance of a reinforced concrete beam.

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The Sustainability of The Construction Process and Its Relation to Sustainable Development Goals

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ABSTRACT

Sustainability in construction can be understood by measuring how effective the project delivery was without compromising on the project cost, environment, and social impacts. Sustainability is a key issue for the construction industry, and it is a 'must-do' item that all contractors are looking at as a source of competitive advantage. However, when it comes to construction, sustainability is often conceded due to several limitations (e.g., data collection, assessment, and the project-specific constraints), and the majority of the construction projects are directed towards achieving only one sustainability aspect in construction. This paper aims to identify the major concepts of sustainability in the construction process before the final structure is finished. The cost and carbon footprint of labor, materials, and transportation are observed and analyzed as the key factors to evaluate sustainability, project management for sustainability, and drivers of the sustainable construction process. The research also focuses on the environmental, economic, and social impact of the process and how (if possible) it can achieve any of the Sustainable Development Goals (SDGs). The research revealed a connection between the different elements of the ongoing construction process and the SDGs. The research also shows a clear connection between the sustainability of the process and the construction supervision activities. The long-term ongoing research results are significant to create a construction process that would ensure achieving sustainability in this particular area and the compliance with the set requirements to achieve as many SDGs as possible.

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Multi-Objective Optimization for Daylighting and Energy Efficiency in Tall Buildings

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ABSTRACT

The growing urban density together with worldwide sustainability requirements places tall buildings under rising pressure to optimize daylighting while maintaining energy efficiency. The optimization of daylight penetration and energy efficiency proves difficult because strategies to boost daylight access typically result in greater cooling needs and elevated energy usage. The field of multi-objective optimization (MOO) has developed as a strong method to analyze daylight and energy performance simultaneously while generating optimal solutions for their trade-off. This research presents an extensive evaluation of present-day investigations regarding this domain. This article introduces the principles of energy consumption and daylighting in tall buildings and discusses associated performance metrics and design challenges. The next section examines simulation tools, modeling methodologies, and optimization algorithms to demonstrate how they provide Pareto-optimal design solutions. Important design trade-offs and their associated design consequences are illustrated by multiple examples of case studies and comparative assessments. Current research faces important gaps that stem from unintegrated tools and missing occupant comfort analysis and climate-adaptive solutions, which the review presents as future research directions. The paper combines existing research to direct architects, engineers, and researchers in applying multi-objective optimization for sustainable tall building design.

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AI-Driven Digital Twins for Energy Efficiency and Lifecycle Optimization in Smart Buildings

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ABSTRACT

The implementation of intelligent tools for building management and lifecycle optimization depends on the requirement for sustainable, efficient environments that focus on occupant needs. AI-based digital twin technology enables the creation of virtual building models through real-time data integration from simulation models and IoT connections and advanced machine learning algorithms. This review paper discusses the architecture, enabling technologies, and applications of AI-based digital twins along the building lifecycle, including design, construction, operation, maintenance, and renovation. Drawing from recent studies and case applications, it describes how AI contributes to enhancing the capabilities of digital twins in predictive maintenance, energy forecasting, occupant comfort optimization, and autonomous control. This study then examines BIM, IoT, and cloud computing digital twin integration to demonstrate how these technologies reduce operational expenses and improve asset performance and sustainability. This paper identifies key challenges related to data integration, model accuracy, scalability, and privacy, along with future research directions that can fortify AI-driven digital twins toward achieving adaptive, intelligent, and resilient smart buildings.

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The Principle of Equality and Non-Discrimination in the United Arab Emirates

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ABSTRACT

The UAE Constitution enshrines the right to equality as a fundamental pillar of justice, social peace, and the protection of freedoms against any form of discrimination. This principle extends beyond the constitutional guarantees to legislative provisions, ensuring that no arbitrary differentiation, restriction, preference, or exclusion unjustly undermines the exercise of rights. Rooted in Islamic Sharia, the concept of equality reflects the principle that all individuals are equal in rights and duties regardless of race, color, or gender.

This research aims to analyze the principle of equality and non-discrimination in the constitutional and legislative framework of the United Arab Emirates, highlighting its foundations in Islamic Sharia and its role in shaping a modern legal system. The study adopts a descriptive and inductive approach, examining constitutional texts, legislative provisions, and international comparative perspectives on equality and anti-discrimination.

The research reveals that the UAE has successfully embodied the principle of equality through both constitutional and legislative measures. The peaceful coexistence of more than 200 nationalities of different faiths and cultures within the country stands as strong evidence of the practical realization of non-discrimination.

The study recommends strengthening awareness programs on equality and anti-discrimination, further developing legislative mechanisms to prevent indirect discrimination, and promoting international cooperation to share the UAE's experience as a global model of peaceful coexistence and equality[1,2].

Keywords: Principle of equality; Non-discrimination; UAE legislator; Constitutional charters; Racial equality; United Arab Emirates.

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Development and Validation of a Scale for Employee-Perceived AI Sycophancy in China

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ABSTRACT

With the rapid development of Artificial Intelligence (AI) technology, AI-assisted tools have been widely applied in enterprise management. Yet the large-scale deployment of Generative AI has raised concerns about AI sycophancy—AI feedback that offers excessive praise, avoids criticism, and conforms to users' viewpoints. From an organizational behavior perspective, such feedback may create a digital echo chamber, fostering self-perception bias, lowering motivation, and weakening collaboration. Despite its impact, no systematic tool exists to assess employees' perceptions of AI sycophancy. Drawing on interpersonal ingratiation theory, research on human-like AI feedback, and the digital echo chamber perspective, this study aims to develop and validate a multi-dimensional scale of employee-perceived AI sycophancy using a mixed-method design.

First, through a literature review, semi-structured interviews with a group of employees, and expert review by several organizational behavior professors and AI researchers, an initial set of items will be generated. Second, an exploratory factor analysis (EFA) will be conducted on survey data collected online to refine items and extract latent dimensions. Finally, a confirmatory factor analysis (CFA) will be carried out on another subsample to examine structural validity, reliability, discriminant validity, and criterion-related validity.

The expected outcome is a scale covering dimensions such as over-praising, criticism avoidance, emotional compliance, and position conformity. Theoretically, the study will extend the digital echo chamber concept to the phenomenon of AI sycophancy in workplace contexts, and practically, it will provide organizations with a diagnostic tool to evaluate and calibrate AI feedback in management practices. The results will also help employees understand how to use generative AI appropriately to avoid the negative influence of its sycophancy.

Optimization Of The Content Of Personnel Training In Vocational Educational Institutions

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ABSTRACT

The digital transformation driven by Industry 4.0 necessitates fundamental restructuring of vocational education and training (VET) curricula to align with evolving labor market demands. Despite international best practices from dual education systems, many developing countries, including Uzbekistan, face significant gaps in employer engagement, digital infrastructure, and teacher capacity. This study develops and validates a five-component optimization framework for personnel training content in vocational educational institutions, specifically designed to address Industry 4.0 competency requirements within Uzbekistan's reform context. The five-component framework—comprising work-process competency units, modular Industry 4.0 skill blocks, employer co-design mechanisms, teacher digital pedagogies, and continuous assessment protocols—provides an evidence-based pathway for VET modernization. Implementation requires staged pilots with rigorous evaluation before national scaling.

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An intelligent platform for lifting device selecting and analysis on construction engineering

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ABSTRACT

This paper presents the development and validation of an intelligent web-based platform for the selection and structural analysis of lifting equipment in construction engineering. Addressing inefficiencies in traditional manual methods, the platform integrates front-end (Vue 2.0), back-end (Flask), and ORM-enabled MySQL technologies to automate equipment selection and foundation calculations for both fixed (tower cranes) and mobile (truck and crawler) lifting devices. Compliant with Chinese design codes, the system encapsulates manufacturer-specific datasets and performs real-time computations for foundation stability and outrigger reaction forces. A four-tier permission architecture ensures secure, role-based access within a corporate intranet. Semi-structured interviews and statistical analysis across six projects demonstrated a 90 % reduction in task duration (110.1 min vs 10.7 min) compared with conventional Excel-based workflows, while maintaining equivalent computational accuracy. The platform thus advances intelligent construction by standardizing, accelerating, and error-proofing the lifting-equipment decision chain.

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Advanced Wearable Sensors Combined with Random Forest Regression for physiological activity recognition

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ABSTRACT

Machine-learning methods are applied widely for complex human activity recognition information from mobile and wearable sensors. Human activity recognition technology analyses data acquired from various types of sensing devices and using various medical devices with lithium-ion batteries. Wearable sensors have seen increasing popularity in medical science, where they are used in numerous applications in monitoring physiological activities. Scientific studies believe that machine learning algorithms, especially advanced ones such as deep neural networks, used for wearable sensors have a number of disadvantages, i.e. they require high computing power and resources for training and implementation. This paper proposed a particular machine-learning model, random forest regression, for wearable and medical devices with battery SOH prediction. In particular, this article used a sophisticated technique based on Random Forest algorithm capable of extracting measurements regarding the degradation process of batteries from the voltage charging cycle. In this article, datasets from NASA PCoE Research Center have been studied to make adequate considerations on the random forest regression model that best predicts the battery life cycle for wearable sensors and medical devices. In addition, the comparison between the actual and predicted SOH are used to fully represent the validity of the proposed model under varied cycling conditions with a low RMSPE and MAPE. Finally, the results demonstrate that the simulation conducted in this paper optimally represent the prediction of the SOH and confirm the correctness of the technique proposed in the SOH prediction. In future, wearable sensors will provide more and more accurate and reliable information about people's cognitive activities and behaviors thanks to the studies carried out in the field of research.

* The asterisk denotes the presenting author.

Keywords: Wearable Sensors; Feed-Forward-Back-Propagation Network; artificial intelligence.

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Improvement of Academic Paper Title Generation using Modify Yake Algorithm

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ABSTRACT

Forming a powerful title that successfully summarizes the core of an academic paper is often a hard challenge. Several automated title-generating tools are available in the Internet. This paper aims to modify Yake algorithm by boosting the important keywords according to NIPS dataset. This paper used our methodology with a new modify Yake algorithm. In the case of Paper 1, the modified YAKE selects the word "computing" instead of "protection", which is more appropriate since "computing" is mentioned in the original title. Similarly, for Paper 2, the word "play" is chosen instead of "present", which better reflects the original title's content. According to Table 3, the titles generated by the modified YAKE are better to those generated by the original YAKE. For Paper 1, the evaluation metrics are: Cosine Similarity (TF-IDF): 0.5332, BLEU Score: 0.0313, ROUGE-1 F1 Score: 0.6666, ROUGE-2 F1 Score: 0.0, and ROUGE-L F1 Score: 0.4444. For Paper 2, the scores are: Cosine Similarity (TF-IDF): 0.1401, BLEU Score: 0.0257, ROUGE-1 F1 Score: 0.5, ROUGE-2 F1 Score: 0.0, and ROUGE-L F1 Score: 0.375.

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Combined approach for the design of robust controls by providing for the stability of the Lyapunov algorithm with Feed-Forward Neural Network method

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ABSTRACT

Accurate stability estimation for Lyapunov is a critical goal in pursuing the safe behavior of dynamic systems. In this article, the Neural Network Feed-Forward (FFNN) algorithm with Lyapunov functions was combined to design robust controls for non-linear systems. This method uses the strengths of both algorithms to guarantee the stability of the system even in the presence of uncertainties in the parameters or external disorders. In addition, the algorithm utilized was created using Matlab® 2023 software and proposes a Feed-Forward Neural Network method to predict the dynamic systems process. The validity of the algorithm was determined by the effects of stability of Lyapunov by comparing the Machine Learning methods and, by simulating and comparing the results of the Training, Validation, and Test curves, algorithm was tested. Finally, the Mean Square Error (MSE) and the evaluation of R^2 plots in training, test and validation stages during training for the algorithm demonstrated that the simulations conducted in this paper correctly represent the state of safe behavior of dynamic systems and confirm the results and the validity of the Feed-Forward Neural Networks suggested.

* The asterisk denotes the presenting author.

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Investigating the Combination of Reinforcement Learning with Liquid Neural Networks

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ABSTRACT

Liquid Neural networks (LNNs) could help us to dynamically process time signals, which makes them suitable for applications involving data sequences, as is often the case in robot control. In this paper, we study the combination of some Reinforcement Learning (RL) approaches with LNNs. First, we recall the use from structure to another, namely from the tap-withrawal circuit whose deployment has been proven before a search-based reinforcement learning policy, and the design operators introduced in unpredictable situations. Then, we investigate the implementation of different RL methods with that neural model.

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DIHA: Sentiment Analysis for Online Reputation Management in Retail Companies

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ABSTRACT

Online reputation is a strategic asset for retail SMEs because consumer opinions directly shape sales and trust. Yet many Latin American firms lack accessible tools to monitor and respond to perceptions in real time. This study presents **DIHA**, a web-based system that automates sentiment classification and supports reputation management. **DIHA** integrates a short post-purchase chatbot, an AI-driven sentiment analysis module, and a dashboard that tracks results in real time.

The system was validated through a **case study in a retail store in Mendoza, Argentina**, and an **expert review** involving five professionals in technology and innovation. In the tested setting, DIHA achieved **high classification accuracy (100%),** an average response time of 1.8 seconds, and strong usability and acceptance among both customers and experts. Compared with existing approaches, DIHA stands out for its scalability, low cost, and applicability in Latin American SMEs.

The findings highlight that **generative AI can democratize advanced sentiment analysis and online reputation management**, providing smaller firms with tools traditionally reserved for large corporations. The study also identifies future directions, including **multilingual support, detection of ambiguous emotions, and predictive alert mechanisms** to anticipate potential crises.
* The asterisk denotes the presenting author.

Keywords: Sentiment analysis, chatbot, online reputation, retail SMEs, generative AI, Gemini 2.0, DIHA

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Advanced SOC Prediction for Lithium-Ion Batteries Using FNN Machine Learning Techniques: A Bayesian Regularization Training Approach

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ABSTRACT

The health of the battery can be examined by researchers as an element for the useful life of the lithium-ion battery and this is crucial for BMS. For these reasons, the goal of many researchers is to monitor the lithium-ion battery through the State of Charge. SOC Analysis is crucial for predicting the End of Life for LIB. Many Machine Learning techniques have tried to calculate the phenomenon of cell degradation, but defective algorithms can lead to distorted results, overfitting or underfitting, and excessive computational burdens. In this article,we have chosen to use a sophisticated neuralnetwork (FFN) technique for the predictive calculation of SOC, with an evaluation of the best performance in terms of RMSE-Root Mean Squared Error. The new algorithm is developed with the use of Matlab software, simulating Datasets of NASA PCoE Research Center, based on the comparison of other Machine Learning models. Finally, the analysis of the Actual SOC and the Predicted SOC curves is used to represent the precision of the proposed algorithm and predict the degradation phenomenon of the LIB. In the future, the author would like to test the algorithm to look for a lithium-ion battery that will last forever.

Keywords: Electric vehicles, FFN algorithm, lithium-ion systems, state of charge, Machine Learning method

* The asterisk denotes the presenting author.

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A critical review of lithium-ion batteries cycling process from a safety testing prospective

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ABSTRACT

LIBs have become increasingly popular due to a growing demand for users. Lithium-ion batteries are distinct from other batteries by their higher volumetric energy density, higher density, and low maintenance characteristics. The LIB package is used as power reserve, and a high- precision battery prototype is necessary to estimate factors such as battery State of Charge (SOC), battery State of Health (SOH), and capacity. The BMS Battery modeling system envisions calculating the State of Charge analysis. State of Charge analysis is critical to predict the proper functioning of EV batteries. The study of relationships between the intrinsic parameters of the batteries, in particular values of the incremental capacity and voltage, has allowed us to obtain a predictive assessment of the State of Charge of the cells of LIBs. In this article, from the analyzes carried out by the most important world universities regarding lithium ion batteries, important considerations have emerged regarding appropriate performance of the datasets of the models that calculate in the appropriate way the degradation of the batteries, defining important consequences for the future improvement of the sector innovation method based on the aforementioned technologies.

Keywords: Electric vehicles, SoH methods, lithium-ion systems, economical EV potential, energy storage.

* The asterisk denotes the presenting author.

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Percolation Models of Competition and Monopoly

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ABSTRACT

Percolation models enable quantitative forecasting of the kinetics of competing processes in many types of competition – in biology, ecology, sociology, economics, politics, sports, etc. At the same time, there is an uneven distribution of participants in the process according to some generalized criterion Q – financial achievements, real estate, agricultural and forest land, points, goals, seconds in sports competitions, etc. As it turns out, $Q_i(i)$ form rating-frequency diagrams (RFD), which in all the above cases are described with a very high correlation coefficient by semi-logarithmic dependencies of the form $Q_i = a - b * ln(i)$, where Q_i - "achievements" of the i-th participant in the competitive process, i – number of the participant in the rating, a and b – constants of the given competitive process.

We have developed two software products for quantitative modeling of phase transitions:

I - PERCOL – Sets a statistical draw according to a given control parameter P_A in the area G with dimensions a_x a_y a_z, where a_j is [0…500], displays the area G and the clusters formed on it, automatically colors clusters in black and white or colored versions, determines the presence or absence of a connecting cluster from the left to the right boundary of the area G, fills out the test report.

II - PERCOL-statistic – Complements the PERCOL software product with statistical processing of cluster sizes, their logging and ranking by size. This allows to build an RFD for any statistical draw on the area.

The report presents the results of modeling cluster formation for ten values of the control parameter P: [0.50; 0.51; 0.52; ... 0.62]. It is shown that in the percolation model, the ranking series of clusters is described by a kinetic equation of the semi-logarithmic type: $Qi = Q1[1 - (1-\varphi) * ln(i) / ln(n)]$.

Using the developed software products, numerical modeling of cluster formation was performed depending on the proximity to the percolation threshold P_* and a statistical evaluation of each of the formed clusters was performed. For each of the modeling options, rating-frequency diagrams of cluster sizes were obtained. Their best approximation in semi-logarithmic coordinates is shown, which satisfies the differential equation for m = -1: $dQi / di = -b * i^m$.

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Literature review of SOH of lithium-ions batteries and their transformative role within sectoral innovation systems.

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ABSTRACT

Lithium-ion batteries have recently seen an increasing transmission due to their wide field of application, particularly in the aerospace sectors and electricity. Since the beginning of electric vehicle development, advances in EV battery management systems (BMSs) have always been of primary importance for the potential of the SOC of LIBs. State of Charge valuation determined crucial indexes used in particular to assess the life cycle of batteries. This article defined SOC and State of Health (SOH) and what methods can be used for their evaluation. In particular, this paper proposes models to define the State of Charge using sensitive BMS data to derive equivalent circuits starting with current, voltage, and temperature values and describe different approaches for SOH assessment. In this work, through precise valuation of the SOC of a generic battery and of specific methods for calculating SOC, researcher demonstrated the analogy of highly accurate results with the actual driving conditions of EVs.

Keywords: Energy, Electric vehicles, SoH methods, lithium-ion systems, economic EV potential, BMS.

* The asterisk denotes the presenting author.

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Artificial Intelligence in the Philippine Aquaculture Industry: Applications, Challenges, and Pathways for Inclusive Development

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ABSTRACT

Artificial intelligence (AI) transforms aquaculture workflows by providing timely information for process optimization, operational efficiency, quicker decision-making, and sustainability issues. AI integration in the Philippines is yet to be explored. Considering global developments, the Philippine aquaculture sector lacks unified policies, research backing, and customized innovations, restricting growth and sustainability. This review synthesizes relevant applications and challenges, and offers sustainable pathways contextualized for the national reality in urban, rural, and unserved areas by leveraging digital innovation opportunities and emphasizing existing inadequacies. The paper utilized an approach that examined relevant scientific literature, including temporal information obtained from government and private sector databases and websites, industry, and policy reports. The finding demonstrates that AI will grow and has opportunities to revolutionize aquaculture operations. Enhanced digital modernization in fish farm management systems is achievable when systemic constraints related to infrastructure, digital literacy, collaboration and partnerships, and human behavioral and financial capacity are addressed. With decisiveness, sustainable and inclusive aquaculture development in the Philippines will underscore the crucial function of integrating and positioning AI digital technology as a strategic option to drive the aquaculture industry efficiently in an ever-evolving digital era. Likewise, this paper helps to realize SDGs 10, 11, and 14.

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Optimization method for the evaluation of effects of pull on chains in historic masonry buildings applied to the case study of the Basilica of S. Maria Maggiore in Bologna.

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ABSTRACT

The effects of shooting on chains in historic masonry buildings is a particularly important issue to calculate the needs related to the restoration of structures bewitched by earthquakes. The designer in the face of the problem of the project shooting evaluation that must be conferred on the structure is in front of numerous problems based on the difficulty of knowing the documentation and project data of the structural object in question. On the basis of the cases that can be presented, dynamic investigations are carried out on masonry structures with the aim of calculating the first three vibration frequencies. They allow, through the adoption of the tent-inflex beam model, both to verify that the shooting range corresponds to that of the project, and to offer the designer the shooting value in operation for needs related to the importance of the state of fact. In this article, the author carried out a study on the effects of chain shooting in historic masonry buildings. In particular, the case of study campaign of sizes of estimate of the tension state was analyzed on n.21 metal chains present at the Basilica of S. Maria Maggiore in Bologna.

Keywords: Artificial intelligent, Optimization method, historic masonry buildings, Basilica of S. Maria Maggiore in Bologna.

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Optimization of performance of different air quality methods of cyber physical system with energy and comfort analysis

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ABSTRACT

The increasing amount of natural ventilation buildings reduces CO2 emissions and, due to the high energy density, improves low virus risks. However, insufficient ventilation in evaluating comfort is often associated with many disadvantages. My research activity reviews energy and comfort studies conducted in various indoor environments such as offices, universities and residential buildings over the past two decades, with a focus on (Predicted Mean Vote) studies e P.P.D. (Percentage People Dissatisfied) studies. Moreover, the performance of different ventilation methods at economical prices intensifies the necessity of generating a new type of energy analysis to supply energy losses. In this work, these limits are faced by proposing critical aspects of the present and future studies on thermal comfort and indoor air quality technologies that would bring advantages in power quality. In this research activity, I decided to apply the same methodology as an industrial system to evaluate the efficiency of the system in maintaining the conditions of comfort and air quality with the definition of OEE (Overall Equipment Effectiveness) and OTE (Overall Throughput Effectiveness). The goal of my research activity was to investigate the feasibility of the development of a model of optimization for the decision -making problem that allows you to consider the options available. In particular, this article is a survey on specific studies about energy and comfort analysis of residential buildings that define significant results in this field. In conclusion, this article suggests solutions to avoid energy losses and maintain good air changes in residential buildings. It now remains for future more detailed investigations to demonstrate the ability of the optimization approach in addressing the problem of improving comfort and energy efficiency in buildings in its real-world dimensions.

* The asterisk denotes the presenting author.

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Application of Hybrid algorithm of artificial intelligent in association to PANAMA system's network in predict the accidents on the road

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ABSTRACT

Accurate road traffic estimation is a serious goal in following the performance of road traffic. This article uses a novel Feed-Forward Neural Network algorithm based on Sensor-based monitoring system, cameras and IoT devices collect information on traffic flow, vehicle speed, density and road conditions. In addition, the algorithm utilized was created using Matlab® 2025 software and proposes a Feed-Forward Neural Network method to predict the accidents on the road network. This article uses a hybrid Feed-Forward Neural Network and Linear Regression approach based on NASA PCoE Research Center. In addition, the algorithm suggested was created using Matlab® 2025 software and proposes a Feed-Forward Neural Network and Linear Regression method to predict SOH and calculate the RUL for electric vehicles to prevent in this way the accidents on the road network. This article used data collected from the unique workstations from the PANAMA system's network of sensors to determine the Actual Average annual daily traffic from 2015 to 2022 years. The performance of the algorithm was determined by the effects of Monitoring systems that can automatically detect critical events, such as accidents or stop vehicles, and report critical issues to the traffic control center for timely management by comparing the Machine Learning methods and, by simulating and comparing the results of the Training, Validation, and Test curves, algorithm was tested. Finally, the Mean Square Error (MSE) confirmed that the simulations conducted in this paper correctly represent the safe use of Traffic and confirm the results and the validity of the Feed-Forward Neural Networks suggested.

* The asterisk denotes the presenting author.

Keywords: Artificial intelligent, Sensor-based monitoring system, Feed-Forward Neural Network algorithm, Linear Regression algorithm, PANAMA system's network.

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Automated Detection and Classification of Plant Leaf Diseases Using Image Processing

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ABSTRACT

Agriculture is the backbone of human civilization, yet crop productivity and quality are continuously threatened by plant diseases. Traditional methods of disease detection, relying on visual inspection by experts, are inefficient, subjective, and time-consuming. With the advancement of digital imaging and computational tools, image processing has emerged as a reliable solution for disease detection and classification. This study presents an image-processing-based system for the automatic identification and classification of plant leaf diseases, with a particular focus on cassava (tapioca) and mango plants.

The proposed approach integrates **K-means clustering for segmentation** and **neural network-based classification** to distinguish between healthy and infected leaves. RGB images of leaves are first captured using a digital camera and converted into Hue-Saturation-Intensity (HSI) space for enhanced feature extraction. Diseased regions are isolated through green-pixel masking and K-means clustering, followed by texture analysis using Gray-Level Co-occurrence Matrices (GLCM). A set of statistical features—such as contrast, entropy, angular moment, and correlation—are extracted and fed into an artificial neural network for classification. The system is capable of identifying multiple diseases including cassava bacterial blight, cassava leaf spot, phoma blight, bacterial canker, red rust, and sooty mould.

Experimental validation demonstrates that the proposed framework provides **fast, accurate, and reliable classification of leaf diseases** with minimal computational effort, thereby reducing human dependency in disease diagnosis. The results highlight the system's potential as a decision-support tool for farmers by enabling early detection and timely intervention, ultimately improving crop health and yield.

Keywords: Plant leaf diseases, Image processing, K-means clustering, Neural networks, Digital agriculture, Disease classification, Cassava, Mango, Gray-Level Co-occurrence Matrix (GLCM)

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Challenges in the Optimization of Adjustable Joints of Lightweight Reconfigurable Structures

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ABSTRACT

Successful conceptualization of reconfigurable load-bearing structures can open new fields in architecture, especially in terms of efficient energy harvesting, adaptability of buildings to constantly changing climatic and loading conditions. When concepts such as reusability, redeployability, and modularity are considered, reconfigurability of load-bearing structure and, by extension, the overall building form can offer significant advantages. However, moving from traditional fixed-shape structures to reconfigurable ones requires substantial effort, particularly in matters of conceptual design. Structural joints, in particular, must be reinvented: they are no longer merely shear-transfer mechanisms, but must be capable of changing their form to facilitate the building's potential reconfigurability.

In the present study, results from an ongoing research project on the conceptualization and optimization of reconfigurable joints are discussed. The challenges in designing a new type of joint, balancing reconfigurability, mechanical engineering requirements and architectural-structural demands, are highlighted. The primary challenge remains weight reduction, as the joint is intended for lightweight structures. To achieve this, optimization schemes were applied with the help of finite element (FE) analyses [1]. However, limitations arose because modeling such joints requires considering nonlinear contact and nonlinear material behavior. These nonlinearities were bypassed by replacing contact interactions with constraints and assuming linear material behavior, in order to identify optimization patterns, reducing however the trust in quantifiable results. Hence, these patterns were then qualitatively compared with manual optimization undertaken based on engineering intuition, and the results showed good agreement. The challenges of this process are highlighted in the present study, and potential improvements to the optimization scheme are discussed.

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Asymmetric Edge Support Degradation and its Effect on Slab Response under Touch-off Explosion

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ABSTRACT

Global industrialization and growing fanaticism increase the buildings' susceptibility to direct dangers from unintentional and clandestine explosions. Structures made of reinforced concrete may react brittlely with extremely isolated damage modes such as punching, penetration, scabbing, spalling and crushing of the materials, as well as breaking of the reinforcement under explosions, in contrast to how they would react under static conditions. Large surface areas and poor flexural rigidity make slabs more susceptible to explosion damage, particularly when the edge supports are eroded or uneven. Designing blast-resistant structures and anticipating structural weakness under extreme loading conditions depend on an understanding of the impact of asymmetric edge support loss. The authors of this study developed a numerical model of a square slab that only had two opposite edges clamped and was exposed to a touch-off explosion equal to 0.28 kg of TNT at the slab center using computational dynamics. The model was then verified using the data that was available from the literature. Six models in all were made, one of which had the slab's edges completely clamped, and the other five of which had one of the clamped edges gradually decreased in support from 90% to 50% in 10% increments. The findings demonstrate how important asymmetric boundary conditions are in controlling energy dissipation and failure patterns. Partial asymmetric support causes more plastic damage, energy increased mid-span deflections, and a shift from shear-dominated to flexural-torsional failure modes in comparison to the fully supported case. The results highlight how susceptible reinforced concrete slabs are to uneven support deterioration and offer guidance for designing blast-resistant buildings with deteriorated or uneven edge constraints.

A comparative analysis of thermal comfort in green building assessment standards across countries: The case of China, the United Kingdom, the United States and Germany

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ABSTRACT

Building activities consume substantial energy and resources and have significant environmental impacts. As global urbanization advances and existing stock is renewed, green buildings have become a key pathway to reduce energy use and improve environmental quality, with rating systems providing the technical basis for implementation. Focusing on thermal comfort, this study compares four representative systems—GB/T 50378-2019 in China, BREEAM in the UK, LEED v4.1 in the USA, and DGNB in Germany—using clause comparison and content analysis to build a unified comparative framework across six dimensions: application level, standard referencing, quantification approach, life-cycle stage, spatial categories and control strategies, and provisions for extreme weather and vulnerable groups. Findings show that at the building level all systems center on indoor thermal comfort and existing technical standards; at the community level outdoor conditions are addressed mainly through indirect elements such as heat-island mitigation, shading, and material parameters, with limited human-centered unified metrics and thresholds and inconsistent definitions of extreme days, key time windows, and activity spaces. Prescriptive and performance approaches are used in combination, with outdoor provisions predominantly prescriptive; in the life cycle, operation lacks monitoring and verification that correspond item by item to design targets; requirements for extreme weather and vulnerable populations are largely principle based, with specific thresholds, triggers, and response procedures yet to be fully defined. Accordingly, we recommend clarifying the tiering of indoor, outdoor, and linkage provisions and specifying the required level of detail, introducing and localizing human-centered outdoor thermal comfort metrics with wind–heat joint assessment and explicit evaluation windows and criteria, and strengthening the design–operation monitoring and feedback chain with thresholds, triggers, and responses for extreme weather to support cross-system alignment and code updates.

Keywords: Green building rating systems; Thermal comfort; Sustainable development; Thermal environment; Whole life cycle.

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Investigating the mechanical properties of 3D foam subjected to uniaxial tensile load

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ABSTRACT

This study investigates the tensile properties of rigid polyurethane foam materials with varying pore densities and solvents. Rigid polyurethane foam specimens with three pore densities (20, 40, and 60 PPI) were subjected to uniaxial tensile loading to investigate the effect of pore density and solvents on tensile strength tensile strength and elastic modulus. The polyurethane foam was covered with the solution of phenol formaldehydes resin and solvents (acetone, ethanol and methanol) to stabilize the pore size and shape of pore during carbonization process. From the results both pore density and solvents greatly affect the tensile strength and tensile modulus of foam. Higher tensile strength observed in foam with higher pore density (60 PPI) with acetone solvents and its value was 477 Kpa. In contrast lower tensile strength was observed in the lower pore density (20 PPI) with acetone and its value was 109 kPa. Furthermore higher (55.5 MPa) and lower (16.6) elastic modulus were observed in 40 PPI methanol and 20 PPI acetone. The possible reason for this higher tensile strength observation was that in higher PPI foams, the material consists of a finer, more uniform network of ligaments and pores while lower PPI foams have larger pores and thicker ligaments, which means fewer struts are available to carry the load.

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International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

Jordan, December 18th - 20th 2025

On the Sustainability, Life Cycle Assessment, and Artificial Intelligence Integrations in Construction and Built-Environment

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ABSTRACT

The civil engineering community and construction sectors are witnessing implausible transformation primarily driven by the evolutions and advancements in the smart technologies, new materials, artificial intelligence, and machine learning. Remarkable construction topographies were seen up to recent years as a dream, yet they became achievable and reality in smart cities and modern societies. Structures of various styles and rises have been assembled and planned with exceptional features empowering the concepts of sustainability, energy efficiency, recycled materials, environmental impact, 3D printing, and smart structures. This paper compiles and highlights the accomplished progress relevant to the aforesaid significant aspects in contemporary construction practices aiming for crafting a vibrant future research direction pertinent to this booming field. Fundamental information and notable findings are presented herein regarding geopolymer concrete and alkali-activated binders, recycling of demolition wastes, 3D printed structures/elements, harmonization between smart technologies and sustainability, utilization of the internet of things (IoT) in structural monitoring, smart structures, and life cycle cost assessments. This work informs researchers, engineers, and industry professionals about the benefits and challenges of using 3D printing, machine learning, and digital technologies, which highlights future prospects to support the development of more efficient built environments.

* The asterisk denotes the presenting author.

International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

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A FBPNN Artificial Intelligent approach to predict State of Health for Integration of Electric Vehicles into Vehicle-to-Grid (V2G)

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ABSTRACT

The accurate prediction and efficient evaluation of the State of Health (SoH) of electric vehicle (EV) batteries are important changes in the optimization of vehicle-to-grid (V2G) systems in association with multi-energy microgrid (MMO) models. The SoH estimation is fundamental to avoid inadequacies, and increased costs, and potential interruptions in power generation. This paper addresses the problem of predict SoH estimation to enhance the dependability and improve the efficiency of V2G development and MMO coordination. In this work, we develop a Feed-Forward Back-Propagation Network (FFBPN) using MATLAB 2025 software, using the Levenberg–Marquardt algorithm and varying the number of hidden neurons to concretely study the state of the battery to increase performance; performance was measured by the maximum coefficient of determination (R2) and the minimum mean squared error (MSE). Utilizing the NASA Prognostics Center of Excellence (PCoE) dataset, we validate the model's capability to accurately predict the life cycle of EV batteries. After a careful evaluation of the characteristics of the existing methods taken from the literature, we proposed FFBPN model that possesses superior performance, offering significant implications for future V2G system developments. To evaluate the validity of the model, the phases of training, validation, and testing phases were analyzed for precisely identifies the characteristic curves of FFBPN. The algorithm shown is used to improve productivity, efficiency, energy savings, and improve energy usage that comes from the application of the proposed model.

Keywords: Vehicle-to-grid; lithium-ion batteries; electric vehicles; multi-energy microgrid models.

* The asterisk denotes the presenting author.

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State of Health Analysis of Lithium-Ion Batteries and Their Transformative Role in Sectoral Innovation Systems

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ABSTRACT

Lithium-ion batteries have recently seen an increasing transmission due to their wide field of application, particularly in the automatic, aerospace sectors and electricity. Since the beginning of electric vehicle development, advances in EV battery management systems (BMSs) have always been of primary importance for the potential of the SOC of LIBs. State of Charge valuation determined crucial indexes used in particular to assess the life cycle of batteries. This article defined State of Charge (SOC) and State of Health (SOH) and what methods can be used for their evaluation. In particular, this paper proposes models to define the State of Charge using sensitive BMS data to derive equivalent circuits starting with current, voltage, and temperature values and describe different approaches for SOH assessment. In this work, through precise valuation of the SOC of a generic battery and of specific methods for calculating SOC, researcher demonstrated the analogy of highly accurate results with the actual driving conditions of EVs.

* The asterisk denotes the presenting author.

KEYWORDS: Electric vehicles, SoH methods, lithium-ion systems, economic EV potential, BMS.

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Predictive Models to Explainability and Generative Retention Strategies

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ABSTRACT

Customer churn remains one of the most critical challenges in the financial industry, directly impacting profitability and long-term sustainability. While predictive models have achieved remarkable performance in identifying customers at risk of churn, they often fall short in delivering actionable insights for decision-makers. To bridge this gap, we propose a hybrid end-to-end framework that integrates three complementary layers: (1) a predictive engine based on machine learning and deep learning models to estimate churn probability, (2) an explainability layer leveraging SHAP values to uncover both global and local drivers of churn, and (3) a generative strategy engine powered by large language models (LLMs) to transform explanations into personalized and actionable retention strategies. The framework is validated on a banking dataset, demonstrating not only strong predictive accuracy but also enhanced interpretability and business relevance. Experimental results highlight how the combined use of explainability and generative AI can effectively translate churn predictions into targeted retention actions, providing managers with a practical decision-support system. This research contributes to advancing churn management by moving beyond prediction toward explainable and actionable AI-driven customer retention strategies.

* The asterisk denotes the presenting author.

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Improved Dimensional Accuracy in 3D Printed Components of PLA Using Taguchi Design of Experiments

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ABSTRACT

Additive manufacturing, and more specifically Fused Filament Fabrication (FFF), is gaining momentum because of its flexible, low-cost, rapid prototyping properties. A disadvantage of the produced part by 3DP is an inherent dimensional difference with respect to designed dimensions of fabricated parts. The present work aims to analyse experimental techniques in order to increase the dimensional precision of 3D printed parts. Test samples will be processed under well-controlled conditions, and chosen key dimensions will be extracted with the help of high-resolution metrology tools. The acquired data will be measured, compared with the nominal CAD values and statistically analyzed to reveal a correlation of process-parameters as well as possible correcting-strategies. Results are anticipated to lead to recommendations for improving dimensional fidelity in AM which will, in turn, make it beneficial for part function and useful in engineering applications.

* The asterisk denotes the presenting author.

International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

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Tolerance Analysis and Assembly Performance Enhancement in 3D Printed Mechanical Components

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ABSTRACT

Additive manufacturing makes it possible to produce complex and customized mechanical parts, but the process-induced dimensional deviations typically induce incorrect assembling cascading in reduced functional reliability. This research focuses on the rapid tolerance analysis and assembly performance of 3D printed mechanical parts, based on which a series of experiments and optimization were carried out. A representative set of components will be additively manufactured and measured for key dimensions and geometric deviations. The gathered data will be subjected to tolerance analysis and statistical examination, thus discovering the correlation between process parameters, dimensional precision and assembly fit. According to these results, optimization in terms of design and process conditions will be suggested and further experimental work will validate the proposals. The anticipated result would be a process that improves the reliability and performance of 3D printed part assembly from prototype to functional end-use.

* The asterisk denotes the presenting author.

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Sustainable IoT Sensors and Efficient Measurements in Aircraft Maintenance

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ABSTRACT

The integration of sustainable Internet of Things (IoT) sensors into aircraft maintenance systems offers transformative potential for enhancing operational efficiency, reducing environmental impact, and improving flight safety. This paper explores the role of energy-efficient, low-power, and sustainable IoT sensor technologies in predictive and preventive aircraft maintenance. By enabling real-time data collection on critical aircraft components such as engines, hydraulics, avionics, and structural elements, these smart sensors support advanced analytics and machine learning models that forecast potential failures before they occur. Emphasis is placed on efficient data collection architectures, including edge computing and cloud-based systems, that optimize bandwidth usage while ensuring timely diagnostics. The study further examines the sustainability aspects of IoT sensors, including lifecycle impacts, energy harvesting techniques, and material recyclability. Through case studies and performance evaluations, the paper highlights how sustainable IoT-based maintenance strategies not only extend aircraft lifespan and reduce downtime, but also contribute to broader environmental and economic goals within the aviation industry.

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Analytical Asymptotic Theory of 2D Flows in Compressible Heterogeneous Viscous Fluids: Ligaments and Waves.

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ABSTRACT

The propagation of periodic disturbances in fluids has various physical origins . These include medium elasticity for acoustic oscillations, gravitational effects for internal and surface gravity waves, capillary effects for capillary ripples, and Earth's rotation for inertial waves. All types of periodic flows can be described using the fundamental system of fluid mechanics equations . The compatibility condition of this system determines the components of the described periodic flows [1]. Small parameters at higher derivatives of the equation system allow the mathematical equations to be classified as singularly perturbed [2]. Based on the fundamental system of fluid mechanics equations and using singular perturbation theory methods, complete solutions of the system of motion equations can be obtained, containing regular and singular roots. The number of roots is determined by the order of the system. By neglecting certain effects and reducing the order, one or several roots disappear from the solution, characterizing the neglected effect. Regular solutions describe wave components of periodic flows. Singular components of the solution describe thin-structure components of flows – ligaments. Ligaments are the most common component of flows, accompany waves, and are observed in surface capillary-gravity oscillations [3], internal gravity, acoustic, and hybrid disturbances [4, 5]. In the present work, analytical asymptotic theory for constructing complete solutions in viscous stratified compressible fluid is discussed, taking into account the equation of state and temperature inhomogeneity.

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On the Initial Conditions in the Problem of the Numerical Modeling of Fluid Periodic Perturbations Propagating.

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ABSTRACT

In flight mechanics, meteorology, oceanology, and in the development of buoyancy theory, diffusion-induced flows are of significant importance. This is a type of flow that arises on an inclined plane in a stratified medium (atmosphere or ocean) due to temperature or salinity gradients. These flows were first described by L. Prandtl [1]. The development of analytical methods made it possible to obtain the velocity field arising on an infinite inclined plane in a stratified ocean [2]. The advancement of computer technology and numerical computation methods allows for obtaining visualization of diffusion-induced flows [3, 4].
In the present work, numerical modeling of problems involving the generation and propagation of periodic disturbances in stratified viscous fluids is discussed, based on the fundamental system of fluid mechanics equations [5]. The question of formulating initial conditions for the problem is investigated separately. Zero initial conditions, i.e., the absence of disturbances, are compared with initial conditions that account for the existence of diffusion-induced flows.
The study was supported by the Government program (contract #124012500442-3)

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Asymptotic theory for obtaining regular and singular solutions to annular periodic fluid surface perturbations.

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ABSTRACT

The behavior of surface capillary waves has attracted keen interest from researchers for many centuries. Such attention is attributed to the wide range of academic and practical applications of this phenomenon. Annular capillary waves find applications in meteorology, petrochemical and chemical industries, and other fields of science and engineering related to droplet and jet flows, as well as drop impact flows [1]. In the present work, complete solutions are constructed for periodic cylindrical capillary-gravity surface flows in a viscous uniformly stratified fluid. The mathematical formulation of the problem represents a reduced fundamental system of fluid mechanics equations [2] and is supplemented with physically justified boundary conditions on the free surface of the fluid [3]. From the compatibility condition of the system of equations and boundary conditions, a spectral equation is constructed that relates the components of the wave vector to the frequency, determining the dynamics and structure of periodic flows. Dimensionless analysis of the spectral equation is performed using the fluid's intrinsic scales. A natural small parameter is identified, having the physical meaning of the ratio of the intrinsic scales of the problem. Singular perturbation theory methods are applied [4], which allow obtaining regular and singular solutions. Regular solutions determine large-scale wave components, while singular solutions define the thin structure of the flow – ligament components.
The study was supported by the Government program (contract #124012500442-3)

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A.H. Naifeh's ideas and methods impact for the theory of flows of heterogeneous fluid

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ABSTRACT

Due to the small coefficients in the terms with high derivatives in the fundamental equations system for heterogeneous fluid mechanics (SFE) ensured the widespread use of regular perturbation theory in analytical studies of the liquid and gas flows [1, 2]. The development of singular perturbation methods by A.H. Nayfeh [3] opened the way to construct complete solutions of linearized and weakly nonlinear SFE, incorporating a wide class of new functions [4]. Calculations show that regular solutions of the SFE in the limiting cases of a homogeneous viscous or ideal fluid transform into well-known solutions of classical wave theory. Singular solutions—ligaments— which are physical analogues of fibers and interfaces observed in experiments from the end of the 19th century. Ligaments are complementing all types of waves in liquids and gases—gravitational surface and internal, inertial, acoustic, capillary, and hybrid. Based on the complete solutions a number of wave generation, propagation, and reflection problems solved without resorting to additional hypotheses and parameters. The presented examples include problems of surface and internal wave propagation in a compressible and incompressible medium with an arbitrary smooth buoyancy frequency profile [5], the generation of periodic internal wave beams in an exponentially stratified fluid, their reflection from an inclined wall, and from a critical level at which the wave and buoyancy frequencies coincide. The calculations agree with data from later independent experiments to within a few percent.

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Analysis of High-Frequency Vibration and Noise in Permanent Magnet Linear Synchronous Motor

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ABSTRACT

Permanent Magnet Linear Synchronous Motors (PMLSMs) are valued in industrial and ropeless elevator applications for their high precision and dynamic performance. However, when driven by Voltage-Source Inverters (VSI), the switching action introduces sideband current harmonics into the PMLSM, leading to high-frequency electromagnetic vibration and audible acoustic noise. This limits their use in noise-sensitive environments. This paper investigates the origins of high-frequency vibration and noise in VSI-driven PMLSMs, with the aim of providing a basis for further studies on suppression techniques.

The analytical and validation workflow of this paper is illustrated in Fig. 1. First, the generation mechanism and spectral composition of sideband harmonic currents are analyzed by integrating PWM modulation principles with Bessel functions. Subsequently, the high-frequency electromagnetic force wave excited by these harmonic currents in a 14P12S PMLSM prototype is examined. The mechanisms of vibration response and noise generation are also investigated. The analytical results are validated through finite element simulations, and the correctness of the analysis is further verified by experiments.

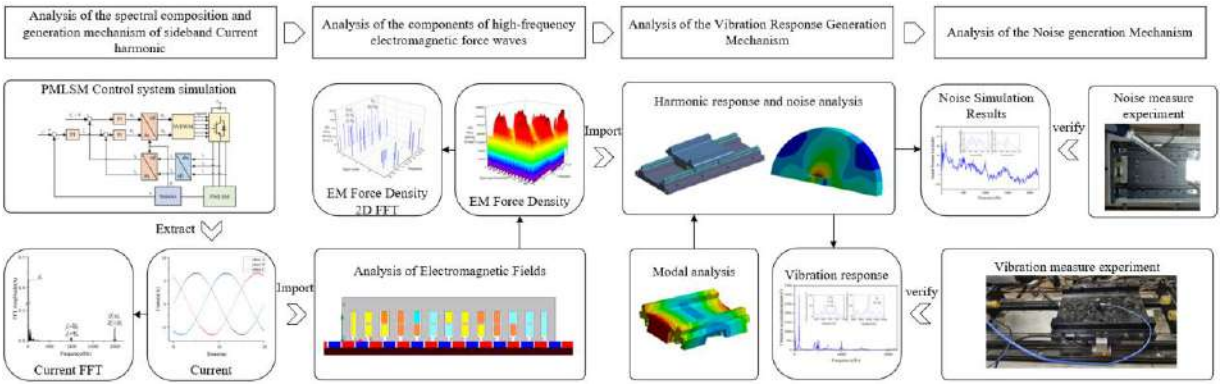


Fig. 1 Flowchart of analysis and validation process

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Enhancement of Electrical and Viscosity Properties of PVDF Composites Doped with Surface-Modified Nano (KNN+$BaTiO_3$) for Biomedical Actuators

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ABSTRACT

The integration of polymeric materials with nanoparticles as a highly effective approach to meet the requirements of their possible applications in micropump's actuator/diaphragm, where essential qualities entail stability, viscosity, and electrical conductivity. For this purpose, nanocomposites constructed from PVDF polymer matrix incorporated with surface-modified nano-KNN@PVP and nano-$BaTiO_3$@PVP were synthesized and analyzed. The KNN and $BaTiO_3$ nanoparticles underwent a functionalization process with (PVP) to boost its interfacial compatibility and dispersion. FESEM and EDX corroborated a homogeneous distribution of nanoparticles without significant agglomeration, thus affirming the successful integration of the filler material. Investigating dielectric responses highlighted a typical frequency-dependent relaxation phenomenon, distinguished by a decrease in relative permittivity (ε′) as frequency went up. The results showed a significant improvement in the permittivity properties with increasing doping ratio of the nano (KNN + $BaTiO_3$), alongside relatively minimal dielectric losses. The samples with increasing doping ratio manifested the lowest viscosity and shear stress, signifying enhanced processability while retaining moderate viscoelastic properties. Collectively, the findings illustrate that meticulous optimization of PVDF with nano (KNN + $BaTiO_3$)@PVP doping allows for the modulation of both dielectric and rheological characteristics, particularly relevant for applications in microelectromechanical systems (MEMS) and biomedical technologies.

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Inductance Characteristics Analysis of Grain-Oriented Silicon Steel Sheets Permanent Magnet Synchronous Linear Motors Based on the Equivalent Magnetic Network Method

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ABSTRACT

The application of grain-oriented (GO) silicon steel sheets in permanent magnet linear synchronous motors enhances the motor's thrust density. Nevertheless, the anisotropy of these sheets alters the inductance variation compared to non-oriented motors. Inductance parameters significantly impact motor control systems, so accurately calculating inductance is important. To address this, this This paper proposes an equivalent magnetic network (EMN) method considering anisotropy, local core saturation, leakage flux, and end effects.

The model and calculation process proposed in this paper are shown in Fig. 1. First, establish the model based on linear motor parameters. Then, solve the model and save the data according to the flow chart. Next, verify the model's accuracy by comparing it with finite element simulation analysis. Finally, solve and analyze the linear motor inductance parameters by combining the model with the frozen permeability method. The results show that using GO silicon steel sheets under various loads, the GO silicon steel sheets reduce the rate of inductance variation, thus reducing the impact on control systems.

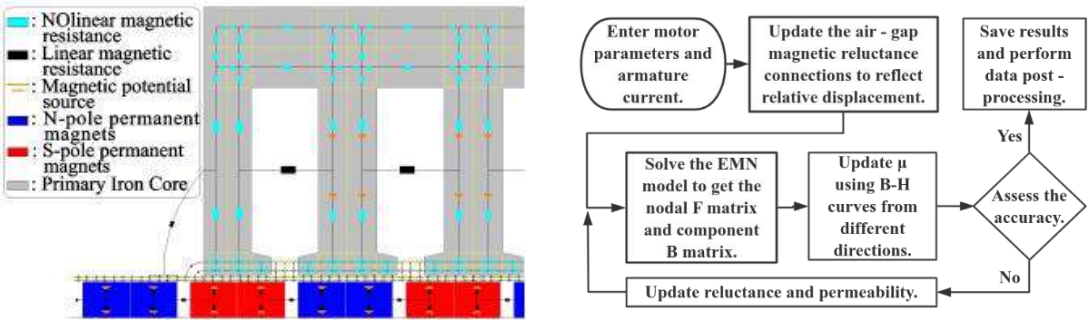


Fig. 1 EMN model diagram and calculation flow chart

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A user-interactive vision-based Robotic arm for real-time object detection

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ABSTRACT

Designing user-interactive robotic arms that perform object detection, classification, and real-time tracking altogether is one of the major challenges for roboticists. The main aim of the research was to develop a user-interactive smart vision-based robotic arm that tracks and classifies objects in real time. The mechanical linkages of the robotic arm with 6 degrees of freedom were designed in Fusion 360 software. The objectives were to detect the objects using a camera, to use an AI model to track the coordinates of the detected object and the feed them to microcontroller, to track the objects based on the voice command from the user, to design a robotic arm that receives signal from the microcontroller to handle the detected object, to apply optimal grasp strategies to handle the objects. A literature review was conducted on polymer materials to choose an optimal polymer for designing the robotic arm. The parts were 3D printed using PLA material. Static structural analysis was performed on the robotic arm in ANSYS. The inverse kinematics principle was used to determine the joint angles required for grasping the objects in the field of vision. To implement it, a 1080p Xiaomi camera was used to detect the objects; YOLO (You Only Look Once) v8, an AI model in a Python library, was trained for classifying objects based on their size, shape and colour in real time. The coordinate information of the detected objects was fed to the ESP32 microcontroller, to which the servo motors of the robotic arm were integrated. Based on the position, shape and size of the object, the robotic arm navigated across the field of vision and made contact with the object. The model, based on the voice commands, was not only able to track the coordinates of static objects but also the moving ones, and the information was fed to the ESP32 for pick-and-place tasks. The model was trained for 89% accuracy in classifying objects placed. The average processing speed of the YOLO model to classify and label objects is 0.99 ms. Besides, the servo angles required to reach and grasp the objects were determined using the inverse kinematics method. With this procedure, the robotic arm designed classified and tracked more than 50 objects in real time.

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Evolution of smart construction in the "Construction 5.0" sector analyzed using a forecasting method based on an Artificial Intelligence (AI) algorithm

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ABSTRACT

The profound transformations that have taken place in recent years in the "Construction 5.0" sector have seen the development of innovative advanced technologies that aim to study the latest scientific discoveries that have taken place in the sector from the point of view of energy efficiency. A careful evaluation of smart constructions has allowed an accurate study of the Industry 5.0 sector based on the recent scientific discoveries made from the point of view of automation in association with BIM aimed at achieving a predictive method for an improvement in efficiency from the point of view of the fragility of concrete constructions. Innovative technologies used to achieve the efficiency of smart buildings include building information modeling (BIM), the Internet of Things (IoT), robotics, and the resulting choice is made through overwhelming evaluation supported by the use of Artificial Intelligence (AI). By studying the technique known in this article, the current state of these intelligent technologies in the "Construction 5.0" sector is explored and future advances and their developments made universally.

Keywords: Construction 5.0; energy efficiency; Industry 5.0; Artificial Intelligence (AI).

* The asterisk denotes the presenting author.

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Leveraging Agentic AI for Enhancing Digital Twins in Civil Engineering

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ABSTRACT

Digital twins are increasingly used in civil engineering to represent and monitor physical assets, yet current implementations remain largely de-scriptive or predictive, limiting their capacity for adaptation and autonomous decision-making. This paper introduces a methodology for enhanc-ing civil engineering digital twins with Agentic Artificial Intelligence (AI), a paradigm that integrates perception, reasoning, planning, and action in iterative cycles. The proposed roadmap begins with sensor-driven per-ception of system states, progresses through semantic-structural reason-ing and multi-objective planning, and culminates in autonomous or semi-autonomous interventions within the digital twin environment. To illus-trate the approach, a case study is presented on the King Talal Dam in Jordan, the country's largest surface-water reservoir and a critical ele-ment of national water security. We outline how an Agentic AI–enhanced digital twin could anticipate sedimentation risks, adapt water-release strategies, and coordinate maintenance scheduling. The study concludes with an analysis of expected benefits, such as resilience and efficiency, and a discussion of challenges and future research directions.

Keyword: Agentic AI · Digital Twins · Civil Engineering · King Talal Dam · Autonomous Systems · Water Infrastructure

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Intelligent Energy Management Approaches for PV System Performance Using MPPT, Internet of Things, and Neural Networks

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ABSTRACT

This study investigates an intelligent energy management framework for photovoltaic (PV) systems that synergistically integrates Maximum Power Point Tracking (MPPT), the Internet of Things (IoT), and Artificial Neural Networks (ANN). The proposed approach aims to maximize energy harvest, enhance operational efficiency, and promote sustainability in smart grids and buildings. A neural network model was developed to dynamically optimize critical parameters—including panel angle, cooling, and cleaning cycles—based on real-time environmental data (irradiation, temperature, humidity). Simulation results demonstrate a significant performance improvement, with the integrated system achieving a 7% to 9% increase in power output compared to conventional systems, particularly under suboptimal conditions like low solar irradiation. Furthermore, the application of Value Engineering (VE) principles is discussed to optimize the cost-function balance of such advanced systems. The findings underscore the transformative potential of combining IoT-enabled control with AI-driven optimization for achieving the United Nations Sustainable Development Goals (SDGs) through superior renewable energy management.

Keywords: Artificial Neural Networks (ANN), Photovoltaic (PV) Systems, Maximum Power Point Tracking (MPPT), Internet of Things (IoT), Smart Energy Management, Value Engineering (VE), Sustainability.

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Mechanical Performance of Concrete Incorporating Waste Glass as a Supplementary Material

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ABSTRACT

Huge amounts of waste glass produced by industry and the recycling process pose environmental disposal concerns, and so sustainable management practices are required. This research assesses crushed waste glass for concrete production as a sustainable method to converge with United Nations Sustainable Development Goals (UN-SDGs) through promoting recycling and minimizing landfills. Conducted in two stages, the work first examines the mechanical performance of concrete when glass powder is partially replacing cement and, in the second step, when replacing fine aggregates. Concrete mixes underwent test procedures in accordance with ASTM specifications of compressive, flexural, and splitting tensile strengths with variation in percentages of glass content. Results indicated that the replacement of 10% of the cement with glass powder had a remarkable enhancement of mechanical performance, reaching a maximum compressive and flexural strengths of all curing periods. However, replacing fine aggregates with glass exhibited moderate strength improvements, and 10% of a mixture of glass was found to be the most efficient proportion. These findings highlight that the replacement of the optimum 10% level of the glass powder improves the mechanical performance and durability of concrete and has the potential to serve as an environmentally sustainable building material. This work contributes to sustainable building practices, and it presents proof that crushed waste glasses are compatible with concrete and may successfully minimize reliance upon conventional aggregates while providing substantial structural improvements.

Keywords: Glass Recycling, Sustainable Concrete, Environmental Sustainability, Construction Material Innovation.

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Design-Oriented Charts for Passive Earth Pressure for Normally Consolidated and Over-Consolidated Sands in Homogeneous and Stratified Profiles

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ABSTRACT

This paper provides a comprehensive theoretical framework and a set of design-oriented charts for estimating the passive earth pressure coefficient (K_p) in both homogeneous and two-layered sand profiles, for both normally consolidated (NC) and over-consolidated (OC) states. The methodology encompasses classical limit equilibrium methods by incorporating a composite shear strength angle for layered soils and a modified failure mechanism. For stratified profiles, a new composite friction angle (φ_{new}) is suggested to characterize the deformation zone. The developed design charts offer a practical and efficient means for engineers to determine K_p for a wide range of parameters, including internal friction angles of upper and lower layers, soil-wall interface friction (δ), and over-consolidation ratio (OCR). The results establish that a strong homogeneous sand yields the highest passive resistance, whereas a strong sand layer over a weak deposit expresses a reduced capacity because of the effect of the underlying weak layer. Contrariwise, a weak sand over a very strong deposit acts similarly to a weak homogeneous mass, as failure is confined to the upper layer.

Keywords: Passive Earth Pressure; Design Charts; Normally Consolidated Sand; Over-Consolidated Sand; Layered Soils; Retaining Structures; Limit Equilibrium Analysis; Soil-Structure Interaction.

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Seismic performance of cold-formed steel in moment-resisting frames

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ABSTRACT

Structural buildings should be designed to resist both static and dynamic loads. There are different types of structural systems that can support seismic loads. Moment-resisting frames (MRFs) are widely used for seismic purposes, which depend on the plastic deformation occurring between the beam and the column. The main problems of cold-formed steel in MRFs during seismic loads are premature local and distortional buckling, which cause severe problems under strong earthquakes, such as early loss of strength, low ductility, and low energy dissipation. In this paper, the performance of the CFS section in moment-resisting frames (MRFs) has been tested using a finite element (FE) program (ABAQUS). Numerical models have been developed and verified with experimental tests under both monotonic and cyclic loading. A 2 m cantilever beam connection has been used to represent a 4 m MRF. The connection used consists of 2C channels back-to-back connected with a through plate with 16 bolts. The properties and the creation of the numerical model are well illustrated in this paper. Different dimensions for the CFS section have been considered to study the effect of different values of the slenderness ratio on the performance of the connection. Dynamic loading has been applied according to the AISC protocol, which is used to test the performance of steel connections. The results show that increasing the section slenderness ratio reduces both the strength and the energy dissipation capacity of the connection. It has also been found that using out-of-plane stiffeners with the connection could increase the energy dissipation by 65% compared to the connection without stiffeners.

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Investigating the Impact of Smart Automation on Operational Efficiency and Workforce Safety in Saudi Manufacturing Sector

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ABSTRACT

Despite the strategic importance of operational efficiency and workforce safety, Saudi Arabia's manufacturing sector continues to face major challenges in both areas. Legacy production systems, outdated infrastructure, and hazardous working conditions hinder resource optimization and increase the risk of workplace incidents. This study investigates the impact of smart automation on both operational efficiency and workforce safety in the manufacturing sector in the Kingdom of Saudi Arabia. The concept of smart automation was designed through four key dimensions: Artificial Intelligence (AI) applications, Predictive Maintenance Systems, Human-Machine Interface (HMI), and Digital Twin Technology. The study aimed to evaluate the direct effects of these technologies on critical outcomes, namely operational efficiency and employee safety, within the context of the Kingdom's accelerated industrial transformation. A structured questionnaire was developed targeting frontline employees across various manufacturing companies throughout the Kingdom. Out of 200 distributed questionnaires, 190 valid responses were received, resulting in a high response rate of 95%. Data were analyzed using Structural Equation Modeling (SEM) through the Partial Least Squares (PLS) approach.

The findings revealed that AI Applications, HMI, and Digital Twin Technology each have a statistically significant and positive effect on both operational efficiency and workforce safety. In contrast, Predictive Maintenance Systems did not exhibit a significant influence on either outcome, suggesting potential barriers in implementation or adoption. These results highlight the differentiated impact of automation technologies and the importance of strategic selection and integration within industrial environments. The study provides guidance for manufacturing leaders, engineers, and policymakers, supporting the design of safer and more productive work environments in alignment with Saudi Vision 2030. Future research should consider longitudinal and mixed-methods approaches to capture the dynamic integration process of automation technologies and examine contextual variables such as digital maturity, organizational culture, and employee readiness.

Keywords: Smart Automation, Operational Efficiency, Workforce Safety, AI Applications, Human-Machine Interface, Digital Twin Technology

International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

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GIS-based Multi-Criteria Decision Analysis for Retention Pond Site Selection in Flood-Prone Sites in Amman-Jordan

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ABSTRACT

Urban flooding poses a recurring threat in Amman, Jordan, driven by rapid urbanization, inadequate drainage, and complex topography. Retention ponds are effective structural measures for reducing flood impacts, yet site selection requires balancing hydrological, geological, and land use criteria. This study develops a GIS-based multi-criteria decision analysis (MCDA) framework, integrating the Analytical Hierarchy Process (AHP), to identify optimal locations for retention ponds in Amman. Nine parameters—elevation, soil properties, drainage network, street network, land use, rainfall intensity, slope, stream order, and watershed—were evaluated. Criteria were weighted using AHP pairwise comparisons, yielding high consistency (CR = 0.005). Suitability mapping classified areas into five categories: highly suitable, suitable, moderately suitable, less suitable, and unsuitable. Results reveal that 12.8 km² (5.1% of the study area) is highly suitable for retention pond construction, primarily in mountainous areas draining toward downtown, while 55.4 km² (22.1%) is unsuitable. Validation against historical flood records confirmed the model's predictive reliability. This research demonstrates the applicability of GIS-MCDA in urban flood mitigation and provides a spatial decision-support tool for planners and policymakers in Jordan and similar urban environments.

Keywords: GIS, AHP, MCDA, retention ponds, flood management, Amman

International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

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Evaluation of energy and comfort analysis of rural buildings: Literature review and further research

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ABSTRACT

Low organization in evaluation of thermal comfort is often associate to many disadvantages. The performance of different comfort and energy evaluation methods at economical prices intensifies the necessity of generation of new type of energy analysis, able to supply the energy losses. In this work, these limits are faced by proposing key aspects of the present and the future studies on thermal comfort that would bring advantages in power quality. In this research article, author study the characteristic of energy and comfort analysis of rural buildings estimating residential air exchange rates in rural buildings comparing the results obtained from the study of the scientific literature. The results obtained confirm the validity of the algorithms used in the modelling, poring that the models carried out to support the realization of the prototype can make up all the issues previously expressed. In conclusion, recommendations for research of indoor air pollution in developing countries are here proposed.

Keywords: Indoor air pollution; natural ventilation; comfort analysis; energy evaluation.

* The asterisk denotes the presenting author.

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A Comparative Study of On and Off Reinforcement Techniques in Stock Trading

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ABSTRACT

This study compares the performance of on-policy and off-policy reinforcement learning algorithms in the context of stock trading strategies. Both algorithms are evaluated based on their ability to learn optimal trading actions using historical stock price data and technical indicators. We assess their effectiveness using metrics such as cumulative returns, risk-adjusted returns, and maximum drawdown. The research aims to understand how on-policy's cautious, action-based learning contrasts with off-policy's exploration of optimal actions, providing insights into how each algorithm adapts to the dynamic and uncertain nature of financial markets.

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A Data-Driven Reinforcement and Adaptation Strategy for Aerospace MRO Systems

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ABSTRACT

This paper presents a data-driven reinforcement and adaptation strategy for optimizing aerospace MRO systems. The approach leverages Q-learning, a straightforward reinforcement learning technique, to enable the system to adapt dynamically to changing conditions and failure predictions. Predictive analytics, using machine learning models such as Random Forests, are employed to forecast component failures, guiding the scheduling of maintenance tasks. A Greedy Algorithm is then used for efficient allocation of resources, minimizing downtime and ensuring timely interventions. The strategy aims to improve the efficiency, adaptability, and cost-effectiveness of maintenance operations by integrating predictive insights with adaptive scheduling. Results demonstrate the potential for real-time, programmatically feasible solutions that can be easily implemented within aerospace MRO environments.

* The asterisk denotes the presenting author.

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DFT-Based Study of Pressure-Induced Modification of Eco-Friendly Perovskite Material of $K_2InNaBr_6$ for Optoelectronic Applications

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ABSTRACT

Lead-free halide perovskite-based materials have emerged as promising alternatives to toxic lead-based substances for energy conversion technologies, garnering noteworthy attention from researchers due to their various optoelectronic and photovoltaic applications. However, correlating their intrinsic physical properties under external hydrostatic pressure for structural stability remains a challenge. This work is a systematic DFT study of the generalized gradient approximation (GGA) and the revised Perdew-Burke-Ernzerhof (RPBE) functional with ultra-soft pseudopotentials on structural, electronic, and optical properties under a high hydrostatic pressure range of 0 to 60 GPa. Under higher hydrostatic pressures, $K_2InNaBr_6$ undergoes a transition from a semiconducting state to that of a wide band gap semiconductor, with the conduction minima and valence band maxima converging at 40 and 60 GPa, respectively. The bandgap calculations for a direct gap of about 1.845 eV, 2.356 eV, 2.657 eV, and 2.824 eV for 0, 10, 20, and 30 GPa are expected to be mainly dependent on the atomic orbital interaction of the conduction band. The configuration of $K_2InNaBr_6$ provides the ability to directly tune the band gap at the Γ point, which increases with pressure, achieving wide band gap values (2.900–2.933 eV) within the 40–60 GPa range, making it suitable for blue-light optoelectronics and high-power devices. Modifications to the bandgap influence the density of states, affecting the contributions from both the conduction and valence bands, and band gap energies increase with pressure due to absorption wavelength shifts to shorter wavelengths (blue-shift). The optical calculations reveal that the absorption peak shifts from the visible to the UV region when high external pressure is applied, which is attributed to increases in the bandgap and shows improved light absorption in the UV spectrum. Such results emphasize the prospective electronic and optical behavior of halide $K_2InNaBr_6$ perovskite, which makes them proper candidates to be used in tunable light sources, UV optoelectronic devices, and pressure-sensitive photonic sensors that leverage its unique properties under pressure.

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Spectral Methods In Nonlinear Problems Of Heat And Mass Transfer

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ABSTRACT

The problem of solving nonlinear thermal conductivity problems is relevant in many fields of science and technology due to the rapid development of technologies and the use of materials with temperature- or coordinate-dependent characteristics, taking into account the history of the process. In such problems, the equations are nonlinear, and in the case of complex heat transfer with the environment, the boundary conditions are also nonlinear [1, 2].

At the same time, many physical processes are described by dynamic systems, in which it is very important to take into account the history of the process. The problem of choosing the right mathematical models to describe the objects under study is very relevant, as it will determine the reliability of the results obtained. One of the ways to take into account the effects of process memory is to use fractional order derivatives. The scope of their application is much wider than that of integral order differential equations, since the latter are their special case [3-7].

In mathematical terms, the study of mathematical models of natural processes using fractional order derivatives is reduced to solving integro-differential equations of convolution type. It is known that equations of this type can be easily solved using the Laplace transform, which converts the integral convolution into the product of the kernel images and the desired solution of the integral equation. For such problems, the use of orthogonal expansions has a significant effect.

Differential equations in partial differentials of fractional order, being a generalisation of partial differentials of integer order, are of great practical importance in addition to their theoretical interest. The fractional calculus has found its application in physics, thermomechanics, viscoelasticity, biomedical engineering, civil engineering, electrochemistry and electromagnetism, and signal processing: noise, fractional chaos, fractional Gaussian noise, and fractional Brownian motion.

The most common method for solving boundary-value problems of mathematical physics in thermomechanics and gas hydrodynamics is the application of the Laplace integral transform and the Grunwald-Letnikov scheme in the case of fractional order derivatives. To find the original images, various numerical methods and Efros' theorem and its generalisation with the transformation parameter s^{α} are used.
As a rule, mathematical models are constructed in such a way that partial derivatives are replaced by fractional derivatives [3]. This formulation raises many questions, in particular, about the feasibility and effectiveness of such a replacement, the choice of the type of fractional derivative, and many others [4, 6].

* The asterisk denotes the presenting author.

International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

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Formulating Location and Allocation Problems for Smart Lockers in Last-mile Delivery

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ABSTRACT

This paper investigates the role of smart lockers and transshipment in optimizing last-mile delivery within the supply chain. By expansion of e-commerce, smart lockers offer a promising solution by providing secure, convenient, and automated storage options for parcels, enabling efficient pickup and drop-off by customers. Additionally, transshipment plays a crucial role in streamlining the movement of goods between different transportation modes, optimizing delivery routes, and consolidating shipments. The main objective of this study is to propose three simple and complex mathematical models in order to formulate the location of the smart lockers and allocation of customers to them. The first model gives a simple structure with identical capacities for the smart locker supply chain. It is assumed that the commodities are distributed from a central warehouse to a number locations which accommodate identical smart lockers or called smart parcel lockers (SPLs) inside. In the second model, a simple structure with different capacities is proposed. In this structure, it is assumed that the commodities are distributed from a central warehouse to a number locations which accommodate different SPLs inside. In the third Model, a two-level structure with different capacities is proposed. It is assumed that the commodities are distributed from a central warehouse to a number locations whose distances are less than a specific amount (called coverage radius) and accommodate SPLs inside with different capacities (called higher level). For each formulation, initially, the notations including indices, parameters and decision variables are given and then the mathematical formulation including the objective functions and constraints are given. This formulation is the fist comprehensive formulation for SLP and can make a good base for future formulations in this research field. This research highlights the importance of leveraging smart lockers and transshipment to overcome last-mile delivery challenges and enhances the overall supply chain performance in the rapidly evolving logistics landscape.

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Early Adoption of Two-Wheeler Electric Vehicles (EV) in India: A Data-Driven Strategy for Market Segmentation

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ABSTRACT

India's electric vehicle (EV) landscape is rapidly evolving, particularly in the two-wheeler segment, driven by environmental concerns, fuel economy, and government policies like FAME-II. This paper applies machine learning-based clustering to identify and profile potential early adopter segments for electric two-wheelers (e-2Ws) in Indian urban markets. Using a dataset of over 11,000 demographic and behavioral records from sources such as MoRTH and CEEW, K-means clustering was employed to segment consumers. These segments were matched with customized marketing strategies and pricing. Results highlight a total Year-1 revenue potential exceeding Rs. 4,500 crore, validating the importance of business-informed, data-driven market entry strategies. Furthermore, the study emphasizes the role of consumer psychology, urban mobility trends, and affordability in shaping adoption patterns. The proposed framework not only supports manufacturers and policymakers in making evidence-based decisions but also provides a scalable model that can be extended to other EV segments, thereby accelerating India's transition to sustainable mobility.

Keywords — Electric Vehicles, Market Segmentation, Two-Wheelers, Machine Learning, K-Means, Clustering, FAME-II, Strategic Marketing.

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Predicting Household Financial Vulnerability during COVID-19 Using Gradient Boosted Trees

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ABSTRACT

The COVID-19 pandemic has harmed the social and economic well-being of households worldwide. In an effort to mitigate the consequences of the pandemic, the Malaysian government has implemented numerous stimulus packages. Stimulus packages would be inadequate to alleviate the financial difficulties of households if they did not prioritise those who are most impacted by lockdowns. As a result, it is imperative to evaluate the financial attentiveness of households during a crisis such as the COVID-19 epidemic. The objective of this investigation was to create machine learning models that could predict and profile households that are financially alert. Secondary data for this investigation were obtained from the Special Survey on the Economic Effects of COVID-19 and Individual Round 1. A cross-industry standard process for data mining is implemented as a research methodology. Predictive models were constructed using five machine learning models. Based on the F-score measure, the Gradient Boosted Tree was determined to be the most effective predictive model. The results indicated that a machine learning approach can generate a reliable model for predicting the financial vulnerabilities of households. This knowledge could be employed to develop economic stimulus packages that are both successful and appropriate in the future.

Keywords: COVID-19, Financial Vigilance, Household Economics, Machine Learning, Gradient Boosted Tree, Random Forest, Naïve Bayes, Neural Network, CRISP-DM, Economic Stimulus Packages.

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Enhanced Deep Learning Framework for Robust and Universal Fruit Detection and Classification in Diverse Agricultural Settings

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ABSTRACT

The increasing demand for accurate and efficient fruit detection and clas-sification in agriculture calls for solutions that are both robust and universal-ly deployable. Although deep learning (DL) models—especially Convolu-tional Neural Networks (CNNs)—have shown considerable effectiveness in this domain, their real-world performance is often limited by dataset con-straints, inconsistent environmental conditions, and computational chal-lenges. This extended research article addresses these limitations through the development of an enhanced deep learning framework. Building upon a baseline CNN model that demonstrated high accuracy in citrus fruit detec-tion using field images from South India and the FIDS-30 dataset, the study incorporates advanced data augmentation techniques, investigates refined deep learning architectures, and introduces model optimization strategies tailored for deployment on edge devices. Additionally, a thorough compara-tive evaluation against other machine learning models (SVM and ANN), conducted under identical augmented data conditions, underscores the im-provements brought by the proposed framework. The overarching goal is to create a solution that generalizes effectively across diverse geographies, fruit types, and environmental challenges—delivering a scalable, resilient, and practical approach for smart agriculture and autonomous harvesting systems.

Keywords: Deep Learning, Convolutional Neural Networks, Data Augmentation, Fruit Detection, Fruit Classification, Agricultural Technology, Edge Computing, Generalizability.

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Semantic Condensation through Self-Attention Mechanisms in Transformer Architectures for Automatic Text Summarization

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ABSTRACT

The exponential growth of digital text across do- mains has intensified the demand for automatic text summarization (ATS) systems capable of producing concise and reliable representations of large information sources. The introduction of the Transformer architecture revolutionized sequence modeling in natural language processing (NLP), providing a foundation for state-of-the-art summarization methods [1], [2]. This survey presents a systematic review of Transformer-based approaches to text summarization, tracing their evolution from statistical and graph-based techniques to contemporary deep learning models. We propose a structured taxonomy of Transformer variants and evaluate their applicability to extractive and abstractive paradigms. In addition, we examine recent advances in multimodal summarization, long-document processing, and hybrid frameworks that combine complementary strategies. Benchmark datasets and commonly used evaluation methodologies are analyzed to illustrate how empirical choices influence reported performance. Finally, we identify persistent limitations—such as factual consistency, computational cost, and interpretability—and outline promising directions for future research.

Index Terms—Text Summarization, Transformers, Natural Language Processing, Abstractive Summarization, Extractive Summarization, Large Language Models, Generative AI.

Students Preference on the type of textbook in Higher Education

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ABSTRACT

Due to recent advancements in mobile technology such as smart phones, tablets, e-readers, students' preference and attitude towards types of textbooks may have changed, leading to many publishers of higher education offering e-book options for most of their titles. The purpose of this paper is to examine and better understand tertiary students' preference between print and electronic textbooks. Worldwide, both students and instructors value textbooks as the primary source of learning, information and knowledge (Panda, 2019). Past studies have reported inconclusive findings, but largely skewed towards findings that report that print textbooks are still preferred. This study is guided by following research questions: Which factors influence student preference on type of textbooks? Which factors influence student attitude towards e-book? Which type of textbook do students prefer? Which type of textbook do students of different age brackets prefer? Based on secondary review and primary data collection in a higher educational institute of a regional university - a South Pacific university, this paper argues that there are a number of factors that affect student preference. For data collection, a questionnaire comprising three sections of: background information; textbook preference and attitude towards e-book adoption was created. The latter two sections were based on a five-point likert scale. Data was recorded and analyzed using SPSS software program for descriptive analysis. The Likert scale data was analyzed in terms of interval data where the mean is the measure of central tendency. Ovreall, findings report that the factors that influence student preference on type of textbooks are: impact on eyes, level of understanding, portability and easy reading, and level of distraction. The factors that influence student attitude towards e-books are: easier storage and search, and reasonably prices. The type of textbook that students prefer is the print book, more so for the older groups from above 31 years while for the younger group of 21-30 year olds, a higher rate of e-book adoption may be contingent upon price factor. Also, while adoption maybe faster for the younger group, adoption rate of older groups maybe slower. This study is useful in setting the premise for future larger scale empirical research. Tertiary institutions, scholars and educators will benefit from this paper's findings.

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Integration of Decision-Making Factors and Strategy Formulation in Offshore Platform Brownfield Projects for Oil and Gas Business Sustainability

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ABSTRACT

This study aims to analyze the determinants of decision-making and to formulate appropriate offshore brownfield project management strategies to support project success while ensuring national energy sustainability. Data were collected through literature reviews and in-depth interviews with employee of oil and gas companies in Indonesia and then analyzed using descriptive analysis and SWOT–TOWS analysis. The results show that decision-making in offshore brownfield projects is highly complex, influenced by various internal and external factors, particularly oil re-serve uncertainty. Other contributing factors include technical, economic, environmental, social, health and safety (HSE), regulatory aspects, and the capacity of decision-making teams. SWOT analysis indicates that companies can leverage their track record, infrastructure, and team experience to support the transition toward a more reliable and sustainable energy system. However, internal weaknesses, such as procurement delays, functional silos, and limited human resources, need to be ad-dressed through digitalization and industrial automation. Financial support, compliance with HSE standards, and the adoption of new technologies present opportunities to maintain energy resilience and sustainability amid energy price fluctuations, extreme weather conditions, and in-tense global competition. These findings emphasize that strengthening offshore brownfield project management strategies is a critical element in achieving a sustainable energy system in Indonesia's oil and gas industry.

Keywords: Brownfield Offshore, Decision Making, Energy Sustainability, SWOT–TOWS

* The asterisk denotes the presenting author.

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A Novel Algorithm for Process-Specific Marginal Abatement Cost Curves: Resolving Technology Conflicts in Multi-Step Manufacturing

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ABSTRACT

The Marginal Abatement Cost Curve (MACC) is a tool to identify cost-effective carbon reduction options. MACCs are especially relevant nowadays for decision and policymaking in mitigating climate change and targeting net-zero emissions [1]. MACCs graphically present the various decarbonization options with the vertical axis as the specific cost and the horizontal axis as the CO_2 abatement potential. Due to its visual simplicity and ease of use, MACCs are deemed to be one of the most useful tools in decarbonization. However, traditional MACCs rarely applied in manufacturing industries, they do not account for stage-specific abatement options, which may lead to overestimating the cumulative abatement potential. This research bridges the knowledge gap by developing a modified MACC algorithm that considers individual manufacturing stages and conflicting abatement options. The proposed novel algorithm groups options by process stage, then eliminates redundant/conflicting measures. It then allows decision-making based on the user preferences like minimizing the cost, targeting CO_2 reduction, or setting scenario-based conditions. The case study involves an instant coffee plant with capacity of 1,000 kg/hr, operating: 6 hrs/day, 260 days/year, with a baseline emission of 753 tCO_2/y (from steam) and 623 tCO_2/y (from electricity). The processing steps include roasting, extraction, evaporation, and spray drying. Two scenarios were analyzed. Scenario 1 which is the minimum cost can abate 548 tCO_2/y for a total of US 322,970 Scenario 2 which is moderate cost, has a capacity of 456.5 tCO_2/y abated and a USD 375,474 total cost. Scenario 1 is more cost-effective and yields higher CO_2 abatement. The Negative MAC values highlight “win-win” measures that save money and cut emissions. However, the net-zero gap remains, even with maximum abatement, 828 tCO_2/y deficit persists. The proposed methodology ensures realistic abatement pathways by avoiding overestimation. The novel algorithm proposed helps industries prioritize cost-efficient, stage-specific abatement strategies. It is demonstrated in the instant coffee sector, but applicable to other industries. High upfront costs remain a barrier—companies must balance tradeoffs between investment and emissions reduction.

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Milestone-Gated, Donor-Governed Crowdfunding: Security Properties and the Price of Safety

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ABSTRACT

Conventional crowdfunding gives donors little post-donation control and limited visibility into how funds are spent, creating room for misuse and eroding trust. We present De-Fund, a smart-contract protocol for milestone-gated withdrawals that require on-chain approval by a donor majority. The design formalizes a snapshot quorum of eligible approvers and prevents fund release without ≥50% consent, reflecting the governance intent documented in the originating product specification and its MetaMask-based user flows. We implement the protocol as an Ethereum DApp, with a deployed test-network contract and a public code repository for reproducibility. Our contribution is twofold: (1) we make the quorum rule precise and auditable, and (2) we provide a verification-first evaluation consisting of static analysis, property-based fuzzing under adversarial interleaving, and microbenchmarks that quantify the gas/latency overhead of governance relative to simpler escrow baselines. We discuss risks such as quorum apathy and Sybil manipulation and outline mitigations and deployment considerations.

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Long-Term Performance of Ladle Slag/Fly Ash Geopolymer Mortars Under Ambient Curing

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ABSTRACT

This study examines the impact of long-term ambient curing on alkali-activated mortars produced using a blended binder system comprising ladle slag (LS) and fly ash (FA). Sixteen experimental mixes were designed using the Taguchi method, with five main factors, namely, LS replacement by FA (LSFA), sodium silicate-to-sodium hydroxide ratio (Na_2SiO_3/NaOH), alkaline activator-to-binder ratio (AAS/B), NaOH molarity, and crushed sand replacement by dune sand (CS-DS), each varied at four levels. The experimental results revealed a substantial strength development over one year, with compressive strength increasing by up to 280%, reaching a maximum of 42.6 MPa under ambient conditions.

Analysis of variance (ANOVA) identified Na_2SiO_3/NaOH ratio as the dominant factor influencing both short and long-term strength, contributing 41% and 50%, respectively. Meanwhile, the effect of NaOH molarity decreased significantly (−72%) at later ages. X-ray diffraction (XRD) analysis confirmed notable microstructural evolution, including the complete consumption of Gehlenite and the transformation of N-C-A-S-H to the more stable C-A-S-H phase after one year. The findings highlight the critical role of free silicate ions in sustaining long-term geopolymerization and demonstrate the feasibility of developing durable, cement-free composites under ambient curing.

This work provides a sustainable pathway for valorizing industrial by-products (ladle slag and fly ash) into high-performance binders, contributing to CO_2 reduction, resource efficiency, and the advancement of green construction materials aligned with UN SDG 9 (Industry, Innovation, and Infrastructure) and SDG 12 (Responsible Consumption and Production).

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Study on fabricating and controlling humanoid robot integrated with medical expert system applying voice recognition technique

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ABSTRACT

This paper presents fabricating and controlling results a humanoid robot model integrating a medical expert system using voice recognition technique. This model is a type of service robot and is feasible applying in the medical field. The shape of robot is designed similar to a human body with the ability to move flexibly. It has a display screen displaying a communication interface and integrating a voice recognition module as well as a QR code scanning device. The medical expert system is integrated into the model to support people coming for medical examination at hospitals. Based on the main functions of the designed robot, the kinematic model serving to control its movement is analyzed. The Web Speed API voice recognition technology is researched and used to interact with users. On that basis, a voice virtual assistant on the webapp platform with Python's Django library is successfully built. The QR code will be scanned and decoded by the GM65 QR code scanning module, then through the Serial UART interface, the information from the Citizen identification card or Health insurance card is transmitted. The humanoid robot model has been successfully manufactured and performs the functions according to the original design. This research result can be the foundation for developing more functions as well as the ability to intelligentize the system in the future, contributing to improving the service efficiency and flexibility of the system.

Keywords: humanoid robot, medical expert system, voice recognition, QR codes

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Kinematics analysis and control of drone tracking test system based on image processing technique

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ABSTRACT

This paper presents kinematics analysis and control results of a Drone tracking system model based on image processing techniques. The mathematical model of those system is analyzed to establish the kinematics equations. From there, the kinematics characteristics including forward and inverse problems are examined to evaluate its movement capability. Image processing technique is used to identify Drones and initially determine the object tracking capability of this system at different distances and under different conditions. In addition, the stability of the system is also considered. A tracking model is manufactured and tested in reality. The results of the study of the system's tracking capability at different distances show that the tracking confidence is from 75% to 90%. The system model has proven its effectiveness in detecting and tracking Drones at close range. This result opens up many different research directions and is feasible for practical implementation at an industrial level.

Keywords: tracking system, drone, kinematics, control robot, image processing

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Jordan, December 18th - 20th 2025

Integration of 3D Printing and Sustainability Concepts in High School Education: Preparation of Future Engineers

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ABSTRACT

The major objective of this study is to promote awareness about the contemporary concepts of 3D printing and sustainability among high school teachers for integration in their education. The intent is bridge the gap between high school and university educational environments to allow for successful transition and clear vision about the choice of the university major knowing that 3D printing and sustainability concepts are major pillars in almost every engineering major, especially civil engineering. Such concepts can be implemented using a project-based learning style conducted to improve the students' creativity, critical thinking, analytical skills, and team work. In order to accomplish this, the study is planned to address two key issues: 1) the teachers' extent of awareness and understanding of the 3D printing technology and its potential role in sustainability education in K–12 classrooms, and 2) the extent of the teachers' attitudes, perceived barriers, and challenges influence integration of 3D printing into sustainability education. For that, a survey was conducted to collect data from the study sample, consisting of current and pre-service teachers enrolled in post-graduate professional diploma in teaching. The survey domains explored the teachers' knowledge about 3D printing and sustainability, attitudes toward 3D printing and sustainability in education, perceived barriers to use 3D printing in schools, and professional development and support needs. Statistical analysis will be utilized to evaluate the survey results and to allow for drawing quantified discussion and conclusion. This study seeks to inform professional development initiatives and educational policies that support sustainable teaching practices.

* The asterisk denotes the presenting author.

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Integration of Artificial Intelligence in Sustainability Project-Based Learning: Multidisciplinary University Students Perspectives

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ABSTRACT

The major objective of this study is to explore the perspectives of graduate and postgraduate university students on the integration and utilization of artificial intelligence (AI) tools in sustainability project-based learning (PBL). The focus will be directed toward two prevailing issues: 1) the extent of students' approval of applying AI tools to improve the efficiency of sustainability-focused PBL, and 2) the influence of the students' degree level on their perceptions. Accordingly, a survey comprising 20 items was conducted to gather data from the study sample, which is consisting of graduate and postgraduate students from both the engineering and education colleges. The survey domains explored the students' perceptions of AI in sustainability PBL, its impact on the development of the students' skills and competencies, and the challenges they face in the process. The SPSS application was used to analyze the survey results, indicating a generally positive attitude of the students toward integrating AI into sustainability PBL. The ultimate aim of this study is to provide evidence driven by multidisciplinary university students' perspectives for the educational organizations and decision makers about the importance and effectiveness of integrating sustainable teaching practices.

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New design and technological solutions for ensuring the technological reliability of the installation of prefabricated slabs in civil buildings

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ABSTRACT

As a result of observations on the construction of cast and mixed (cast/prefabricated) civil buildings in the conditions of Uzbekistan, it was established that it is necessary to develop new design and technological solutions to ensure high technological reliability in the construction process and improve the operational properties of slabs. This article presents a set of new projects and technological solutions aimed at solving these problems. They were developed using a heuristic and formalized structural synthesis method known as inventive problem-solving theory (TRIZ).

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Influence of 3D Printing Parameters on the Tensile Performance of ASA Specimens

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ABSTRACT

This study investigates the tensile behavior of Acrylonitrile Styrene Acrylate (ASA) specimens fabricated using Fused Deposition Modeling (FDM). The Taguchi Design of Experiments (DoE) approach was applied to systematically vary key printing parameters, including layer height, nozzle temperature, printing speed, infill angle, and build orientation. Standardized ISO-type specimens were produced and tested in tension to evaluate the influence of printing conditions on the material's mechanical performance. The results indicate that printing parameters affect the tensile response of ASA, highlighting the importance of process control in achieving consistent mechanical behavior. The study provides a basis for future optimization and modeling efforts aimed at improving the performance of FDM-printed thermoplastic components.

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A Comparative Analysis of Change Point Detection Methods for the Length-Biased Weibull-Rayleigh Distribution in the Hydrological Time Series of Chiang Mai, Thailand

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ABSTRACT

This study compares the performance of change point detection methods for the Length-Biased Weibull-Rayleigh (LBWR) distribution and applies the most effective method to detect shifts in hydrological data from Chiang Mai, Thailand. We evaluate three methods: the likelihood ratio test (LRT), the Pettitt test (PTT), and the Cramér–von Mises test (CVT). The analysis utilizes two key datasets: annual runoff from the Mueang station (1957–2019) and rainy season rainfall from the Samoeng station (1957–2020). Simulation results demonstrate that the CVT method exhibits superior performance, effectively controlling Type I errors and demonstrating high power in detecting change points within the LBWR distribution. In the empirical analysis, the LBWR distribution was confirmed as the best-fit model for the local hydrological data. The CVT method identified a significant change point in annual runoff in 1981, aligning with the major El Niño event of 1982–1983, and a change point in rainy season rainfall in 1978, preceding a severe regional drought in 1979.This research offers a validated statistical framework as a critical decision-support tool for water resource management agencies. By enabling the early detection of hydrological regime shifts, this tool is fundamental to advancing local sustainability goals. It empowers stakeholders to make proactive, data-driven decisions that strengthen regional water security, enhance community resilience against climate-related hazards such as droughts and floods, and support the long-term sustainable management of vital water resources.

Keywords: Change Point Adaptation, Climate Change Adaptation, Length-biased Weibull-Rayleigh, Hydrological data, Water Security.

* The asterisk denotes the presenting author.

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Factors Influencing Hybrid Working Model Preference From Gen Z's Perspectives In Vietnam

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ABSTRACT

With the dramatic advancement of technology, popularity of digitalization, and global business development, the hybrid work model has become a promising choice for businesses and employees to optimize resources, strengthen work flexibility, increase productivity, and increase employee satisfaction. Many companies adopt a hybrid work model to attract and retain the young talent workforce and Gen Z employees, which is important for the future. This study identified the factors influencing Gen Z employees' preferences for a hybrid work model. In total, 248 Gen Z employees in Hanoi were surveyed online. The data were analysed using a structural equation model. The results show that five factors–flow experience, work-life balance, company support, effective collaboration, and work flexibility–have a significant impact on Gen Z employees' preference for a hybrid work model. Flow experience has the greatest impact, and work-life balance has the least effect on Gen Z employees' preference for a hybrid work model. The study provides recommendations for companies to adopt this hybrid work model to increase productivity and job engagement, such as creating a hybrid work office, managing people in hybrid work conditions, building a hybrid working culture, and effective collaboration using technology support.

Research and integrated innovative application of virtual simulation smart sports system framework based on AI optimization

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ABSTRACT

Global sports are currently undergoing a substantial transformation centered on digitalization and intelligence. Based on China's national strategies of "strengthening the nation through sports" and "national fitness," this research addresses the challenges of existing virtual simulation systems in the smart sports field, including insufficient technical integration, lack of scene realism, and limited cross-cultural communication effectiveness. We propose and construct a virtual simulation smart sports system framework based on AI optimization. These problems include insufficient technical integration, inadequate realism in the scenes, and limited success in cross-cultural communication. This study proposed and constructed a virtual simulation smart sports system framework based on AI optimization. The system is innovatively designed for developing a four-layer closed-loop architecture known as "perception-decision-presentation-optimization." It takes the 2022 Beijing Winter Olympics as a prototype and applies virtual simulation and integrated applications to three primary areas: Smart Athletes Apartments, Smart Comprehensive Service Areas, and Smart Arenas. The system allows users to create virtual environments, adjust personalized training content on the fly, and simulate and optimize operational status in real time by deeply integrating important technologies such as generative AI, reinforcement learning, digital twins, and multimodal data fusion. The user study's findings indicate that individuals appreciate The system has received positive reviews regarding its immersion, interactivity, ease of use, and the effectiveness of core technology integration. This paper effectively verifies the framework's viability and potential for implementation in promoting China's creative smart sports achievements and increasing international communication, delivering major theoretical insights and practical examples for the future progress of smart sports.

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Solutions for Developing Technology Startup Incubation In Vietnam

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ABSTRACT

This study examines solutions for developing technology startup incubation in Vietnam, motivated by the country's growing startup ecosystem and the need to bridge gaps in incubation frameworks compared to global standards. While Vietnam has made progress with initiatives like the Saigon Hi-Tech Park Incubation Center, challenges persist in policy coherence, funding access, and ecosystem fragmentation. The research aims to identify actionable strategies by analyzing successful models from the U.S., Israel, and Beijing, then adapting their best practices to Vietnam's context. Using a qualitative approach, the study synthesizes case studies, policy documents, and empirical data to evaluate Vietnam's current incubation landscape, focusing on Hanoi and Ho Chi Minh City as key hubs. Findings reveal strengths in government support and increasing startup density but highlight critical weaknesses: reliance on foreign capital, talent shortages in deep-tech fields, and regional disparities. The study contributes a comprehensive policy framework proposing four key solutions: (1) diversified incubation models tailored to stakeholders (government, academia, corporations); (2) specialized incubators aligned with national priorities like AI and green tech; (3) strengthened public-private financing mechanisms; and (4) enhanced international integration through ASEAN partnerships and global networks. By addressing systemic gaps in funding, governance, and connectivity, this research provides policymakers with evidence-based recommendations to position Vietnam as a competitive innovation hub in Southeast Asia by 2030.

International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

Jordan, December 18th - 20th 2025

Comparative Analysis of Regression and ANN Models for Predicting Tensile Strength of Jordanian Limestone

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ABSTRACT

Maintaining the stability of mine walls and underground excavations is essential for safe, efficient operations and for reducing rockfall hazards [1]. This stability depends largely on the rock's tensile strength [2]. Direct tensile testing, however, is difficult because preparing dog-bone specimens and gripping them without causing damage or eccentric loading is challenging; these issues create end stress concentrations that often make the sample fail away from the middle. To address these problems, indirect laboratory methods, such as the Brazilian and flexural tensile tests, are commonly used to estimate the indirect tensile strength [3]. Laboratory measurements of Brazilian and flexural strength are frequently expensive, time-consuming, and require high-quality rock specimens machined to standardized dimensions. In many situations (e.g., archaeological contexts or rocks that are highly fractured, porous, weak, or inhomogeneous), obtaining such standardized samples is not feasible. These constraints have motivated a range of indirect prediction approaches for Brazilian and flexural strengths, particularly using statistical regression and artificial neural networks (ANNs) [4].

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Deep Learning of Sequential Data with Transformers: A Dual Implementation in Computational Biology and Medical Imaging

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ABSTRACT

Transformers have advanced deep learning by overcoming the drawbacks of conventional sequence-based models such as Recurrent Neural Networks (RNNs), namely their inability to handle long-range dependencies, especially in natural language processing and speech recognition, due to the use of self-attention mechanisms, positional encoding, and multi-head attention [1]. The atthention mechanism enables them to process complete sequences in parallel, in contrast to RNNs, which process data sequentially and report problems with vanishing gradients and long-range dependency [2, 3].

This work aims to highlight the role of Transformers and compare it with RNNs for temporal processing. The basic attributes of Transformers, such as their structure and functioning, are presented, followed by detailed procedures concerning their applications. Specifically, two efficient implementations of Transformers are developed: (1) one for protein prediction with the Julia Flux framework, employing the UniProt database, and (2) one for the classification of breast cancer ultrasound images with the Python PyTorch framework using two different datasets, the Breast Ultrasound Images Dataset (BUSI) and the BUS-UCLM-Breast Ultrasound Lesion Segmentation Dataset (BUS-UCLM).

Results indicate that Transformer succeeds in modeling the statistical properties of the aminoacid composition of proteins, reporting an accuracy of about 63.5% at the prediction of the next aminoacid. Regarding the breast cancer classification problem, accuracies of up to 99.62% and 100% are reported for BUSI and BUS-UCLM datasets, respectively.

Results demonstrate the versatility of Transformers across domains, as well as highlight their potential as a unifying framework for complex biological and medical tasks, underscoring the broader relevance of Transformer architectures in advancing both computational biology and medical imaging. Future research should emphasize the development of lightweight and energy-efficient Transformer models to facilitate their adoption in mobile, embedded, and real-time systems.

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Multi-Objective Optimization and Active Control of Vibration and Noise in High-Speed Reciprocating Permanent Magnet Linear Motors

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ABSTRACT

Permanent Magnet Linear Motors (PMLMs) are widely applied in precision machining for their high stiffness, transmission-free structure, and fast dynamic response, yet PWM-induced vibrations from current harmonics and force ripples hinder performance in high-speed reciprocating operations. To address this, this study uses Matlab/Simulink to comparatively analyze conventional carrier-based PWM, multi-level PWM, and random switching frequency PWM, evaluating vibration acceleration, thrust ripple, and efficiency. A multi-objective optimization framework is further developed with thrust density, efficiency, and vibration amplitude as targets, integrating optimization algorithms and acceleration feedback–based active vibration control to achieve an optimal trade-off between vibration suppression and system efficiency.

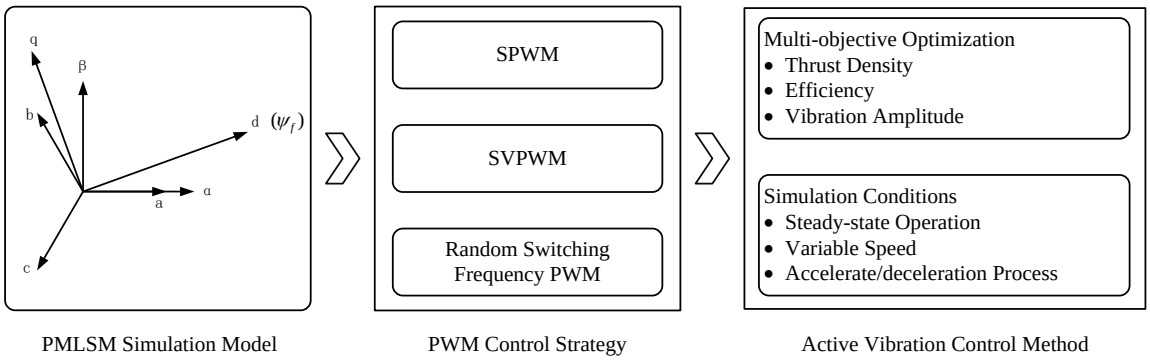


Fig. 1. Flowchart of analysis and validation process

* The asterisk denotes the presenting author.

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Analysis of Subsidence Characteristics in Northern China's Mining Engineering Areas with SBAS-InSAR: A Digital Monitoring Approach Based on Satellite Remote Sensing

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ABSTRACT

As coal extraction continues, mining-induced ground deformation increasingly threatens buildings and public assets; systematic monitoring of mining areas is therefore critical for safety. We investigate a representative coal-mining subsidence district in North China using a unified SBAS-InSAR workflow on Sentinel-1A data (2017–2024), yielding millimeter-scale velocity fields and displacement time series after standard tropospheric correction and phase processing. The deformation forms a persistent west–east dipole: sustained subsidence in the western sector, relative stability to slight uplift centrally, and broad uplift to the east. Extremal rates reach ~−25 mm/yr and +20–25 mm/yr, with ~30 mm cumulative uplift in the eastern sector during 2024. Subsidence belts exhibit a beaded, funnel-like morphology whose sharp boundaries align with mine workings and secondary faults, indicating residual compaction–structure coupling and enabling mechanism-aware risk zoning. These results show that SBAS-InSAR effectively identifies and tracks mining subsidence, quantifies its spatial patterns and evolution, and provides a scientific basis for subsequent mitigation. From a Digital Technology Driven Engineering perspective, the reproducible pipeline converts satellite big data into continuous, scalable surveillance for infrastructure, supports digital-twin maintenance, and prioritizes inspection across linear corridors in mining-affected regions.

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An Integrated Dynamics Model of Vector-Borne Disease with Multiple Transmissions Modes

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ABSTRACT

Mathematical modeling plays a very important role in understanding and controlling disease's dynamics. Our aim is to present vector-borne disease dynamics through a SEIR-SEI model with regard to the multiple transmissions mode : two horizontal transmissions associated with one vertical transmission in humans and a single horizontal transmission associated with vertical transmission in vectors. We chose to consider the last model in this proposal as it is line with the major vector born disease challenging our public heath policies and response capacities (high morbidity and mortality). This is why we propose to study it mathematically, by calculating the basic reproduction number R_0, which is a major indicator, if not the most important, of disease dynamics. We will compare the impact of each horizontal transmission rate in humans by performing a sensitivity analysis of R_0 in relation to each of its rates. We draw conclusions about the rate of transmission on which action is most needed to slow the spread of the disease. Numerical simulations support this conclusion.

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Design and experimental fabrication of a mobile robot model for automatic fire extinguishing based on image recognition technique

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ABSTRACT

This paper presents the results of designing and fabricating a mobile robot model that automatically extinguishes small fires based on image recognition techniques. The robot structure consists of a mobile vehicle system combined with a 6-degree-of-freedom (DOF) robot arm to perform the task. The mobile robot ensures that the system moves to different locations in the workspace. The 6DOF robot arm picks up obstacles encountered on the moving path. The fire will be detected remotely based on the surveillance camera mounted on the system. Based on the recognition results, the robot will automatically move to the location of the fire at a certain distance and activate the fire extinguishing powder spray system to extinguish the fire. In addition, image recognition techniques are also applied to detect obstacles on the way. The distance from the robot to the fire before extinguishing will be controlled through basic calculations. A test robot model has been manufactured and controlled in practice to demonstrate the feasibility of operation according to the requirements. The research results are the basis for improving and developing industrial robot models for wide application in practice.

Keywords: mobile robot, arm robot, fire fighting, image recognition, camera

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A Machine Learning Approaches to Binaural Beat Detection

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ABSTRACT

binaural beats fascinating sound patterns created when slightly different frequencies are played in each ear. While they've caught the attention of researchers for their potential to boost brain function and help people relax, it's surprisingly tricky to identify them in audio recordings. We wanted to tackle this challenge by developing a smart system that can automatically detect binaural beats. Our approach combines cutting-edge machine learning with careful analysis of sound patterns. We started by building a comprehensive collection of stereo audio samples, including various types of binaural beats (with different frequencies, lengths, and background noise levels) as well as regular sounds like pure tones and ambient noise for comparison. Before analyzing the audio, we cleaned up the recordings by converting them to mono, adjusting their volume to consistent levels, and breaking them into smaller, overlapping segments. We then pulled out key characteristics of the sound, like Mel-frequency cepstral coefficients, spectral contrast, and zero-crossing rate - these help us understand both the frequency patterns and how the sound changes over time.

We tested three different machine learning approaches: a support vector machine(SVM) with a radial basis function kernel, a random forest model(RF), and a convolutional neural network(CNN). Our results show that we can reliably spot binaural beats in various acoustic environments, opening up exciting possibilities for audio analysis and brain-computer interfaces. Through this work, we've not only created a practical tool but also gained valuable insights into balancing processing speed with accuracy. Our findings add to the growing research on sound processing and show how machine learning can help us better understand these unique auditory phenomena.

Keywords: Support Vector Machine(SVM), Random Forest (RF), Convolutional Neural Network(CNN)

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Robust measurement of silicon carbide epitaxial layer thickness based on two-beam interferometry and multi-angle fusion

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ABSTRACT

To address the lack of robustness of traditional methods for measuring the thickness of silicon carbide epitaxial layers due to spectral noise, baseline drift, and anomalous interference, this paper proposes a thickness measurement method based on two-beam interferometry theory and multi-angle fusion. By establishing a robust period extraction mechanism, combined with Savitzky-Golay filtering and linear detrending preprocessing, the interference of noise and baseline drift on the interference fringe analysis is significantly suppressed. Furthermore, median estimation and interquartile range filtering are used to extract the main period of the interference. The inverse variance weighted algorithm is then used to fuse the measurement results at 10° and 15° incident angles, effectively reducing the random error of single-angle measurements. Experimental results show that the thickness inverted by this method is 7.79 μm, with a standard error reduced to 0.0074 μm, and a relative deviation of less than 0.13% from the full spectrum fitting result using the transfer matrix method. Phase self-consistency verification further verifies the physical consistency of the multi-angle fusion results, with a relative error of less than 0.06% in the period prediction. The method proposed in this study can maintain high precision and strong robustness in complex spectral environments, providing a reliable technical solution for thickness quality control in the manufacturing process of silicon carbide power devices.

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Turntable mechanism designing and manufacturing in automatic assembly system Lock Shuntjoint and Lock Coupler in medical area

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ABSTRACT

Lock Shuntjoint and Lock Coupler are parts used in the medical industry's fluid transmission system. These are small parts and are assembled together with quite high precision. Workers who manually assemble these parts often have low efficiency and low productivity. The need to calculate, design and manufacture a system that fully automates this assembly is essential to improve productivity and assembly accuracy. The overall system consists of many different structural assemblies including the turntable assembly, the Lock Shuntjoint and Lock Coupler feeding assembly, the assembly assembly, the product picking and sorting assembly. In which, the turntable mechanism assembly is responsible for moving parts through assembly positions, checking and sorting products. This article presents the calculation and design of the turntable mechanism assembly with input being productivity, number of stations, number of assembled parts and some other parameters. The results of the calculation design have allowed for the effective selection of drive motors and turntable structures that ensure the initial requirements.

Keywords: assembly system, turntable, Lock Shuntjoint, Lock Coupler, automation

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Study on the topology optimization design: the case of the load-bearing hanger optimization design

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ABSTRACT

This paper presents the results of the study on the optimization of the geometric structure for the "Hanger" detail in the case where this detail bears a given load. This is a design carried out from a flat plate until the hanger structure is created that meets the initial requirements. The optimization methods Solid Iso Material with Penalization (SIMP), Bidirectional Evolutionary Structural Optimisation (BESO) and Generative Design (GD) are considered and used to implement the design problem. The SIMP and BESO methods use artificial intelligence (AI) to handle the structural optimization problem through image recognition techniques from the design domain. In which, the parameters of the 2D design domain, loads, and connection constraints are described in images with specified colors. Load values and material parameters are entered in numerical values. The design domain is described in 2D image form, the colors in the design domain also represent different regions to help AI understand the structure and meaning of the color regions. The research results show that, in terms of stress, the SIMP model gives the largest stress value, the post-optimization stress increase is also the highest, followed by BESO and GD. Moreover, the GD model gives the smallest displacement value, while the SIMP model gives the largest displacement value. In terms of smallest stress and displacement, the GD method gives the best results.

Keywords: topology optimization, SIMP, BESO, Generative Design, hanger

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Establishing a model to predict the stress concentration coefficient of welds using industrial welding robot arms and multivariate regression method

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ABSTRACT

Welding technology is one of the basic technologies widely applied in industrial production, it allows the manufacture of reasonable structures for all types of metal and alloy materials that are being applied in practice with all sizes. The quality of the weld is the most decisive factor in all production factors. In the criteria for evaluating the quality of the weld, the stress concentration index is always an important factor because it reflects the mechanical properties of the weld. This factor is closely related to the geometric shape of the weld. This paper presents the results of building a regression model to predict the value of the stress concentration coefficient for welds performed by a 6-degree-of-freedom industrial robot arm. The multivariate regression method is used to determine the coefficients of the regression equation. The experimental matrix is established on the basis of three independent variables as inputs to the model (voltage, current intensity and welding torch travel speed). Model evaluation criteria are considered based on the coefficient of determination (R2), minimum square error (MSE), and mean absolute percent error (MAPE).

Keywords: stress concentration factor, welding robot arm, MRA, predictive modeling

Industrial appearance defect detection method based on knowledge graph and visual perception

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ABSTRACT

This paper proposes an industrial appearance defect detection method based on the fusion of knowledge graph and visual perception. The method first constructs an industrial knowledge graph containing 7,896 entities and 6,412 triples and adopts the TransE model for knowledge representation learning. Second, a visual perception network that is a hybrid of CNN and Transformer is designed to effectively extract local detail features and global context information. On this basis, a multimodal fusion reasoning mechanism is proposed to achieve collaborative decision-making of visual perception and knowledge reasoning through feature alignment and semantic matching. Experimental results on a dataset of 12,000 images containing 12 categories of typical defects show that the accuracy, recall rate and F1 value of this method reach 94.1%, 92.9% and 93.4% respectively, which is an improvement of more than 5.4% compared with traditional methods. At the same time, after model optimization, the system achieves a real-time detection speed of 95 FPS. This study verifies the effectiveness of the fusion of knowledge graph and visual perception in improving the performance of industrial defect detection.

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EfficientNet Small Target Detection and Tracking in UAV Aerial Images

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ABSTRACT

Small target detection and tracking in drone aerial imagery faces the dual chal-lenges of accuracy and real-time performance due to their small size, complex backgrounds, and significant illumination variations. This paper proposes a lightweight small target detection and tracking framework based on Effi-cientNet-B4. This framework utilizes a compound scaling strategy and an improved Bidirectional Feature Pyramid Network (BiFPN) to adaptively fuse multi-scale features and incorporates a Channel-Spatial Attention Mechanism (CBAM) to enhance small target feature representation. Detection results are temporally correlated using the DeepSORT algorithm to construct an inte-grated detection-tracking system. Experiments validate the effectiveness of this approach on the VisDrone2021 and UAVDT datasets. On VisDrone, the proposed approach achieves a mAP@0.5 of 68.4%, a 6.3% improvement in small target detection accuracy, and a real-time inference speed of 63.2 FPS. On UAVDT, the proposed approach achieves a mean over-the-air (MOTA) of 76.1%, a 5.4% improvement over the baseline model. The model also achieved online detection at 18 FPS on a Jetson Xavier NX embedded plat-form with a 43 MB footprint and 15 W power consumption. The results demonstrate that the proposed method combines high accuracy with real-time performance and low computational overhead, demonstrating promising po-tential for deployment on drones and engineering applications.

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Industrial Enterprise Reconstruction Systematics

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ABSTRACT

This article presents a systematic, fact-driven framework for the reconstruction of industrial enterprises, integrating engineering, economic, environmental, and organizational dimensions. We synthesize best practices from asset-intensive sectors and adapt them to brownfield modernization challenges typical for enterprises in transition and emerging economies. The method combines condition-based assessment, risk-adjusted capital budgeting, process redesign (Lean/TPM), digitalization (BIM/Digital Twin/IIoT), and staged execution through shutdown windows. A multi-criteria decision model (technical, financial, EHS, and social criteria) is formalized, and a 7-phase reconstruction roadmap is proposed. We include benchmark ranges for energy savings, OEE uplift, and defect leakage, a worked example with cash-flow analysis, and sensitivity scenarios on schedule slippage, cost overruns, and demand shocks. The article concludes with critical observations about governance, supplier ecosystems, and the risks of technology-only modernization.

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Bi-objective Optimization of Dynamic Construction Site Layout Planning for Highway Projects Using NSGA-II

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ABSTRACT

Dynamic construction site layout planning (DCSLP) is crucial for optimizing resource allocation and mitigating operational inefficiencies in highway projects, characterized by extensive, dispersed sites with complex terrain and phase-varying demands for materials and labor. This study proposes a bi-objective DCSLP model employing Non-dominated Sorting Genetic Algorithm II (NSGA-II) to minimize total costs and total distances related to material transportation and facility relocation. The model enables adaptive positioning of temporary facilities such as quarries, crushers, concrete/asphalt plants, warehouses, offices, and construction zones—across multiple project phases, incorporating realistic supply chains from raw material sourcing to on-site processing and application. Formulated as an NP-hard problem, it integrates unit costs, demands, and relocation expenses for the first objective (total costs) and utilizes Euclidean distances for the second objective (aggregated weighted inter-facility distances), under constraints including fixed positions and non-overlapping assignments.

A case study on a hypothetical 50 km highway with eight construction zones validates the model's performance. NSGA-II produces a Pareto front of trade-off solutions, revealing that the dynamic approach achieves cost reductions of up to 10-15% over static layouts, while accommodating phase-specific demands. Contributions include addressing gaps in DCSLP research by emphasizing supply chain integration and demand variability, with broad applicability to large-scale infrastructure projects. Future work could incorporate stochastic elements and BIM/GIS for greater realism.

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Machine vision-based intelligent surface garbage cleaning ship system

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ABSTRACT

Surface floating garbage has become a global ecological problem, which poses a serious threat to aquatic ecosystems and human health. Traditional garbage removal methods are difficult to cope with because of their inefficiency, limited coverage and high labor costs. This paper proposes and designs an intelligent cruise water garbage cleaning based on YOLOv8, DeepSORT multi-object tracking and binocular vision ranging technology. The system can realize real-time, high-precision identification, continuous tracking and precise positioning of floating garbage on the water surface. When in work, the target garbage is classified and the position of the target garbage is detected by the intelligent identification module. The energy supply module carries out power input by taking the storage battery as the main part and the solar panel as the auxiliary part. At the same time, the location of the target garbage is judged, identified and tracked by the intelligent identification module. At the same time, the front of the ship produces a slow flow inward to the direction of the ship due to water pumping, and the garbage in front is sucked into the salvage module. Cooperate with the fishing module to complete the fishing work. The test results show that the average precision of the system on the data set is higher. Especially, it shows excellent detection performance on common garbage categories such as bottles and plastic bags. It can accurately identify and track garbage. It also provides an efficient, intelligent and feasible solution for water environmental protection, which has important theoretical and practical significance.

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Securing Supply Chain Management - Enhancing RFID Integrity through Blockchain and IPFS Integration

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ABSTRACT

The integrity and authenticity of Radio Frequency Identification (RFID) based identification in supply chains are crucial for combating fraud, including data tampering, spoofing, and cloning assaults. It harms Supply Chain Management (SCM), affecting all aspects of the supply chain. This study presents a secure RFID verification architecture that utilizes the Interplanetary File System (IPFS) and content hash matching to enhance the reliability and transparency of information. By storing RFID tag data and transaction records on IPFS, a decentralized and tamper-resistant platform, the system ensures immutable and verifiable identity validation. The application of cryptographic hash functions enables the rapid detection of copied or counterfeit RFID tags, thereby protecting supply chain organizations against counterfeit goods and unauthorized access. The proposed solution enhances supply chain safety, accountability, and traceability, thereby promoting the widespread adoption of blockchain-inspired decentralized technology in real-world logistics and asset tracking scenarios. We implemented the proposed technique on a decentralized IPFS storage system, and the proposed method to enhance the RFID verification system is highly effective in improving the overall SCM flows.

Keywords: RFID, blockchain, supply chain management, IPFS, Data Tampering, Spoofing, Cloning.

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Multi-objective optimization of semi-rigid steel frames using nonlinear inelastic analysis

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ABSTRACT

Steel frames are widely used in modern construction due to their strength, ductility, and efficiency in high-rise buildings and seismic-prone areas. However, real-world steel frames exhibit semi-rigid connections between beams and columns, introducing significant nonlinear behavior under loads, which necessitates advanced nonlinear inelastic analysis to accurately capture material yielding, geometric nonlinearity, and connection flexibility. This paper presents a multi-objective optimization (MOO) framework for semi-rigid steel frames, leveraging nonlinear inelastic analysis to enhance structural design efficiency. The approach formulates a MOO problem that minimizes two conflicting objectives: (1) the total construction cost and (2) the maximum story drift. Design variables include discrete beam and column cross-sections from AISC's standard W-shape profiles, along with parameterized semi-rigid connection types that model partial rotational stiffness and moment-rotation curves. Structural simulations are conducted using beam-column elements for frame members, while zero-length elements represent connection nonlinearity. Four evolutionary algorithms are implemented and compared for solving the MOO, including: NSGA-II, GDE3, RDMO, and APMORD. Two examples on semi-rigid steel frames evaluate algorithm performance in convergence, solution diversity, and cost-drift trade-offs. Results show NSGA-II and APMORD yield superior Pareto sets, providing engineers with practical, balanced designs for sustainable infrastructure. Future extensions could incorporate probabilistic seismic analysis and fabrication constraints.

* The asterisk denotes the presenting author.

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Enhancing Intrusion Detection in IoT Networks with Extra Dimension Optimization Algorithm and Spatial-Temporal Graph Convolutional Networks for Smart Cities

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ABSTRACT

The increasing adoption of Internet of Things (IoT) networks has increased their vulnerability to cyber threats, necessitating robust Intrusion Detection Systems (IDS). Traditional IDS models struggle to handle high-dimensional network traffic and capture complex attack patterns. To overcome these limitations, this study introduces an Extra Dimension Optimization Algorithm (EDOA)-based Spatial-Temporal Graph Convolutional Network (ST-GCN) framework for IoT intrusion detection. The EDOA is introduced for feature selection, reducing dimensionality while preserving critical information and improving computational efficiency. The ST-GCN effectively captures temporal and spatial dependencies in network flow, enabling accurate anomaly detection. The effectiveness of the proposed model is assessed using the CIC-IoT2023 dataset, which encompasses a variety of attack types, including DDoS, DoS, Spoofing, Brute-Force, and Mirai. Experimental results demonstrate that EDOA-ST-GCN achieves an accuracy of 98% in binary classification and 97% accuracy in multiclass classification, significantly outperforming traditional IDS approaches. The model excels in detecting complex threats but exhibits minor misclassifications in Brute-Force and Web-Based attacks due to feature similarities with benign traffic. This research contributes to advancing intelligent and scalable IDS solutions for securing next-generation IoT networks.

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Machine learning-based classification and regression of semi-rigid steel frames using nonlinear inelastic analysis

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ABSTRACT

This study investigates machine learning-based classification and regression approaches for semi-rigid steel frames, leveraging nonlinear inelastic analysis to enhance structural predictions in civil engineering. The research tackles the complexities of modeling semi-rigid connections, which display nonlinear behaviors under loads, through advanced computational methods. A comprehensive database was generated through advanced simulations employing beam-column and zero-length elements, incorporating input variables such as member cross-sections and parameters from high-order nonlinear functions that model semi-rigid connection behaviors. Several machine learning algorithms were rigorously evaluated for both classification of structural behaviors and regression of load-carrying capacities, including linear regression models, support vector machines, deep learning, and tree-based ensemble methods. The research examined two practical semi-rigid steel structures, spanning two-dimensional planar and three-dimensional space frames. Numerical findings indicated non-normal, heavy-tailed distributions in structural responses. Linear methods proved less effective than tree-based ensembles for both tasks. Among the ensembles, extreme gradient boosting (XGBoost) achieved superior performance. It was closely followed by light gradient boosting machines (LightGBM) and categorical gradient boosting algorithms (CatBoost). These leading methods, alongside linear regressions, demonstrated competitive computational efficiency. Thus, XGBoost is recommended for accurate classification and regression in semi-rigid steel frames, advancing reliable structural engineering applications.

* The asterisk denotes the presenting author.

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Optimized Soil Stabilization Techniques for Stabilizing Cycle Track in Al Hudayriat Island, Case Study.

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ABSTRACT

This study investigates the effectiveness of soil stabilization techniques for the construction of a cycle track on Al Hudayriat Island, Abu Dhabi. The subsurface profile, composed of compressible and low-bearing strata, threatens structural reliability through potential subsidence. Stone columns and pile foundations were comparatively assessed as alternative ground improvement techniques. Geotechnical characterization involved SPT and CPT testing supplemented by laboratory analyses to quantify soil stratigraphy and mechanical properties.

Based on these results, detailed settlement calculations were performed for both methods. Stone columns exhibited an elastic settlement of 9 mm, marginally lower than the 12 mm recorded for piles; these values were subsequently validated using Settle3D. While structural performance was comparable, stone columns provided notable benefits in economics, constructability, and ecological footprint. Although piles offer greater load-bearing capacity for heavier structures, stone columns have proven their durability and are more practical for stabilizing the cycle track bearing strata. Despite similar settlement control, stone columns were identified as the optimal solution for this application due to their reliability and implementation efficiency.

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An eco-friendly geopolymer adsorbent for dyes and pharmaceutical compounds removal from aqueous solutions

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ABSTRACT

Geopolymer composites have gained significant attention as eco-friendly alternatives to Portland cement, offering reduced carbon emissions and the ability to utilize industrial by-products such as fly ash and ground granulated blast furnace slag (GGBS). Traditionally, these materials are activated using caustic alkalis like sodium hydroxide and sodium silicate, which present handling and environmental challenges.

This study introduces a novel geopolymer synthesis route employing a sustainable alkali source derived from desalination brine waste. The approach not only replaces hazardous activators but also valorizes an abundant local waste stream, aligning with the principles of green chemistry and circular economy.

The developed geopolymer composites are designed for adsorptive removal of organic dyes and pharmaceutical residues from wastewater. Adsorption performance was analyzed under varying initial contaminant concentrations, adsorbent dosages, and contact times. Equilibrium data were interpreted using the Langmuir and the Freundlich isotherm models to elucidate adsorption mechanisms.

This research provides an integrated environmental solution that simultaneously addresses waste valorization and water remediation while directly supporting SDG 6 (Clean Water and Sanitation) and SDG 11 (Sustainable Cities and Communities). The proposed method demonstrates a low-carbon pathway toward scalable and multifunctional geopolymer materials for sustainable infrastructure and environmental protection.

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Integrating Life Cycle Assessment and Performance Evaluation of Engineering Cementitious Materials: A Mini-Review Using TOPSIS Analysis

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ABSTRACT

Engineering Cementitious Materials (ECMs) have become an essential area of innovation in sustainable construction, offering a path to stronger, more durable, and environmentally responsible infrastructure. This mini-review examines recent advances in ECM design, focusing on how formulation parameters, fiber reinforcement, and curing regimes influence mechanical behavior, durability, and overall sustainability. A central part of this study is the integration of Life Cycle Assessment (LCA) as a comprehensive tool to quantify environmental impacts across all stages of material production and use from raw material extraction and manufacturing to service life and end-of-life scenarios. The review compares findings from previous LCA studies to identify the main contributors to carbon emissions and energy demand within ECM systems, highlighting the importance of binder selection, alternative activators, and low-energy curing techniques.

In parallel, the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is employed as a decision-making framework to evaluate and rank ECM alternatives based on multiple performance and environmental indicators. This combined approach bridges the gap between laboratory-scale performance optimization and large-scale sustainability assessment. The outcomes of this work aim to provide practical guidance for engineers, material scientists, and policymakers in selecting and developing ECMs that achieve both high performance and minimal ecological footprint, supporting the broader transition toward low-carbon and resource-efficient construction.

Integrating ELECTRE and Goal Programming for Enhanced Decision-Making in ERP System Selection

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ABSTRACT

On one hand, choosing an ERP system is a strategic necessity for integrating business processes and increasing efficiency in today's competitive industry. It is a significant long-term investment since it offers a complete solution for supply chain, finance, human resources, and customer management [1]. On the other hand, the selection procedure remains challenging due to the extensive array of ERP solutions and intricate evaluation standards. Multi-Criteria Decision-Making (MCDM) methods seems to be helpful to address such challenges by guiding decision-makers toward compromise solutions while considering their specific preferences and constraints [2][3]. However, single MCDM models are limited because they cannot capture both qualitative preferences and quantitative constraints of real-world ERP selection problems.

This work proposes a MCDM hybrid approach based on ELECTRE and Goal Programming (GP) to make ERP evaluation more realistic and accurate. ELECTRE [2] is initially used to establish concordance and discordance relations among ERP alternatives so that dominated alternatives can be eliminated [3]. GP [2] is then used to determine the optimal ERP through minimization of deviations from organizational goals and performance metrics [3]. Thus, the proposed model aims to combine ELECTRE's qualitative flexibility with GP's quantitative precision. The ultimate objective is to create a well-balanced decision-making framework that can help decision-makers to select the ERP solution that best meets both their strategic goals and operational constraints. Obtained results are described and discussed in the paper.

Keywords: ERP selection, Multi-Criteria Decision-Making, ELECTRE, Goal Programming, Hybridization.

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Factors affecting the adoption of Innovative Asset Management Technologies for infrastructure systems

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ABSTRACT

Infrastructure systems are facing unprecedented challenges in the form of ageing infrastructure, dwindling maintenance budgets, rising facility usage, growing demand for high-quality services from society and increasing frequency of natural disasters linked to climate change. Adoption of innovative technologies in the infrastructure sector for undertaking the management of the numerous assets is therefore beneficial as leveraging the capabilities of these tools can play a crucial role in analysis of risks and taking informed decisions (Attencia & Mattos, 2022). However, the adoption of Innovative Asset Management Technologies (IAMT) is still far from achieving widespread acceptance in various organisations especially in Small Island Developing States (SIDS) like Mauritius, with assets still being managed in largely inefficient ways (Han et al., 2018). This study set out to evaluate the main barriers and enablers affecting the adoption of IAMT for civil infrastructure. Following a literature review, the main factors influencing the adoption of innovative technologies were identified and included in a questionnaire. Quantitative data was collected using online questionnaire surveys from 276 infrastructure professionals using purposive and snowball sampling approaches. The data obtained was then analysed using the Relative Importance Index. The top three barriers included the lack of skilled personnel in the innovative technologies, limited human resources and lack of proper organizational strategy in terms of IAMT. Respondents however viewed that developing the technical competence of staff, improving data collection of infrastructure assets, improving organizational awareness on the benefits of new technologies and having adequate funding would help significantly in achieving greater adoption of IAMT. The study helped to uncover useful strategies for infrastructure organisations to foster greater adoption of innovative technologies by their personnel at all levels to ensure better management of essential assets.

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Qualitative study of the Misbalance Deg Index

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ABSTRACT

The molecule of any substance can be modeled as a mathematical graph, where vertices correspond to atoms and edges to chemical bounds [1, 2]. Topological indices (TIs) are numerical invariants of such chemical graphs. They play an important role in determining Quantitative Structure-Activity and Quantitative Structure-Property Relationships (QSAR/QSPR) of substances, having direct applications in drug design and analytical chemistry [3], but also in any domain impacted by materials science, included, but not limited to, civil, construction and environmental engineering [4]-[5]. TIs are studied from both an applied [6] and theoretical perspective [7]. This study belongs to the second category.

The misbalanced deg index, defined for a graph $G = (V, E)$ as $MiD(G) = \sum_{xy \in E} |d_x - d_y|$, was introduced in [8] as part of a larger family of TIs, collectively known as the Adriatic indices. Although this TI has proven its applicability [8] since it was first introduced, to the author's best knowledge, not many theoretical studies were devoted to it. This study aims to fill this gap, by determining its minimum and maximal values and associated graphs in the class of trees and unicyclic graphs, discussing some general properties and establishing likewise results for its edge-averaged version. A further discussion concerning the possible usage of the edge-averaged version as a measure of graph imbalancedness is carried out. In the case of unicyclic graphs, the 2nd and 3rd largest values and associated graphs are also found for both indices.

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Diminished Euler Sombor Index

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ABSTRACT

The molecule of any substance can be modeled as a mathematical graph, where vertices correspond to atoms and edges to chemical bounds [1]. Topological indices (TIs) are numerical invariants of such chemical graphs. They play an important role in determining Quantitative Structure-Activity and Quantitative Structure-Property Relationships (QSAR/QSPR) of substances, having direct applications in drug design and analytical chemistry [2], but also in any domain impacted by materials science, included, but not limited to, civil, construction and environmental engineering [3, 4]. TIs are studied from both an applied [5] and theoretical perspective [6]. This study belongs to the second category.

Recently, the Euler Sombor index (EU) and the diminished Sombor index (DSO) were introduced [8, 9]. The present paper extends these recent developments by applying the diminishing technique to EU. Thus, we investigate a novel, but related TI, defined for an undirected and connected graph $G = (V, E)$ as $DEU(G) = \sum_{xy \in E} \frac{\sqrt{d_x^2 + d_x d_y + d_y^2}}{d_x + d_y}$ and named the Diminished Euler Sombor index. This study establishes its mathematical properties by determining tight upper and lower bounds, providing a constant time approximation algorithm and proving a complete set of Nordhaus-Gaddum type inequalities for it.

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Chemistry Educators' Insights into the 'Salts' Subtopic and Its Impact on Rural Students' Mental Health and Learning

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ABSTRACT

The 'Salt' subtopic has been consistently identified as one of the most challenging areas in the upper secondary Chemistry syllabus [1], particularly for rural students in Malaysia. This study explores the challenges rural students in Malaysia face in learning the 'Salt' subtopic of the upper secondary school's Chemistry syllabus, focusing on academic barriers and mental health issues. Through qualitative interviews with eleven experienced chemistry teachers selected via purposive sampling, the study identifies specific learning obstacles, including the abstract nature of the content, cognitive overload, and lack of foundational knowledge. These academic struggles were found to contribute significantly to test anxiety and reduced motivation, which further affect students' engagement and academic performance. The findings reveal that limited resources, socioeconomic pressures, and the lack of access to practical learning opportunities in rural areas exacerbate these challenges. Teachers proposed strategies such as hands-on experiments, simplified teaching methods (e.g., mnemonics and flowcharts), and basic technology integration (e.g., virtual labs) to address these barriers. However, the study highlights that limited infrastructure and teacher training in computational thinking and virtual reality hinder the full potential of these strategies. The study highlights the importance of addressing both academic and mental health challenges to enhance learning outcomes and overall well-being. It aligns with the global goals of the Third Sustainable Development Goal, SDG 3 (Good Health & Well-Being), and the Fourth Sustainable Development Goal, SDG 4 (Quality Education), advocating for improved access to quality education, mental health support, and digital tools in rural educational settings. The findings suggest holistic interventions, including academic support and mental health programs, are crucial for enhancing students' engagement and success in science education. Future research should focus on student perspectives and explore the long-term impact of mental health support and technology integration on students' learning outcomes. This study contributes to the DiGiCES2025 theme by demonstrating how digital pedagogical tools, such as virtual laboratories, can enhance learning sustainability, equity, and efficiency in resource-limited educational settings.

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Digital Microwave Characterization of Ice-Accreted Power Transmission Conductors for SAR-Based Monitoring

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ABSTRACT

Icing on power transmission conductors threatens grid safety and reliable operation. At present, measuring the radar-echo characteristics of ice-accreted conductors with SAR satellites enables large-scale monitoring and early warning of icing disasters. Understanding the underlying microwave scattering mechanisms is therefore essential to robust SAR-based monitoring. This work implements a digital measurement-and-inversion workflow to characterize radar echoes from ice-accreted conductors under controlled experiments. We first generate one-dimensional range profiles for conductors with known ice thicknesses and use peak spacing to reconstruct echo paths and retrieve thickness; we then perform inverse synthetic aperture radar (ISAR) imaging to validate the inferred mechanisms with spatially resolved scattering signatures. For a 70 mm ice accretion, the echo is dominated by three components: (i) specular reflection from the ice–air interface, (ii) edge diffraction from the conductor after transmission through the ice layer, and (iii) a weaker specular-like return associated with multiple transmission/scattering in the ice–conductor system on the distal side. Thickness estimates from range profiles are consistent with the ISAR interpretation. The results show that digitally enabled microwave characterization can support SAR-based monitoring and early warning of icing on transmission conductors, quantify thickness from radar observables, and provide physics-grounded references for translating laboratory signatures to remote-sensing scenes—advancing Digital Technology Driven Engineering for grid icing diagnostics and risk mitigation.

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Machine Learning Algorithms for the Segmentation of Brain Tissues-Bibliometric Analysis

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ABSTRACT

This study presents a comprehensive bibliometric analysis of machine learning algorithms for the segmentation of brain tissues from 1990 to 2024. Using data from 188 sources and 685 documents, we analyze research trends, leading contributors, and the global impact of this growing field. Results indicate a significant increase in the number of publications and a high annual growth rate of 12.96%. United States of America, China, and India are identified as the most prolific contributors, with key journals like "IEEE Transactions on Medical Imaging" leading the dissemination of research. Collaboration metrics reveal that approximately 28.18% of publications involve international co-authorship, reflecting the collaborative nature of this research domain. Brad-ford's Law and Lotka's Law are employed to identify core journals and author productivity patterns, respectively, indicating a concentration of output in a few impactful sources and authors. The findings provide a detailed understanding of the development and influence of machine learning in medical imaging, highlighting key trends and potential areas for future research.

Keywords: Magnetic resonance imaging, Machine Learning, Segmentation

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Diagnostic Study on the Matching Degree of Supply and Demand for Community-Based Elderly Care Facilities in Megacity

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ABSTRACT

As China's population ages, the proportion of elderly citizens reached 15.6% by the end of 2024, highlighting the growing mismatch between supply and demand for elderly care facilities. Against this backdrop, this study uses Beijing's subdistricts as a case study to construct a comprehensive evaluation model for supply-demand matching and a spatial autocorrelation model, providing scientific basis for coordinating elderly care services.

The study integrates multi-source data, including the number of elderly care institutions, and employs the Entropy-weighted TOPSIS method to quantitatively assess supply-demand matching. This assessment categorizes matching levels into three tiers and reveals spatial differentiation patterns. Through global spatial autocorrelation combined with adjacency matrix analysis, it is discovered that the matching levels across subdistricts exhibit a spatial pattern of “high-value clustering and low-value clustering,”. Local spatial autocorrelation analysis pinpointed “hot spots,” “cold spots,” and a few anomalous subdistricts in supply-demand matching. Finally, the relationship between matching levels and spatial weights was analyzed to uncover underlying patterns linking subdistrict influences to matching outcomes.

The findings reveal: Global spatial autocorrelation indicates a tendency for similar matching levels to cluster together. Local spatial autocorrelation identifies “high-low” and “low-high” anomaly zones, while LISA clustering maps unveil local spatial association patterns. Analysis of spatial association strength shows that most street points cluster in low-weight zones, with some streets having large influence areas but low supply-demand matching levels.

Based on these findings, recommendations include consolidating hotspots, strengthening cold spots, addressing facility and service gaps, and guiding optimization in anomalous areas to promote precise allocation of elderly care resources and regional coordinated development.

Keywords: elderly care services; supply-demand matching; entropy-weighted TOPSIS method; spatial autocorrelation analysis.

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Big Data-Driven Structural Equation Modeling for Interactive Effects Analysis of Health and Longevity Factors in Chinese Elderly

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ABSTRACT

Against the backdrop of accelerating population aging, exploring the mechanisms influencing healthy longevity among older adults holds significant importance. This study utilizes data from the 2023 China Elderly Social Tracking Survey to conduct an in-depth analysis of the comprehensive impact of factors such as health behaviors on healthy longevity among older adults.

First, through dataset analysis, latent variables (health behaviors, family support, community services, digital literacy, healthy longevity) and their corresponding 18 observed variables were identified. Observed indicators were coded to form the research dataset. Subsequently, reliability and validity tests were conducted: Reliability analysis revealed that all observed variable indicators exceeded a reliability value of 0.6, meeting reliability requirements. Validity analysis yielded a KMO value of 0.687, indicating good factor loading fit between observed variables and their corresponding latent variables. Confirmatory factor analysis further validated the multi-item fit and reliability of the latent variable measurement model.

After constructing a structural equation model based on the validated variables, the results revealed that health behaviors and digital literacy exert positive effects on healthy longevity, while family support and community services exert negative effects. The model demonstrated good fit (GFI=0.907, RMSEA=0.054, CFI=0.913, RMSEA=0.012), with all indices meeting or approaching ideal levels. Regarding mediating effects, digital literacy significantly influenced overall healthy longevity through the positive mediating effect of health behaviors and the negative masking effect of community services. In terms of moderating effects, only community services mitigated the negative impact of family support, while other variables showed no significant moderating effects. Robustness tests confirmed the reliability of all models.

In summary, this study quantitatively reveals the multidimensional mechanisms through which various factors influence healthy longevity among older adults, providing scientific evidence for policy formulation while advancing the cause of senior health.

Keywords: Validity and reliability testing; Structural equation modeling; Mediating effect analysis; Moderating effect analysis; Healthy longevity

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Base on Reinforcement Learning for Adaptive Operator Scheduling: The Animated Oat Optimization Algorithm and Its Application to Engineering Optimization Problems

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ABSTRACT

To overcome the shortcomings of the Animated Oat Optimization Algorithm (AOO), which adopts a fixed random selection strategy to determine search operators, lacks the ability to perceive and adaptively adjust to the current search state, and thus tends to fall into local optima and exhibit slow convergence in complex optimization problems, this paper proposes a reinforcement learning-integrated Animated Oat Optimization Algorithm (RL-AOO).

Built on the foundation of AOO, this algorithm introduces the Q-learning reinforcement learning mechanism to achieve adaptive scheduling of operators. Its core innovations include: constructing a three-dimensional state space based on the population's average fitness, population diversity, and iteration progress; and designing a dynamic ε-greedy strategy to realize an adaptive balance between exploration and exploitation. By establishing the state space, action space, and reward mechanism, the algorithm can dynamically select the optimal operator according to the search state.

To verify the effectiveness of the proposed algorithm, experiments were conducted on 27 classical benchmark functions and practical engineering problems. The experimental results show that RL-AOO outperforms other optimization algorithms in both accuracy and convergence speed, demonstrating its potential in solving complex optimization problems.

Keywords : Animated Oat Optimization Algorithm (AOO); Reinforcement Learning; Q-learning; Adaptive Operator Scheduling;

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A Privacy-Preserving and Scalable Blockchain Framework for Intelligent Recommender Systems

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ABSTRACT

The growing reliance on data-driven personalization across digital platforms has intensified global concerns about privacy, transparency, and user data control. Traditional recommender systems based on centralized architectures often expose sensitive data to security breaches, manipulation risks, and limited user authority.

This paper presents a privacy-preserving and scalable blockchain framework for intelligent recommender systems that integrates Ethereum smart contracts with off-chain storage using the Inter Planetary File System (IPFS). The Blockchain layer enforces data ownership, integrity, and traceability, while IPFS enhances scalability and computational efficiency. To improve adaptability and recommendation accuracy, a hybrid deep learning architecture combining DualLight-Graph Convolutional Network (GCN) for multimodal feature fusion and a Multi-Information Fusion and Interaction Neural Network (MFINN)-based classification is introduced.

Experimental results on the MovieLens dataset demonstrate a 12% improvement in recommendation precision and a 35% increase in scalability compared with conventional federated learning models. The proposed framework supports a trustworthy, explainable, and privacy-aware recommendation ecosystem, offering broad applicability across e-commerce, education, and smart city domains. This work contributes to the ethical advancement and transparency of next-generation digital technologies.

Keywords: Blockchain · Recommender System · Privacy Preservation · Smart Contracts · IPFS · Scalability · Graph Neural Networks

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From Waste to Pavement: Life Cycle Assessment of Recycled Additives in Asphalt Pavement

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ABSTRACT

Waste generation continues to increase year by year, most of which is currently landfilled. Against the background of high population growth and increasing industrialization, a further increase in waste volumes is expected. Without a material and energetic use of this waste, vast amounts of resources are wasted annually. In addition, the dumping of waste causes increased land use, environmental pollution, and socio-economic problems. To address this issue, the current paper examines the feasibility of integrating recycled waste materials such as reclaimed asphalt pavement (RAP), crumb rubber, fly ash, and waste plastics into asphalt pavement as a sustainable alternative to conventional techniques. This approach not only minimizes the demand for virgin materials but also contributes to mitigating greenhouse gas emissions and landfilling. To comprehensively examine the environmental impacts of incorporating these recycled materials, a Life Cycle Assessment (LCA) framework designed according to ISO 14040 standards is used. The LCA evaluates several impact categories, such as energy consumption, global warming potential, and resource depletion, across cradle-to-gate system boundaries, including all stages from raw material extraction to end of life. The results show that the use of recycled materials in asphalt mixtures can substantially reduce the environmental footprint of asphalt production. Furthermore, the results indicate that LCA serves as a reliable tool for optimizing mix designs and selecting sustainable materials.

Keywords: Recycled materials, Asphalt pavement, Sustainable development, Sustainability, Life Cycle Assessment.

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Optimization of Burning Temperature and Cooling Rate of Rice Husk Ash for Enhanced Pozzolanic Reactivity and Concrete Performance

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ABSTRACT

To improve the performance of concrete, this study examines the effects of burning temperature and cooling rate on the pozzolanic reactivity and physical properties of rice husk ash (RHA). Rice husks were burned for two hours at 600°C, 750°C, and 900°C in two different cooling regimes: medium air cooling and slow furnace cooling. The chemical composition, amorphous silica content, specific surface area, and microstructural evolution of the generated ash were assessed using XRF, XRD, FTIR, BET, and SEM. While concrete mixtures containing 4%, 8%, and 12% RHA as partial cement replacements were tested for compressive strength, water absorption, and chloride permeability, the pozzolanic activity was assessed using Chapelle and R^3 tests. The findings showed that increasing the burning temperature from 600°C to 750°C decreased the residual carbon and resulted in finer ash particles because of structural densification and partial sintering, which improved the pozzolanic reactivity and specific surface area. Particle coarsening and decreased reactivity were the result of excessive silica sintering and crystallization (formation of cristobalite and tridymite) at 900°C. Additionally, medium-air cooling preserved the amorphous phase and fine texture better than slow furnace cooling, which enhanced the mechanical performance and reactivity of the concrete. To create reactive and sustainable rice husk ash appropriate for long-lasting concrete applications, the results highlight the significance of managing thermal treatment and cooling conditions, in addition to attaining high particle fineness. rice husk ash (RHA), burning temperature, cooling rate, pozzolanic reactivity, amorphous silica, sustainable construction [1-3].

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Extremal Graphs for the Inverse Degree Index

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ABSTRACT

The molecule of any substance can be modeled as a mathematical graph, where vertices correspond to atoms and edges to chemical bounds [1]. Topological indices (TIs) are numerical invariants of such chemical graphs. They play an important role in determining Quantitative Structure-Activity and Quantitative Structure-Property Relationships (QSAR/QSPR) of substances, having direct applications in drug design and analytical chemistry [2], but also in any domain impacted by materials science, included, but not limited to, civil, construction and environmental engineering [3, 4]. TIs are studied from both an applied [5] and theoretical perspective [6]. This study belongs to the second category.

The inverse degree index is defined for an undirected graph $G = (V, E)$ with minimum degree $\delta \geq 1$ as $ID(G) = \sum_{x \in V} \frac{1}{d_x}$. It was first defined in the context of automated conjecture generating [7], and subsequently investigated to some extent by mathematical chemists. The present paper continues its qualitative study by determining the minimal and maximal graphs with respect to it in the general classes of graphs with minimum degree ≥ 1, connected graphs, trees and unicyclic graphs. Though some results were previously obtained in the literature, we provide a new, more streamlined approach, which hint at possible extensions to novel classes of graphs.

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Synthesis of two-level control in constructing the optimal trajectory of the UAV using a predictive model

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ABSTRACT

The article considers the problem of unmanned aerial vehicles (UAV) optimum trajectory generation that ensures performance of the flight mission while adhering to established constraints. These constraints are achieved by optimizing trajectory-level control in accordance with an optimality criterion of the generalized work functional type, which includes penalty functions. A predictive model is used in the form of spiral prediction equations, which represent an analytical solution to a system of equations describing the UAV's motion dynamics in the body axes. The partial derivatives the Bellman function are definited numerically lengthwise the analytical solution for an assignment of optimal control during next control cycle.

Optimal trajectory inputs obtained using the spiral prediction equations are developed by solving inverse problems of dynamics applicable to stabilizing the UAV's motion relative to a supporting trajectory.

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Enhancing Hyperparameters for Solar Energy Forecasting in Kirkuk, Iraq: Grid and Cuckoo Searches Techniques

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ABSTRACT

The Mala Abdullah region is situated in southwestern Kirkuk, Iraq, and hosts one of the country's largest power plants, which operates using gas extracted from local fields. Due to pollution from oil and gas activities, solar energy has become an urgent need to reduce emissions. Accurate forecasting of solar irradiance is vital for optimizing photovoltaic (PV) and concentrated solar power (CSP) systems. This study compares traditional machine learning models—including Support Vector Regression (SVR) and Random Forest (RF)—to enhance monthly global horizontal irradiance (GHI) predictions for the region. The dataset, spanning 1984–2022 and sourced from NASA POWER, includes meteorological factors such as temperature, humidity, and wind speed. Data quality is improved through preprocessing methods like Min-Max normalization and cyclic encoding. Hyperparameters are optimized using Grid Search and Cuckoo Search techniques, significantly boosting prediction accuracy. Results show that the Random Forest model performs reliably, while the SVR model, properly tuned, achieves an R^2 of 0.9789. This study highlights the critical role of hyperparameter optimization in improving solar irradiance forecasts, supporting more effective solar energy management.

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Identifying Key Risk Factors for Breast Cancer Using Comparative Feature Selection Techniques

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ABSTRACT

Accurately selecting the risk factors for breast cancer remains a challenging task due to the large complexity of clinical datasets and the heterogeneity in feature selection methods [1]. Several existing research studies rely on classification performance without thoroughly analyzing the stability of the identified features, creating uncertainty about the reproducibility of results across slightly varied datasets [2].

In this work, we address these gaps by examining and comparing different feature selection methods, such as filter, wrapper, and embedding methods on the Breast Cancer Coimbra dataset [3]. The stability of each method was assessed using the Jaccard Index and Spearman Correlation Measure, measuring how consistent the selected features persist against dataset perturbations. Classification performance was then examined using Support Vector Machines, Logistic Regression, and Decision Trees, comparing models trained on all features and only the top-ranked variables.

The findings demonstrate that Decision Tree achieved the best accuracy (over 90%) and demonstrated the highest stability across repetitions. Filter-based approaches indicated a moderate level of stability, while wrapper methods were less resistant to changes in the data. Significant features namely age, adiponectin, BMI, HOMA, insulin, leptin, glucose, resistin, and insulin were constantly identified as key predictors, whereas MCP-1 showed minimal contribution. These results contribute to the development of more precise diagnostic models providing a trustworthy framework for selecting reproducible breast cancer risk factors.

Keywords: Feature selection, Stability analysis, Classification, Breast cancer, Machine learning

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Adoption of AI-driven Project Quality Management Systems in the construction industry in Small Island Developing States from a TAM-TOE perspective

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ABSTRACT

The construction industry currently accounts for 13% of the world's Gross Domestic Product (GDP) and is integral to global economic development (Korke and Gobinath, 2024). Yet it faces persistent challenges in ensuring quality management, plagued by issues such as delays, cost overruns and poor quality outcomes due to traditional methods of project quality management (Egwim et al., 2024). The use of Artificial Intelligence (AI) in construction quality management has gained a lot of focus recently because of its potential to increase efficiency, reduce mistakes, and improve project results. This study focused on identifying the critical factors for the adoption of AI-driven Project Quality Management Systems (PQMS) in the construction industry with Mauritius as the case study. A cross-sectional questionnaire survey was carried out using a purposive sampling strategy with 160 professionals working in the construction sector. The survey was administered online via Google Form and consisted of Likert scale questions adapted from the Technology Acceptance Model (TAM) and the Technology-Organisation-Environment (TOE) Framework. The findings from the survey indicated that there was a significant positive relationship between top management support and environmental factors such as industry standards and regulations and the adoption of AI-driven PQMS. On the other hand, at an individual level, professionals who reported lower digital literacy and perceived usefulness had decreased intention to adopt the innovative technologies. These findings suggest that it is essential for the construction industry to develop policies geared towards promoting the adoption of AI tools both at the organizational and national level, while also providing training to improve current digital literacy of professionals.

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Acehnese Traditional Ornament Simulations in Polar Coordinate and Fractal

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ABSTRACT

This article elaborates the graphical simulations of some traditional ornaments from Aceh, Indonesia, which were sketched in polar coordinates. It also presents the analytical fractal investigations of an ornament called *Bungong Meulu* which is often found in fabrics known as *songket*. In the polar coordinate system, each point is represented by the distance from the point of origin and the angle from the positive x-axis. Some graphical models of polar equations can be developed to plot the artistic pattern of ornaments which contain circular and symmetric properties. Fractal is described as mathematical object with its self-similarity properties that are produced by iteration process in various scales. First of all, the analytical method was done to develop the ornament's equation in polar coordinates. The iteration process was then applied for the governing equation to perform its fractal, as shown in Figure 1.

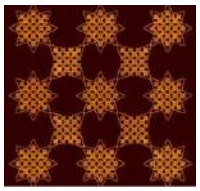


Figure 1.

The picture simulations and the visualizations were done by using GeoGebra software application. Here the graphical results of some Acehnese ornaments are shown, namely for some iconic traditional patterns of flowers. The graphical results of the Acehnese ornaments in some fractal patterns were sketched to provide an alternative for the contemporary motives of fabrics.

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AI-Driven Innovation in Sustainable Buildings: Large-Scale Sensor Data Framework

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ABSTRACT

Buildings equipped with internal and external IoT sensor networks are usually capable of generating millions of data points per day, including both internal and external variables. Typically, operators are not using the full capacity of data density within building and construction, as traditional methods are insufficient to extract all value-relevant insights.

This paper offers a methodological framework that uses AI to manage and transform large-scale sensor datasets into actionable knowledge for sustainable building operations. The work proposes a four-step approach of working with massive, high-frequency data: i) data preparation and integration, ii) feature engineering customized to build energy performance, iii) architectural decisions between batch and streaming processing, and iv) application of AI-supported activities such as forecasting, anomaly detection, and causal analysis. Real-world examples show how those methods enable predictive and agile maintenance routines, performance benchmarking, and weather-consumption correlation analysis, different options representing an innovation pathway for sustainability in construction.

The novelty of this research lies in generalizing the methodological approach to any environment where even millions of sensor data points are generated daily, rather than optimizing it for a single building or homogeneous dataset.

The special combination of technological innovation (AI), methodological innovation (scalable framework), and managerial innovation (decision support for sustainable operations) provides a toolset for supporting energy efficiency, waste reduction, and achieving sustainability goals in the construction and building industry.

Keywords: sustainable construction, building energy management, innovation, artificial intelligence, IoT sensors, big data analytics, methodological framework

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Intelligent Power Allocation in NOMA-IBFD Systems: A Hybrid Machine Learning and Reinforcement Learning Approach for Interference Mitigation and Performance Optimization

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ABSTRACT

Non-Orthogonal Multiple Access (NOMA) schemes, especially when combined with In-Band Full Duplex (IBFD), can yield significant spectral efficiency gains, albeit at the cost of increased complexity in interference management. Optimal transmit power allocation for base stations (BS) and users is crucial to mitigate interference and satisfy desired Quality of Service (QoS) metrics, such as throughput and Signal-to-Interference-plus-Noise Ratio (SINR). Traditional optimization techniques often struggle to address the dynamic and challenging environment of NOMA-IBFD systems, thereby necessitating efficient and adaptable solutions.

In this work, a novel hybrid technique combining supervised machine learning (SML) and reinforcement learning (RL) is introduced for intelligent transmit power management (TPM) in NOMA-IBFD cellular networks. Initially, an SML model is employed to predict 'good' and 'bad' power levels based on channel gain, interference, and SINR. Trained on the IEEE DataPort dataset, this SML component achieves 94.5% accuracy in identifying preferred power configurations. Building upon this, an RL agent dynamically adjusts its transmit powers, learning to minimize aggregate interference and energy consumption while adhering to predefined throughput and SINR targets. Preliminary simulations demonstrate a reduction of up to 25% in interference, and that the RL agent learns stable and efficient power control strategies, meeting target SINR levels with 98% reliability. This proposed ML/RL-based integrated framework offers a robust and adaptive solution for real-time resource management in next-generation wireless networks.

Keywords: NOMA, IBFD, Power Allocation, Machine Learning, Reinforcement Learning, Interference Management.

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A framework of digital metrics for justifying the value of human capital investments in engineering

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ABSTRACT

The development and intensification of the use of digital technologies, big data, artificial intelligence, and robotics does not exclude the use of human labor in most engineering processes. Engaging human capital to solve problems in engineering is essential for generating value based on digital technologies. Technologies evolve faster than engineering and management personnel can adapt to them, leading to the failure of digital transformation. Management personnel often underestimate the importance of investing in human capital because they do not have sufficient metrics to confirm its effectiveness and the impact of engineering personnel on the use of digital tools. The purpose of this study is to summarize approaches and propose a unified system of digital metrics to justify the value of investments in human capital based on the generalization of individual disparate metrics.

The system includes metrics that measure the results and economic impact of the use of digital tools by personnel who have acquired new digital skills.

To determine the result, the system includes the metrics to assess the direct impact of new skills on the quality of work; metrics to assess the effectiveness of engineers' use of modeling tools to create high-quality digital assets; metrics related to hybrid skills; metrics on the degree of openness of staff to the use of new technologies; metrics that measure the quality of collaboration, communication effectiveness, and data integration.

It is offered to include economic effect metrics in the system that measure the quality and cumulative effect of decisions made, show the effectiveness of decisions made based on data and new skills, and measure the long-term value created by staff after additional training.

The proposed system of digital metrics shows managers the possibility of quantitatively assessing the effectiveness of staff acquisition of new skills and investments in human capital. A change in attitude towards the value of human capital and an increase in investment in its development leads to an improvement in staff skills, the effectiveness of their use, and the economic effect of applying digital skills.

Integrating Physics-Based and Data-Driven Modeling: A New Paradigm for Multiscale and Multiphysics Problems

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ABSTRACT

Engineering systems are increasingly characterized by nonlinear behaviors, complex geometries, and strong couplings across multiple spatial and temporal scales. In such multiscale and multiphysics environments, traditional physics-based modeling approaches, although rigorous, are often constrained by prohibitive computational costs and incomplete constitutive descriptions. Concurrently, the emergence of data-driven methodologies—particularly those utilizing machine learning—has been associated with new possibilities for model discovery, uncertainty quantification, and efficient surrogate modeling. In this work, recent advances situated at the intersection of physics-based and data-driven modeling are reviewed, with attention directed toward their synergistic integration in the context of complex engineering problems. The challenges arising from nonlinearities, scale interactions, and multimedium couplings are first analyzed. Subsequent sections provide a summary of progress achieved in multiscale and multiphysics coupling strategies, followed by an overview of data-driven modeling approaches that have been developed to complement or extend established physical theories. Emerging coupling frameworks, including data-based constitutive models, physics-informed machine learning, and hybrid methodologies unifying both paradigms, are then discussed. The paper concludes with an assessment of current limitations and an outline of future research directions aimed at the establishment of robust, interpretable, and generalizable hybrid modeling frameworks for next-generation engineering applications.

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SIPENDA Intelligent E-Governance: A Web-Based Archival Optimization Model for Retired Employee Data Management in Public Enterprises

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ABSTRACT

Digital transformation in administrative systems has become an important pillar of organizational modernization, especially in large-scale public companies. From a theoretical perspective, this study contributes to the growing discourse on digital transformation and intelligent governance by linking system optimization with organizational learning and human system interaction [1]. The performance of this system aligns with the principles of e-governance and the Industry 5.0 paradigm, which emphasizes human-centered technology that enhances resilience, accountability, and transparency in data management [2]. This study presents an applied innovation through the development of SIPENDA (Digital Pension Information & Archive System), a web-based archiving solution designed to optimize pensioner data management at PT PLN (Persero) UP3 South Surabaya, Indonesia. Prior to its implementation, the organization relied on manual archiving using physical folders, which caused long retrieval times, limited accessibility, and increased risk of data loss. These inefficiencies highlight the urgency of adopting structured, technology-based solutions to strengthen operational performance and data governance. Using a descriptive qualitative approach, this study collected data through field observations, in-depth interviews, documentation, and a literature review. The optimization process followed the Waterfall software development model, involving five sequential stages: needs analysis, design, implementation, testing, and maintenance. The results showed that SIPENDA effectively (a) accelerated document retrieval time from hours to seconds [3], (b) improved data accuracy through structured classification [4], and (c) enhanced information security through role-based access control and automated audit trails [5]. Furthermore, SIPENDA minimizes data vulnerability through secure storage, automatic backups, and controlled access. This study concludes that optimizing digital archives through user-driven system design strengthens information accessibility, security, and organizational agility in responding to administrative challenges. The implementation of SIPENDA serves as a scalable model for other public institutions seeking to integrate digital archiving into their transformation strategies. Future developments are recommended to incorporate AI-based predictive search features and cross-unit interoperability to support the archiving ecosystem.

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Integrated RAMS–OEE Framework for Reliability Growth in High-Temperature Polymer Shrink Packaging Systems

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ABSTRACT

Operating high-temperature polymer shrink packaging systems poses persistent reliability and safety challenges. The shrink machine at Arya Sasol Polymer Complex had long faced main-switch breakdowns and heater-chain failures that disrupted production and raised operational risks due to polymer dust and ambient heat.

To address these recurring issues, a multidisciplinary team was formed under the company's Management of Change (MOC) initiative. Instead of applying short-term fixes, the team conducted a full system review. The control topology was redesigned—from a series-dependent circuit to an opto-isolated parallel logic—eliminating cross-trigger faults. Pneumatic circuits were upgraded using high-temperature FKM/PTFE components, and a structured preventive maintenance (PM) program for cleaning, inspection, and lubrication was introduced.

After four years of field operation, the mean time between failures (MTBF) of the main switch increased from about 14 to over 48 months, while overall equipment effectiveness (OEE) improved from 82 % to 93 %. The changes produced estimated annual savings of 30000–40000 USD, mainly from reduced downtime and elimination of heater-chain failures.

A follow-up assessment based on IEC 61508 and IEC 60300-3-1 confirmed a safety upgrade from SIL 1 to SIL 2, attributed to better isolation, PM discipline, and new soft-trip logic for controlled shutdowns. This integration of RAMS and OEE offers a practical and repeatable pathway for reliability growth and cost optimization in harsh polymer packaging environments.

Keywords: RAMS, OEE, Reliability Growth, Management of Change (MOC), Preventive Maintenance, Shrink Machine

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The Effect of Integrating Scratch Programming with Project-Based Learning in Fostering Students' Disposition

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ABSTRACT

Computational thinking (CT) is a key 21st century competence that extends beyond coding to encompass problem-solving, creativity and innovation. Yet, many students, especially in rural area, show low or moderate dispositions due to limited exposure, scarce resources and the perceived difficulty of programming, which weakens persistence and motivation. Thus, effective pedagogical interventions are needed to build CT skills while fostering positive dispositions.This study aims to examine the effectiveness of integrating scratch programming with Project-Based Learning (PBL) in fostering students' dispositions towards CT. Grounded in Papert's constructionism, which emphasises learning through the creation of meaningful artefacts, the study positions scratch-PBL as a theoretically sound approach to enhance cognitive, affective and conative dimensions of disposition. A quasi-experimental design with non-equivalent groups was employed, involving 150 lower-secondary students in rural Malaysia (treatment group n = 78; control group n = 72). The Student Disposition towards Computational Thinking Questionnaire (SDCT) was used as the instrument and data were analysed through repeated-measures MANOVA. Findings indicate that the scratch-PBL intervention significantly improved students' cognitive, affective and conative dispositions (Pillai's Trace = 0.365, $p < 0.001$). These results confirm that scratch with PBL provides an authentic, collaborative, and inquiry-driven learning environment that promotes persistence, creativity and motivation. The study implies that the integration of scratch programming with PBL can serve as an inclusive pedagogical approach to enhance computational dispositions in STEM education and support equitable student engagement in the digital era.

Keywords: Computational thinking, disposition, scratch programming, project-based learning

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International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

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Digital Transformation through Next-Generation Archiving: Empirical Insights from DOF Implementation

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ABSTRACT

Digital transformation has become a critical pillar of organizational modernization and operational resilience, particularly in large-scale industrial enterprises [1]. From a theoretical standpoint, this study contributes to the growing discourse on intelligent governance and user-centered digital systems by linking technology adoption with organizational performance and behavioral engagement. The Digital Office File (DOF) application, developed by PT Petrokimia Gresik, represents an applied innovation designed to streamline document management, minimize physical paperwork, and accelerate workflow processes. Unlike conventional manual documentation practices that are prone to inefficiency, delays, and data vulnerability, DOF enables seamless, transparent, and real-time information access across organizational units [2]. This study examines the impact of DOF usage on employee productivity, with user satisfaction serving as a mediating variable that reflects human system interaction and acceptance[3]. A quantitative research design was employed involving 84 respondents, with data collected through structured questionnaires and analyzed using multiple linear regression, t-test, F-test, coefficient of determination, and Sobel mediation analysis. The findings reveal that DOF significantly enhances both user satisfaction and employee productivity, while user satisfaction partially mediates the relationship between system usage and performance outcomes. The results align with the principles of digital governance and the Industry 5.0 paradigm, emphasizing the integration of human-centric design with adaptive technology to strengthen organizational agility, accountability, and efficiency[4]. Beyond its immediate operational benefits, DOF illustrates a scalable and transferable model for public and private sector organizations aiming to accelerate their digital transformation roadmaps. Future developments are recommended to incorporate predictive analytics, AI-driven workflow automation, and interoperability across organizational systems to support sustainable productivity growth and enterprise-wide digital maturity[5].

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BIM in Healthcare System: A Strategic Roadmap for Adoption in Egyptian Healthcare Facilities

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ABSTRACT

Healthcare facilities are essential in achieving global sustainability and wellness goals. The recent COVID-19 pandemic acted as a powerful catalyst, highlighting the urgent need to expand healthcare system efficiently and effectively. This has accelerated the adoption of advanced digital technologies within the Architecture, Engineering, and Construction (AEC) industry, with Building Information Modeling (BIM) emerging as a transformative force. While BIM has important impact on the design and construction phases by reducing errors and improving scheduling, its full potential in the post-construction operation and maintenance (O&M) stage remains largely unrealized. Furthermore, a systematic consolidation of BIM best practices for healthcare is lacking particularly in developing contexts like Egypt.

This paper aims to develop a strategic roadmap for BIM adoption in Egyptian healthcare facilities. Employing a mixed-methodology approach, the study commences with a literature review to analyze the global use of BIM in healthcare units. This review is synthesizing a comprehensive framework of best-practice BIM actions across key domains such as operability, resilience, collaboration, and sustainability. Subsequently, an expert survey is administered to AEC professionals in Egypt to investigate the potential for implementing these specific BIM actions within the local context.

The analysis of survey data, integrated with the literature review, will culminate in a tailored roadmap for local BIM adoption. This study is anticipated to offer practitioners, policymakers, and stakeholders priceless, fact-based recommendations. By bridging the gap between theoretical BIM capabilities and practical implementation, this research helps to optimize healthcare facilities' lifecycles, promoting increased sustainability, efficiency, and patient-centered care.

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The Use of Artificial Intelligence Applications in University Education from the Perspective of Early Childhood Program Students at the University of Sharjah

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ABSTRACT

In recent years, the accelerated development of Artificial Intelligence (AI) technologies has influenced teaching and learning in higher education. In this research, the opinions of female students who are currently studying Early Childhood program at University of Sharjah on their perceptions about AI applications in university education were examined. A descriptive cross-sectional research method was used to examine students' attitudes, perceived advantages and possible challenges when including AI in an academic setting. Information was collected from a sample of female students through an explicit questionnaire, and both quantitative and qualitative methods were used for analysis. Findings suggest that, overall, there are predominantly positive perceptions of AI by participants regarding its ability to serve as an enabler for information access, personalized learning, and academic performance. On the other hand, some participants reported ethical concerns, technology dependency and the necessity for adequate training and guidance. The research highlights the necessity to train future female students' teachers in effective and responsible use of AI tools for education. Suggested reforms for integrating AI literacy into teacher education programs and establishing policy to foster sound implementations of AI technologies are offered.

Keywords: Artificial Intelligence (AI), Artificial Intelligence, Students, University of Sharjah

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An Approximate Method for Analyzing Self-Excited Oscillations Using Elements of Bifurcation Theory

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ABSTRACT

This paper presents an approximate method for analyzing self-excited oscillations in nonlinear dynamic systems, demonstrated using the Duffing equation and extended to the inverse double pendulum under a follower (circulatory) force. The proposed approach combines a modified harmonic balance method with elements of bifurcation theory to determine conditions for the onset of oscillations, analyze the multiplicity and stability of limit cycles, and identify critical parameter values corresponding to Hopf bifurcations. Unlike classical techniques based on Taylor series expansion, the method avoids excessive algebraic complexity while maintaining analytical accuracy. The results allow evaluation of both the nature of stability loss (soft or hard) and the structure of multistability. The developed approach provides a practical analytical tool for predicting and understanding nonlinear dynamic behavior in engineering systems.

Keywords: Nonlinear dynamics; self-excited oscillations; harmonic balance method; bifurcation theory; Hopf bifurcation; stability analysis; Duffing oscillator; inverse double pendulum.

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A Scalable and Adaptive Big Data Pipeline for Real-Time Anomaly Detection in Distributed Systems

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ABSTRACT

The rapid evolution of digital infrastructure and the proliferation of data sources have profoundly transformed the need for real-time monitoring and security. In the context of the exponential growth of volume, variety, and velocity of data, anomaly detection becomes a strategic challenge to anticipate failures, identify attacks, and ensure service continuity. Traditional approaches, often limited to static analysis or non-adaptive models, face difficulties in dynamic and distributed environments.

This work aims to design an intelligent, scalable architecture able to automatically detect anomalies in streaming big data. The work proposes the implementation of a fault-tolerant pipeline, combining distributed analysis, streaming technologies, and supervised machine learning adaptive algorithms. This approach aims to guarantee reliable real-time analysis, even in the presence of noisy or incomplete data, while maintaining low operational latency.

The obtained results aim to demonstrate the feasibility of a proactive and autonomous monitoring system that combines robustness, accuracy, and scalability. This methodological framework opens the way to new applications in the fields of cybersecurity, predictive maintenance, critical systems monitoring, and, more globally, intelligent management of complex digital environments.

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Instructions for Preparing a one Page Abstract for the International Conference

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ABSTRACT

The Internet of Things (IoT) is an essential component in most surveillance systems across various fields. To optimize, these networks must be designed to operate self-organizing to meet current network requirements. In literature, Monte Carlo algorithms have been proposed to improve these systems' quality of service (QoS); these algorithms provide practical solutions to most challenges by leveraging random sampling and probabilistic modeling. Recently, quantum computing has been integrated with these algorithms through quantum amplitude estimation (QAE) algorithms. Compared to classical techniques, it provides quadratic speedups for probabilistic inference and reliability assessment; thus, network performance is improved, especially if processors with few quantum qubits are available in network nodes. However, quantum energy consumption poses a significant challenge to integrating such algorithms with embedded devices used in the IoT, due to the lack of a theoretical basis that addresses the physical concept of energy and the complexity of quantum computation. To bridge this gap, we present a theoretical analysis of the energy consumption of quantum circuits used for such quantum algorithms; it is a computational model that relies on the study of query complexity in computational complexity theory. Our analytic results are compared with the properties of the currently used embedded devices to check their ability to perform such algorithms. Our result shows that it cannot be performed with today's devices, but hybrid quantum-classical nodes are suggested as a solution to be able to perform such algorithms. Additionally, quantum algorithms must be optimized to meet the requirements of limited-resource devices.

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From Spatial to Semantic Tools and Back to Support the Resilience Analysis of Critical Infrastructures to Natural Hazards

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ABSTRACT

As climate change increases the frequency of extreme events, possibly compounding other natural hazards such as earthquakes, utility networks, and their interdependent assets, are becoming increasingly vulnerable. This growing risk calls for flexible frameworks that incorporate environmental studies to assess and enhance infrastructures resilience. We are witnessing an increasing availability of environmental data, such as ground motion data and climate projections providing valuable insights into future scenarios and induced hazards. At the same time, digital platforms and numerical codes for infrastructure planning and operation are evolving to support the integration of new technology and to enhance system security through more efficient and resilient management. However, these tools often operate as closed environments due to data confidentiality concerns, limiting interoperability, open research experimentation and hindering collaborative efforts.

We propose an integrated approach, fostering open technology and reuse, that combines Geographic Information Systems (GIS) and Knowledge Graphs (KGs) to support the resilience analysis of critical infrastructure systems and interdependencies. In this architecture, GIS-derived data is mapped to semantic models, and conversely, the knowledge graph can be utilized to infer, organize, and expose information that is visualized on GIS maps, supporting analyses processes for planning and risk assessment.

As an extension of [1], the paper will focus on the structure of the knowledge graph and on a practical software application demonstrating its use for the analysis of water systems and the impacts from real earthquakes in urban environments.

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Readiness and Equity in AI-Supported Science Teaching: A Survey of Pre-Service Teachers

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ABSTRACT

Artificial intelligence (AI) is reshaping how science is taught, but the readiness of future teachers to integrate AI remains unevenly reported. This study examined the level of readiness to use AI in science teaching and tested whether readiness differs by gender. The investigation was anchored in the Technology Acceptance Model (TAM), focusing on perceived usefulness and perceived ease of use as antecedents of intention to use. Using a quantitative approach with a survey design and purposive sampling, data were collected from 112 pre-service teachers (male = 60; female = 52). Readiness was measured with the *Readiness to Use AI in Teaching Science* instrument adapted from Alshorman (2024) and contextualized for the program. Data screening confirmed normality and homogeneity of variance, after which descriptive statistics and an independent-samples t-test were performed. Results showed a high overall level of readiness and no statistically significant difference between male and female participants ($p > .05$). The findings indicate favorable conditions for AI adoption among pre-service science teachers and suggest that teacher-education programs should prioritize authentic AI-enhanced learning tasks and strengthen TAM pathways to sustain intention to use, rather than designing gender-targeted readiness initiatives.

Keywords: Artificial intelligence, science education, teacher readiness, Technology Acceptance Model (TAM)

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Impact of AI-Generated Content on Social Media: A Case Study Across Domains

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ABSTRACT

There has been a sharp increase in use of AI generated content on social media platforms in recent times, mostly because of the need for consistent content across channels, scalability, reduced effort, and cost-effectiveness. While these posts can enhance engagement, there is also a significant risk across all age groups, including exposure to misleading information, emotional influence, and social impact. This study presents a case analysis of AI-flagged social media posts across various domains, including entertainment, sports, education, and politics. The aim of this study is to provide an insight into how AI generated content influences opinions and interactions on social media, highlighting the associated societal risks. Sentiment analysis of user comments and reactions was conducted to assess the influence of these posts, alongside user profiling to understand demographic trends among active responders. Findings indicate a high tendency for users to accept AI-generated content as authentic without verification, and to share it within their networks, which expand its reach and potential impact. The results indicate that there is a critical need for awareness of AI-generated posts and measures to limit the impact of misinformation.

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Multivariate Statistical Analysis of Readiness for Music and Yoga Interventions in Stress Management through a Pilot Study

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ABSTRACT

Stress affects physical and mental health. It is important to find ways to manage it without medication. Music therapy and yoga are two methods that can help. They can improve heart rate regulation and emotional strength. Unfortunately, there is limited data on whether people are willing to try these options. In this study, we used a survey to measure readiness of people for music and yoga for stress management. The response from 303 people was analyzed using statistical methods. The first three components of the Principal Component Analysis (PCA) analysis utilize 48% of the data. The scree plot showed an elbow after the third component were enough to reduce the data. The K means clustering was then performed on the PCA values and classified into two groups low-stress and high-stress The high-stress group had more younger people aged 19–35 and slightly more women. These results show that people differ in their readiness to use music and yoga. Our data can help design better stress management programs.

Keywords: Stress Management, Music Therapy, Principal Component Analysis (PCA), Yoga, K-Means Clustering, Emotional Well-being

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Vibration Control Using Piezoelectric Synchronized Switch Damping Techniques

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ABSTRACT

Structural vibration control is essential for enhancing the durability, reliability, and acoustic performance of engineering systems. Piezoelectric materials, due to their electromechanical coupling, offer a promising solution for passive, semi-passive, semi-active and active vibration attenuation. Among the various techniques developed, Synchronized Switch Damping (SSD) has emerged as a robust method for improving damping efficiency without requiring significant external energy input.

This work builds upon previous efforts [1] as well as fundamental study by Ducarne et al. [2], which introduced the concept of switch shunting of piezoelectric elements for vibration reduction. In SSD techniques, piezoelectric patches bonded to a vibrating structure are connected to electrical circuits via switches that operate synchronously with the structural motion. The present study focuses on careful review, modeling and implementation of SSD variants, including SSD techniques. A cantilever beam partially covered with piezoelectric patches serves as the test structure. The switching control laws are derived based on motion rules, following approaches like those in [3] and [4]. Results from analytical and numerical simulations confirm that SSD techniques significantly outperform traditional passive methods in terms of broadband damping capability and adaptability. This research contributes to the advancement of smart structural systems and lays the groundwork for future autonomous vibration control applications.

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A Hybrid Approach for Forecasting Arable Land in Iraq

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ABSTRACT

This research provides a combined forecasting model, which joins Artificial Neural Network (ANN) and Autoregressive Integrated Moving Average (ARIMA) models to forecast arable land per person in Iraq. The hybrid ANN-ARIMA has been constructed to capture the linear and nonlinear aspects of the time series, which, at the same time, improved the forecasting technique. The models are assessed based on their precision, on three statistical parameters: Root Mean Square Errors (RMS), Mean Absolute Percentage Errors (MAPE), and coefficient of determination (R^2), and goodness of fit. The results reveal an outstanding precision of forecasting with RMS = 0.1, MAPE = 0.3%, R^2 = 1, which indicates an almost perfect correlation between predicted and observed values. The forecasting results indicate a falling per capita arable land from 0.1140 hectares in 2022 to 0.1126 hectares by 2031, due to the demographic and environmental pressures still ongoing in Iraq. The results of this exercise emphasize the strength and efficacy of the hybrid ANN-ARIMA model as a sound forecasting technique, which is perfectly suitable for advice in agriculture and environment forecasting; as well as invaluable for data inside useful notice to planners and policy decision makers, to the generalist idea of struggling towards improved sustainable management of land and resource use.

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GC–MS OF BIODIESEL (FAME) PRODUCTION FROM BLENDED FEEDSTOCK OILS USING POTASSIUM HYDROXIDE AS A CATALYST

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ABSTRACT

Biodiesel offers high lubricity and a higher cetane number, which improve engine performance. In Nigeria, groundnut oil and coconut oil are readily available feed-stocks for biodiesel production. Groundnut oil is high in unsaturated fatty acids, providing good combustion properties but lower oxidative stability. Coconut oil, by contrast, is highly saturated, offering stability but relatively poor cold-flow properties. Blending the two oils provides an opportunity to combine their strengths and mitigate their weaknesses, thereby producing biodiesel with balanced properties. This study therefore focused on the production of biodiesel (Fatty Acid Methyl Esters – FAME) from a blend of groundnut oil and coconut oil using potassium hydroxide (KOH) as a catalyst through the transesterification process. The study investigates the effect of blending oils to improve fuel properties, by using GC–MS analytical method. The findings revealed that the blended oil biodiesel exhibited improved fuel quality within acceptable biodiesel standards, thus demonstrating its potential as a renewable and environmentally friendly alternative to fossil diesel.

Keywords: Biodiesel, groundnut oil, Coconut oil, KOH, transesterification, Analytical methods

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AI-Driven Software Engineering for Immersive Metaverse Experiences: Challenges and Opportunities

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ABSTRACT

The Metaverse, which integrates augmented reality (AR), virtual reality (VR), and artificial intelligence (AI), is transforming digital interactions by creating engaging, interactive, and intelligent environments. This research explores how AI-driven software engineering facilitates the growth of the metaverse through adaptive security systems, real-time personalization, and procedural content creation. Our analysis highlights significant progress in enhancing user immersion, fostering cross-platform compatibility, and automating complex tasks. The main discoveries underscore the implementation of generative models, reinforcement learning, and decentralized AI systems to tackle persistent challenges such as ethical issues, data privacy, and scalability. We also outline a comprehensive approach along with proactive strategies that could guide future developments in this evolving domain.

Keywords—Artificial Intelligence, Metaverse, Software Engineering, Virtual Reality, Machine Learning, Blockchain, Cybersecurity, Ethical AI, Procedural Content Generation..

Machine-Learning–Assisted Wavelet Whittle Estimation of Gegenbauer ARMAX

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ABSTRACT

We present a fast, robust, and hybrid estimation framework for the Gegenbauer Autoregressive Moving Average with Exogenous inputs (GARMAX) model that improves parameter recovery across diverse situations—including short samples, strong cyclic persistence, weak frequency identification, moderate model misspecification, and heavy-tailed innovations. The core estimator is a wavelet-domain Whittle pseudo-likelihood computed from nonboundary MODWT coefficients, which preserves scale-localized structure and yields an approximately diagonal covariance in the transform domain for efficient optimization. To better capture nonlinear exogenous effects, we integrate a lightweight machine-learning regressor $g(X_t;\vartheta)$ (gradient boosting or a shallow neural net) that models the exogenous response; its residuals drive the GARMAX spectral core. A compact CNN operating on wavelet scalograms provides data-driven initialization for the Gegenbauer frequency λ (with $u = \cos\lambda$), stabilizing search and reducing multimodality. Robustification via Huberized scale-wise contributions and automatic selection of informative wavelet scales enhances small-sample efficiency and mitigates transient artifacts. Monte Carlo experiments across wide grids in (d, λ), innovation distributions (Gaussian/Student-t), and signal-to-exogenous ratios show lower bias/variance in $\hat{d}$ and $\hat{\lambda}$ and more stable confidence intervals than time-domain QMLE or purely data-driven ML baselines, while maintaining interpretability through the estimated spectrum. Application to electroencephalogram (EEG), using the PhysioNet EEG Motor Movement/Imagery recordings (e.g., S001R01, 160 Hz, Fz), the method separates intrinsic oscillations (posterior peaks near the alpha band) from task-driven exogenous cues (eyes-open/closed indicators), delivering coherent estimates for $(d, u, \phi, \theta, \sigma^2, \beta)$ and improved predictive residual diagnostics relative to conventional ARMA/ARMAX.

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Plan2FEM: Can Large Multimodal Models Turn Plans into Finite-Element Graphs?

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ABSTRACT

Parsing architectural/structural plans into finite-element (FE) inputs is still a stubborn bottleneck. We investigate whether recent large multimodal models (LMMs)—both proprietary (e.g., GPT-5o, Claude 4.5) and open (e.g., Qwen-VL, Llama-3.2-Vision)—can convert 2D plan images directly into FE-ready graphs (nodes and members) in JSON. We introduce **Plan2FEM**, a task definition, strict output schema, and a validation/repair pipeline, and benchmark models with element-detection F1, adjacency accuracy, and structural sanity checks. Our study shows that proprietary LMMs are typically stronger at end-to-end topology assembly and OCR-free parsing, especially on cluttered drawings with heavy annotation; state-of-the-art open models approach parity on clean, high-contrast plans but lag when symbols overlap or scale cues are ambiguous. Across all models, errors concentrate in scale recovery, node snapping at intersections, and resolving overlapping linework; zero-length members and dangling nodes remain common failure modes. A hybrid approach—lightweight document/primitive detectors feeding an LMM "planner" constrained by the schema—consistently improves connectivity and geometry while preserving the flexibility of LMM reasoning. We release prompts, schema, and evaluators to enable reproducible comparisons and conclude that LMMs can produce usable FE graphs in constrained settings today, but robust deployment still benefits from detector-assisted pipelines and post-validation.

Key resources: GPT-5o and Claude 4.5 (proprietary LMMs); Qwen-VL and Llama-3.2-Vision (open LMMs), JSON Schema validators, FAISS + text-embedding-3-small (RAG).

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Generative AI–Driven Corrugated Board Design Recommendations on the Pareto Front

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ABSTRACT

Selecting corrugated board grades demands explicit trade-offs among weight, edge-crush strength (ECT), and out-of-plane stiffness. We present an AI-driven recommendation system that combines Pareto-front navigation with a domain-grounded generative AI layer to accelerate decisions and lower cost. Engineers express priorities (e.g., lightweighting vs. stiffness); these preferences are mapped to a reference direction over normalized objectives, and candidates on a precomputed Pareto set are ranked with a simple geometric score to yield a single, reproducible recommendation. On top of this selector, a generative AI module transforms the chosen (and nearby) Pareto-optimal designs into supplier-ready specification text, plain-language justifications, and side-by-side comparisons, all constrained to the validated design space. In practice, this turns multi-day, iterative email/test cycles into an interactive, minutes-scale workflow: fewer back-and-forths with suppliers, reduced over-specification, and faster convergence to fit-for-purpose grades—thereby cutting both engineering time and material cost. Consistent with recent literature, our approach advances calls for multi-objective, Pareto-guided optimization as a key lever for sustainable and cost-effective corrugated design [1].

* The asterisk denotes the presenting author.

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Implementation of Dispatching Rules for Job Scheduling in a Mobile Printer Assembly Line: A Case Study in Electronic Components Manufacturer

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ABSTRACT

This study investigates the application of dispatching rules to enhance job scheduling optimization in a mobile printers assembly line of an electronics company. The research issue is the inefficiency under the current First Come First Served (FCFS) strategy resulting in longer completion time and increased overall tardiness, thereby disrupting on-time delivery and overall productivity. Based on the case study method, four dispatching rules - Shortest Processing Time (SPT), Earliest Due Date (EDD), Longest Processing Time (LPT), and FCFS - were applied to actual data of 14 jobs with processing times and due dates for three machines. Total completion time and total tardiness were used to measure performance. These findings indicate that SPT and EDD significantly surpass FCFS and LPT, with SPT registering a total completion time of 81 time units and a total tardiness of 24, and EDD registering 82 and 25, respectively, compared to FCFS values of 101 and 56. LPT was worst at 138 and 94. It is recommended that the company adopt either SPT or EDD to enhance scheduling effectiveness, reduce operation delays, and maximize utilization of resources, with possible refinements to hybrid rules or dynamic settings in future research.

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Examining Forest Disturbance Using Artificial Intelligence and Remote Sensing Techniques

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ABSTRACT

This study examines forest disturbance in the Ajloun region of Jordan using artificial intelligence and remote sensing over four decades (1986–2025). Multi-temporal satellite images have been integrated with environmental variables such as rising temperature trends and shifting precipitation patterns, topographic elevation, soil moisture proxies, and land surface temperature (LST) data, as well as anthropogenic pressure indices to identify drivers of forest change. Advanced computational approaches have been employed, such as supervised machine learning classifiers (Support Vector Machines and Random Forests) for land cover mapping, combined with Principal Component Analysis (PCA) for spectral dimensionality reduction; regression models to quantify climate–vegetation relationships; and spatial autocorrelation (e.g., Moran's I) to assess clustered disturbance patterns.

Results indicate robust model performance and significant land cover transitions: the supervised classification achieved an overall accuracy of 83–90% (Kappa 0.82–0.86), providing a reliable basis for change detection. Forest cover declined by approximately 8% of the study area, while built-up (urban) land increased by about 4% (nearly doubling in extent, 2% annual growth). Climate analysis shows a strong coupling between precipitation and vegetation health: NDVI-based vegetation cover correlates with total rainfall (R^2 = 0.87), consistent with precipitation–NDVI relationships in semi-arid ecosystems. Rising temperatures and drought frequency over the study period have further exacerbated forest stress, as reflected by higher LST and reduced soil moisture during disturbance events. These multi-faceted findings underscore the combined impact of climate change and unchecked urban expansion on forest ecosystems, offering critical insights for environmental monitoring and evidence-based guidance for policy-making and regional planning. Moreover, the integrative approach supports optimization-driven architectural design strategies for sustainable development in data-constrained, mountainous, and climate-sensitive regions.

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Machine Learning-Based Employee Productivity and Retention Analytics for Small and Medium Enterprises (SMEs) in Ghana

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ABSTRACT

This study explores the application of AI-driven analytics to enhance workforce management in Ghanaian SMEs, focusing on predicting employee attrition and optimizing productivity. Employee turnover, which refers to employees who leave an organization and productivity management remain significant challenges but are under-researched for Small and Medium Enterprises (SMEs) in Ghana, where limited resources hinder the adoption of advanced human resource analytics [1]. High attrition rates disrupt workflow and decrease productivity, increase recruitment costs, and reduce overall firm performance. Conventional Human Resource (HR) methods frequently fall short in identifying the risks associated with employee engagement and retention. Using Natural Language Processing (NLP) models (BERT, GPT-4), this study analyzes employee sentiment from surveys, internal communications, and performance reviews to identify key factors influencing job satisfaction. Additionally, machine learning classifiers (Random Forest, XGBoost, SVM) are employed to predict employee turnover based on work patterns, attendance records, and engagement metrics [2]. Time-series models (LSTMs, ARIMA) further assess productivity trends, enabling business owners to implement proactive retention strategies. Findings from this study provide SMEs with a data-driven approach to employee retention and performance optimization, reducing operational disruptions and improving firm competitiveness. By integrating AI-powered analytics, SMEs can shift from reactive HR management to predictive workforce planning, ensuring sustainable growth in Ghana's evolving business landscape.

Keywords: Employee retention, Productivity optimization, Machine learning in HR, SME workforce management. Natural Language Processing (NLP)

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Implementing an Internet of Things (IoT)-Based Street and Traffic Light Monitoring System in the Cities in Ghana

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ABSTRACT

This study designs and implements an Internet of Things (IoT)-based monitoring and control system aimed at improving operational efficiency, enhancing public safety, and supporting data-driven maintenance decisions. Urban street lighting and traffic-signal systems in Ghana often face challenges such as energy inefficiency, delayed fault detection, and inadequate centralized monitoring [1]. The system architecture employs NodeMCU (ESP8266/ESP32) microcontrollers as edge controllers interfacing with light-dependent resistors (LDRs) for ambient light detection, voltage and current sensors for monitoring electrical health, gyroscope sensors for stability analysis, and traffic-light modules for automated signal control. Firmware was developed using the Arduino IDE, while a cloud-integrated web dashboard enables real-time visualization, remote device control, system analytics, and an interactive device-location map [2]. The project adopted an iterative and incremental development methodology that allowed progressive integration, testing, and refinement of hardware, software, and communication subsystems. Controlled laboratory tests and limited field trials confirmed the system's ability to detect ON/OFF states, identify electrical faults accurately, and maintain proper traffic-light sequencing with low latency [3]. The dashboard successfully aggregated and displayed live data, generating alerts for anomalies in real time. The prototype demonstrates a cost-effective, scalable framework for centralized monitoring of urban lighting and traffic infrastructure. Future recommendations include improving communication reliability through MQTT QoS, integrating solar power, implementing predictive analytics, and strengthening end-to-end cybersecurity.

Keywords: IoT, Smart City, Street Lighting, Traffic Management, Real-Time Monitoring

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An IoT-Enabled Water Quality Monitoring System for Communities Affected by Illegal Mining (Galamsey) Activities in Ghana

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ABSTRACT

This study presents the design and implementation of an IoT-enabled water quality monitoring system developed to address pollution caused by illegal mining (galamsey) activities in Ghana. Illegal mining operations have severely contaminated rivers and streams, posing serious health risks and threatening community water supplies which is affecting livestock in these communities since they drink from these rivers.

Traditional water testing methods are often slow, manual, and lack real-time data, limiting timely responses [1]. To solve this, a real-time monitoring system integrating pH, turbidity, and temperature sensors with a NodeMCU/ESP8266 microcontroller was developed. The system transmits data wirelessly to a ThingSpeak cloud dashboard for continuous visualization and analysis.

Using the Spiral Model, the project underwent iterative cycles of planning, risk assessment, and testing. Hardware implementation involved sensor calibration, microcontroller programming with C++ (Arduino IDE), and Wi-Fi connectivity validation. Testing confirmed reliable performance, accurate readings, and effective real-time logging [2].

The system provides environmental agencies and communities with immediate access to actionable water quality data, supporting informed decision-making and timely interventions. It demonstrates how IoT technology can enhance environmental monitoring and public health protection.

The study recommended that future developments may include solar-powered operation, machine learning-based predictive analytics, and mobile app integration to strengthen sustainability and accessibility.

Keywords: Internet of Things (IoT), Water Quality Monitoring, Galamsey, Environmental Sustainability, Real-Time Data

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Sustainable Tourism: A Multi-Objective Optimization Framework for Juneau and Beyond

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ABSTRACT

This study explored the tourism development plans under different policy orientations through a multi-objective optimization model. Taking Juneau, Alaska, USA as a case, it deeply analyzed the complex balance relationship among economic benefits, social satisfaction, and environmental protection in a tourist city.

Based on the concept of human-land coordination, a comprehensive evaluation index system including fiscal revenue, social satisfaction, and total carbon emissions is constructed. Key variables such as the number of cruise ships, tourist scale, residents' income, housing costs, and infrastructure carrying capacity are comprehensively considered. Through a quantitative model, the multi-dimensional interaction mechanism in tourism development is revealed. The study founds that the three evaluation indicators are difficult to simultaneously meet the requirements to a certain extent. A dynamic regulation mechanism has been established through refining policy parameter adjustments, meanwhile the negative impact on the environment has been minimized as much as possible to ensure economic benefits and social satisfaction.

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ABSTRACT

The article evaluates how certain machine learning computing methods, as part of the larger phenomena of Artificial Intelligence (AI), deepens the connections of investments to FinTech as an emerging innovation and sustainability. The Random Forest technique extends the parameters of transactions and investments on finance with respect to a carbon footprint, ESG scores, and levels of seconded FinTech adoption. The modelling proofs the potential for predictive analytics on creating new investments to which the suggestive analytics of AI, for the purpose of financial decision making, have been verified. The analyses suggested carbon footprint and ESG scores can even arise out of the first primary predictors to sustaining forecasting investment activities to create sustainable investment. The ESG criteria seemed to be more prevalent present investment parameters for both financial primary and socially responsible financial decision making and strategies. Also, the FinTech and AI synergy in the green finance modelling supports new sustainable investments with better financial capital allocation, the palliative reduction of risky investments, and transparency. The article contributes a great deal toward creating an sustainable machine learning predictive financial investment. The future ready Artificial Intelligence based fintech computing models and solutions have the potential to facilitate more inclusive financial services.

Keyword: Artificial Intelligence, AI-Driven Financial Analytics, Sustainable Investment Strategies, AI Computing and Modeling, Carbon Footprint Forecasting, Regulatory Technology, SDGs

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Innovative Tools for Cost Management in the construction industry: A systematic review

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ABSTRACT

The construction industry faces various risks with cost overruns plaguing projects during their implementation (Regona et al., 2022). Recent advances in available tools and artificial intelligence offer promising solutions to better manage risks and control cost overruns. This systematic literature review (SLR) explores the integration of innovative tools in the construction sector focusing on recent technological advancements, areas of application with respect to cost management, potential benefits and the current barriers. The PRISMA protocol was adopted for the SLR, utilizing two main databases, namely Scopus and IEEE Xplore. The search focused on the main areas of "innovative technology" and cost management, with a rigorous process adopted for the identification, selection and critical appraisal of studies. This was followed by an analysis to uncover research trends, influential authors and thematic clusters. A total of 72 papers were selected and findings from these indicate that technology is increasingly transforming the field of construction project management by providing advanced tools such as machine learning, natural language processing, and predictive analytics that enhance decision-making, improve efficiency, and reduce risks. Yet, although several tools have emerged for management of cost, it is found that their uptake is notably slower compared to other sectors due to technological, organizational, economic and regulatory barriers (Chong et al., 2021). The findings of this study indicate that regulatory frameworks and on-the-job-training are essential to ensure that construction industry professionals leverage the potential of innovative techniques for cost management in projects.

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Rule-based expert system for risk analysis and mitigation in construction projects

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ABSTRACT

This study presents the development and validation of a rule-based expert system designed to assist risk analysis and mitigation in construction projects. The system integrates the C Language Integrated Production System (CLIPS) as the inference engine with a Python-based graphical user interface (Tkinter), combining computational transparency with practical usability. It automates the calculation of the Risk Priority Number (RPN) following the Failure Mode and Effects Analysis (FMEA) approach, assessing twenty critical risk factors based on severity, probability, and detectability. Fifty simulated construction scenarios and expert validation involving five professionals were conducted to evaluate accuracy and consistency. The system achieved a 92% agreement with expert assessments, precision of 0.89, recall of 0.98, and a System Usability Scale (SUS) score of 82/100, confirming its reliability and accessibility for non-technical users. Compared to fuzzy FMEA and machine learning methods, the proposed approach demonstrated superior interpretability and computational efficiency, with an average inference time of 1.2 seconds per scenario. These results validate the system as a cost-effective, interpretable, and open-source decision-support tool for enhancing safety and performance in construction risk management.

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Portable machine tool design for large-diameter component machining: a field-oriented engineering approach

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ABSTRACT

This study presents the design, development, and validation of a portable machine tool capable of machining large-diameter components (up to 1,200 mm) directly under field conditions, addressing a recurrent limitation in industrial maintenance, the impossibility of transporting oversized parts such as flanges and cylindrical couplings to conventional workshops. By integrating modular architecture, structural optimization, and a dual-drive mechanism (electric/pneumatic), the proposed equipment achieves both mobility and precision suitable for in-situ operations in pipeline systems, refineries, and construction sites. The design process followed a four-stage engineering methodology comprising conceptual design, structural modeling via finite-element analysis (FEA), system assembly, and experimental validation. The FEA demonstrated a maximum deformation of 0.042 mm and a minimum safety factor of 3.8, ensuring mechanical stability, while experimental results confirmed dimensional accuracy within ±0.1 mm, vibration amplitude below 15 µm, and setup time under 60 minutes. The modular and reconfigurable structure reduced total system mass by 35%, and a comparative cost analysis showed a 52% reduction in maintenance costs relative to outsourced machining. Environmentally, the system decreases energy consumption and CO_2 emissions by approximately 40% through localized processing. These outcomes validate the proposed approach as a sustainable and economically viable solution for industrial maintenance, highlighting how engineering-based design aligned with Industry 4.0 principles.

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Enhanced MPPT Algorithm for Photovoltaic Systems Based on Fuzzy Logic Control

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ABSTRACT

This study introduces an enhanced Maximum Power Point Tracking (MPPT) algorithm for Photovoltaic (PV) systems, utilizing a robust Fuzzy Logic Control (FLC) strategy. Traditional MPPT methods, such as Perturb and Observe (P&O) and Incremental Conductance (InC), often face a trade-off between achieving fast convergence and minimizing power oscillations during steady-state operation.The proposed FLC-based technique overcomes these drawbacks by employing linguistic fuzzy rules to adaptively adjust the perturbation step size (duty cycle). The FLC takes the power change ΔP and voltage change ΔV (or the power-voltage gradient *dP/dV*) as inputs to dynamically determine the appropriate step change in the duty cycle ΔD. This intelligent mechanism ensures rapid convergence when the operating point is far from the Maximum Power Point (MPP) and effectively suppresses steady-state oscillations when the MPP is reached.Simulations conducted on a PV system integrated with a boost converter demonstrate that the proposed FLC method achieves superior tracking capability and stability compared to conventional InC techniques. Due to its inherent robustness against system non-linearity and its non-reliance on a precise mathematical model, the FLC algorithm is highly suitable for real-time PV applications operating under dynamic environmental conditions, offering improved system efficiency and operational stability.

Keywords: Photovoltaic systems, MPPT, fuzzy logic control (FLC), adaptive step size, power optimization, boost converter.

* The asterisk denotes the presenting author.

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Optimization of Onshore wind turbine foundation. - Analysis of the method and advantages

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ABSTRACT

The green energy sector is continuously evolving, attracting significant attention from stakeholders committed to reducing environmental impact, lowering costs, and developing infrastructure that meets increasingly stringent regulatory standards. While wind energy research has primarily focused on optimizing tower and blade design to maximize efficiency, comparatively little attention has been given to the foundation systems, which are often based on generic manufacturer specifications.

This study presents an innovative approach to optimizing onshore wind tower foundations, balancing both engineering integrity and financial viability. The methodology includes a detailed analysis of critical load cases, with particular emphasis on overturning resistance, all within the framework of Eurocode compliance. The proposed foundation is designed as a beam-slab system incorporating voids filled with soil—either reused from excavation or sourced from designated deposits.

This optimized solution significantly reduces construction costs by minimizing the use of steel and concrete, while also improving installation efficiency and reducing construction time. At the same time, it enhances the structural performance of the foundation by targeting the most critical components affecting its overall behavior and stability.

Acknowledgements

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Comparison of Onshore & Offshore Wind Turbine Foundations – A Comprehensive Review

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ABSTRACT

The green energy sector is rapidly evolving, attracting strong interest from stakeholders committed to minimizing environmental impact, reducing costs, and developing structures that meet rigorous sustainability standards.

While wind energy research has largely concentrated on optimizing tower and blade designs for maximum efficiency, the design of wind tower foundations—often predetermined by manufacturers—has received comparatively limited attention and has remained relatively unexplored.

This study introduces a comparative approach of onshore & offshore wind turbine foundations emphasizing both engineering, operational and financial feasibility. The approach involves a comprehensive analysis of design loads for both cases, implementation field particularly emphasizing the structural parts of each type of wind turbine foundation, while ensuring compliance with cost efficiency and highlighting the need for optimal use of each type to enhance overall system performance and cost - efficiency.

The type of each wind turbine foundation is thoroughly analyzed and extended emphasis is drawn on further analysis of each category of onshore and offshore wind turbines foundation. The conclusions include the significance of separating onshore and offshore wind turbine foundations, their structural distinction and the unexplored field of further optimizing each type so as to fully comply with the needs of each type.

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Literature Overview of Offshore Floating Wind Turbine Foundations.

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ABSTRACT

Offshore wind energy has emerged as a leading solution in the green energy sector, with steadily increasing effectiveness. Offshore wind turbines are preferred over onshore alternatives due to stronger and more consistent wind conditions at sea, which allow for higher energy production. These systems are generally categorized into two main types: fixed offshore wind turbines and floating offshore wind turbines (FOWTs).

This study presents a holistic analysis of the entire foundation system for offshore wind turbines, with particular emphasis on floating systems. The findings highlight the importance of further advancing floating offshore technologies, which play a critical role in enhancing stability while accounting for wave dynamics and environmental loads. These elements are systematically analyzed to better harness their effects for the benefit of FOWT foundation performance.

Recent research has demonstrated significant achievements, including effective vibration suppression, reduction of pitch motion, and the realization of low moments of inertia in both bending and torsion—key factors in improving overall system behavior.

Despite these advancements, there remain important challenges and opportunities for further innovation. For instance, monopile depth implementation can be further optimized, jacket structures can be redesigned for more efficient fabrication, and materials used in gravity-based systems can be enhanced for performance and sustainability. Additionally, the costs associated with tripods and tension leg platforms can be targeted for reduction to improve feasibility at scale.

Lastly, this work includes a comprehensive review of existing literature to contextualize current advancements and identify areas where further research is needed, offering a clear overview of the progress achieved and the future direction of offshore wind foundation development.

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Multi-Scenario Simulation and Performance Analysis of Intelligent Transportation Systems Based on VANET Using SUMO and OMNeT++

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ABSTRACT

Intelligent Transportation Systems (ITS) are critical for modern urban mobility, aiming to enhance road safety, reduce traffic congestion, and optimize travel efficiency. This study presents a multi-scenario simulation framework for analyzing ITS performance using Vehicular Ad-Hoc Networks (VANETs). The framework integrates SUMO for traffic simulation, OMNeT++ for network communication, and Veins for vehicular network integration. The research focuses on key parameters including vehicle arrival rate (λ), road type (urban vs highway), and mixed vehicle speeds to evaluate their impact on traffic flow, trip time, and speed distribution.

Results demonstrate that higher arrival rates significantly increase trip time and congestion, particularly in urban networks. Mixed-speed traffic introduces variability in inter-vehicle distances, affecting both network connectivity and mobility patterns. Simulations using real-world road maps from OpenStreetMap validate the scalability and realism of the proposed model. The study confirms the value of VANET-enabled ITS for improving traffic safety and efficiency, offering a robust simulation methodology for future adaptive routing protocols and smart mobility applications.

Keywords: Intelligent Transportation Systems; VANET; SUMO; OMNeT++; Veins; Arrival Rate; Traffic Simulation; Performance Analysis.

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Numerical Study on Enhancing Convection Heat Transfer in Back Step Cavity

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ABSTRACT

The present study analyses the laminar flow and heat transfer over a backward-facing step with an isotherm wall in a channel and cavity except the heated bottom wall of the gap. The governing Navier-Stokes and energy equations are solved using finite volume method, ANSYS Fluent 2022R2.

The effect of Reynolds number on the fluid flow and heat transfer characteristics of the backward facing step flow have been studied numerically. The range of Reynolds number are (100-250). The working fluid is assigned a Prandtl number of 0.71 throughout this investigation. The flow and thermal fields have been explained by streamline and isotherm profiles respectively. It is observed that the flow field and heat transfer rate are influenced by the variations of Reynolds number. Noted that when Reynolds value increase the values of Nusselt number increases.

Keywords: Heat Transfer; Laminar flow; Cavity; Back step; Ansys Fluent; Reynolds number.

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Optimization Design of a Ming-Style Round-Backed Armchair Using Bamboo-Integrated Material with the Finite Element Method

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ABSTRACT

In response to the increasing demand for sustainable materials in the era of "green development," bamboo-integrated materials have emerged as a viable, eco-friendly alternative to expensive and unsustainable hardwoods in furniture design. Traditional Ming-style round-backed armchairs, typically made from hardwood, are celebrated for their ergonomic design, durability, and aesthetic elegance. However, there is limited research on how bamboo can effectively replace hardwood while maintaining these qualities and enhancing sustainability and material efficiency. This paper aims to explore the use of bamboo-integrated material as the primary material for a Ming-style round-backed armchair, utilizing the Finite Element Method (FEM) to optimize the structure for high strength and material efficiency. Additionally, mechanical testing is conducted on bamboo-integrated materials to aid in material selection, and the stability of the armchair's traditional Chinese connection structure is analyzed. In the methodology section, Finite Element software Ansys Workbench is used to simulate the strength of the bamboo-integrated materials, followed by mechanical properties testing, detailed simulation analysis, and structural optimization of the chair's design. The results indicate that bamboo-integrated material possesses excellent mechanical properties for use in furniture. Moreover, weaknesses in traditional furniture design, particularly in connection points, are addressed through structural optimization, resulting in improved material utilization efficiency and a shortened design cycle. To verify the accuracy of the FEM results, a physical test is conducted on the optimized chair prototype, with the results compared to the FEM simulations. The findings confirm that using FEM to simulate the loading of the chair produces reliable data. By addressing these practical aspects, manufacturers can successfully translate theoretical advancements into real-world applications, offering numerous possibilities for future innovation in furniture design.

Keywords: Finite element method; Bamboo integrated material; Structure optimization design; Chinese Ming dynasty armchair; Ansys workbench

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The Impact of Corporate Governance on Investment Decisions: International Experiences and Implications for Vietnamese Industrial Enterprises

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ABSTRACT

In the context of globalization and unpredictable legal fluctuations, corporate governance is increasingly considered as a key factor determining investor confidence and corporate value. This study analyzes the impact of governance structure on investment decisions, focusing specifically on industrial enterprises in Vietnam. Based on Agency Theory, Stewardship Theory, Stakeholder Theory, Institutional Theory, and Behavioral Theory of the Firm, the study compares international governance models such as Anglo (US), Continental Europe and East Asia to show how institutional context shapes board structure, ownership model, disclosure standards and investor protection. The results show that enterprises with good governance foundations are more transparent, less exposed to financial risks and more attractive to long-term investors. International evidence also shows that reforms such as strengthening board independence, improving disclosure requirements and protecting shareholder rights help reduce the cost of capital and attract more investment flows. In Vietnam, despite progress in institutional reform and increasing foreign investor participation, many limitations still exist, such as the strong influence of state-owned and family-owned enterprises, weak enforcement mechanisms, and a shortage of professional executives. To overcome this, the study proposes policy solutions including harmonizing the legal framework with international standards, improving transparency and accountability, strengthening board capacity and promoting ESG practices. Overall, the results show that improving corporate governance is not only a prerequisite for attracting sustainable investment but also a necessary strategy to strengthen the competitiveness and long-term development of Vietnamese industrial enterprises.

Keywords: Corporate governance, investor attraction, Vietnam industrial enterprises, international experience, policy implication.

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Performance–Energy Efficiency Tradeoff Analysis of Distributed Multi-RIS Systems under Co-Channel Interference

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ABSTRACT

This paper provides a comprehensive investigation of the performance and the tradeoff between spectral efficiency and energy efficiency (EE) in distributed Multi-RIS-aided wireless systems under Co-Channel Interference (CCI). Two operation schemes are compared: the Exhaustive RIS-Aided (ERA) scheme, where all RISs participate, and the Opportunistic RIS-Aided (ORA) scheme, where only the strongest RIS is activated. Under a realistic i.n.i.d. Nakagami-*m* fading model, the Method of Moments framework is employed to characterize the end-to-end (E2E) Signal-to-Interference-plus-Noise Ratio (SINR). The analysis is further extended to derive the Ergodic Capacity (EC) and Energy Efficiency (EE). Numerical results demonstrate that ERA achieves higher EC but suffers reduced EE due to increased circuit power consumption at multiple RISs, whereas ORA attains higher EE in the low-rate region due to lower hardware energy costs. The impact of CCI is found to be substantial, introducing a clear interference floor that limits the achievable performance of both schemes.

Keywords: Multi-RIS, Co-Channel Interference (CCI), Energy Efficiency (EE), SINR, Nakagami-*m*, Method of Moments.

* The asterisk denotes the presenting author.

Topology Optimization for Daylight Analysis (T.O.DAY): A Constructability-Driven Methodology for Additively Manufactured Façades.

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ABSTRACT

The early study of Topology Optimization for Daylight Analysis (T.O.DAY) has demonstrated interesting results regarding how to reduce a façade's material us-age while achieving optimal Daylight Autonomy (DA) in a space's interior. Building on this foundation, this paper focuses on the critical challenge to translate the purely optimized façade geometry into constructible, real-world solutions. This paper develops constraints related to additive manufacturing in the early design stages. To achieve that, instead of having a void and solid element, we replaced the void element with a new element that is a frame element with a rectangular whole in the middle. This modification resolved 100% of the continuity issues found in the unconstrained T.O.DAY geometries, leading to a system that is fully ready for large-scale additive manufacturing. This study validates a robust framework for integrating manufacturing constraints into Daylight Analysis in the early design phase.

Keywords: Topology Optimization (TO), Daylight Analysis, Daylight Autonomy (DA), Additive Manufacturing (AM), Façade Design, Constructability, Early De-sign Stage
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International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

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Machining Process Design and Quality Evaluation of Freeform Surface in Ultra-Precision Turning Based on Diffsys Software

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ABSTRACT

Freeform (FF) surfaces have outstanding physical and optical properties, so they are widely used in advanced optical systems. In this study, a "Design and programming" process for FF surface machining is presented. The process is implemented on Diffsys software, including describing the parameters of freeform surfaces, simulating machining and checking in Diffsys before exporting G-codes. A modern tooling technique that combines many complex movements between the spindle and the cutting tool to create rotationally asymmetric surfaces is used. That is the slow tool servo (STS) technique on an ultra-precision lathe (UPT). The approach in this study provides an important way to better understand the shaping and forming mechanism of FF surfaces. A low-order Zernike free surface is designed, programmed and measured for demonstration purposes. Experimental results demonstrate the feasibility of the DiffSys-based machining programming approach using STS techniques. At the same time, this is also the foundation for expanding the optimization of product quality indicators in the future such as shape accuracy, surface quality, and machining time.

Keywords: UPT; Freeform surface; Toolpath generation; Slow tool servo; NC- Diffsys

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Research on Measuring Technique of the Quality Indexes for Diffraction Surface on White Light Interferometer Equipment in Ultra-Precision Turning

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ABSTRACT

The diffraction (DF) surface is a surface with a complex structure consisting of many grooves designed and manufactured to distribute the desired phase to control the complex light field that is difficult or impossible for traditional optical surfaces. To achieve the best performance for diffraction lenses, the evaluation criteria for the quality of the DF surface are very important. Typical factors for evaluating the quality of the DF surface are surface roughness (Ra), profile error (FE), step height (SH), and side angle (SA). Roughness and profile error must be the smallest, step height and side angle must be closest to the theoretical calculation value. Through the study of the white light interferometer (ZeGage Pro HR), it can be seen that the evaluation criteria for the quality of the DF lens surface can be measured on the white light interferometer. Through this article, it is possible to grasp the method of measuring parameters of Ra, SH, SA and lay the foundation for further research and development to measure more complex surfaces.

Keywords: Diffraction surface, step height, roughness, side angle, white light interference

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Multi-objective optimization of quality indicators of Copper alloy sphere surface in ultra-precision turning using MRA technique and biomimetic optimization algorithms

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ABSTRACT

This paper presents the results of building a prediction model and multi-objective optimization for the quality indicators of a Copper alloy surface in ultra-precision turning (UPT). The prediction model is built on the basis of multivariate regression analysis (MRA) technique with a data set formed from a reliable experimental matrix. The model evaluation criteria include R2, MSE, RMSE and MAPE. In addition, a number of other criteria are also considered to increase the reliability of the model. Biomimetic multi-objective optimization algorithms based on the simulation of the behavior of animals in nature are used to determine the Pareto surface, which is a surface that allows the superiority of quality indicators to be evaluated when there are many outputs that need to be prioritized. The research results are important in confirming the effectiveness of the applied methods of modeling and multi-objective optimization. Furthermore, these results also serve as a basis for developing research on the machining quality of similar ultra-precision surfaces.

Keywords: Ultra-Precision Maching, Copper alloy, MRA, Optimization algorithms

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An Explainable Hybrid Machine Learning Approach for Early Diabetes Prediction: Comprehensive Feature Engineering and Multi-Model Analysis

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ABSTRACT

Diabetes is one of the major health issues worldwide and early prediction can have a huge impact in the lives of those affected by the disease. In this work, we have developed an end-to-end machine learning pipeline for the prediction of diabetes based on a complete feature engineering task followed by a thorough, head-to-head comparison of multiple models, and we have used the PIMA Indian Diabetes dataset to train and test 11 algorithms, including ensemble methods, gradient boosting, and classical classifiers, while also engineering 24 new features in order to capture relevant interactions, risk factors, and clinically important patterns. We have evaluated the models' generalization capabilities by testing them on four different train-test splits, specifically 80:20, 70:30, 60:40, and 50:50, and in the 80:20 split, LightGBM had the best performance, with 77.9\% accuracy, an F1-score of 0.685, and an AUC-ROC of 0.810, while Random Forest, with 77.3\% accuracy, and XGBoost, with 76.6\% accuracy, came in close second, although K-Nearest Neighbors was the worst performer, with an accuracy of 68.8\%. Hyperparameter tuning was observed to improve model performance across all metrics for the best performing models, and consequently, we have also developed a FastAPI web application that provides a simple, practical interface for real-time risk assessment. Importantly, the explainability analysis indicated that our engineered Health Risk Score was the strongest predictor, because it demonstrated both robust model performance and interpretable, clinically meaningful insights, and therefore, our study contributes to the literature of explainable AI in healthcare.

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Advanced Feature Engineering and Machine Learning for Hybrid Wi-Fi/BLE Indoor Localization: A Comprehensive Study

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ABSTRACT

Indoor localization has become increasingly critical for location based services in smart buildings, healthcare facilities, and industrial environments. This paper presents a comprehensive study on hybrid Wi-Fi/BLE fingerprinting based indoor localization using advanced feature engineering and machine learning techniques. We collected a dataset of 1,142 fingerprints from 15 reference points within a 6 × 14 m area, incorporating both Bluetooth Low Energy (3 beacons) and Wi-Fi (7 APs) Received Signal Strength Indicator (RSSI) measurements. Ten-scan windows were averaged into fingerprints, yielding 1,142 samples after filtering. Through systematic feature engineering, we derived 47 discriminative features from original RSSI measurements, including statistical aggregations, signal quality indicators, technology-specific features, and stability metrics. We evaluated eight machine learning algorithms with appropriate regularization to ensure realistic generalization performance. Our experimental results demonstrate that ensemble methods, particularly Random Forest and Gradient Boosting, achieve accuracies of 89.53% and 88.95%, respectively, with excellent cross validation consistency. Comprehensive ablation studies confirm that our engineered features provide significant improvements over raw RSSI measurements, and overfitting analysis indicates robust generalization across all models.

Keywords: Indoor localization, Wi-Fi fingerprinting, BLE RSSI, machine learning, feature engineering, ensemble methods, Random Forest, Gradient Boosting

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Global Human Resource Management: Navigating talent Across borders

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ABSTRACT

Global Human Resource Management (GHRM) is critical for navigating talent across boundaries in an increasingly interconnected environment. As businesses develop globally, managing a varied and geographically dispersed staff has become both a strategic benefit and a challenging task. This study, which draws on secondary data from academic publications, organisational reports, and worldwide HR surveys, investigates how GHRM practices contribute to effective talent acquisition, development, and retention across various cultural and legal contexts. The report highlighted significant strengths such as access to a global talent pool, cultural diversity-driven creativity, and operational scalability improvements. However, it also identifies challenges such as communication barriers, cultural misunderstandings, compliance complexities, and the high costs associated with international mobility. Opportunities originating from global trends, including remote work, diversity and inclusion programs, and cross-cultural management, are also investigated. The findings indicate that organisations that implement adaptive HR strategies, technological integration, and culturally sensitive policies can obtain a long-term competitive advantage in the global market. Overall, the study emphasises the necessity of aligning global HRM practices with organisational goals to improve worker performance, develop cooperation, and assure long-term success in today's global business climate.

Keywords: Global Human Resource Management, SWOC Analysis, Multinational Corporations, Globalisation, Cultural Diversification.

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Adaptive Crow Search Algorithm with Dynamic Neighborhood *Structures* for Flow Shop Scheduling Problem

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ABSTRACT

The Flow Shop Problem (FSP) concerns determining the optimal sequence of jobs processed across multiple machines in a fixed order. The importance of FSP is due to the fact that it is frequently encountered in production factories. However, this problem is known to be NP-hard [1], which makes it difficult to solve exactly within a reasonable time for large instances. Therefore, researchers often rely on heuristic and metaheuristic approaches to obtain high-quality solutions.

This paper proposes an enhanced version of the well-known crow search metaheuristic [2], called Adaptive Crow Search Algorithm (ACSA), which can be used to solve permutation flow shop problems. The main innovation of ACSA lies in a structured adaptive mechanism that dynamically balances exploration and exploitation phases. The proposed framework incorporates a multi-strategy neighborhood approach capable of switching between diverse local search operators based on real-time performance metrics. Additionally, a dedicated stagnation detection mechanism continuously observes the search progress and introduces diversification strategies when the algorithm shows signs of stagnation or limited improvement. Preliminary evaluation on FSP benchmark datasets demonstrates that the proposed algorithm significantly improves solution quality compared to basic crow search algorithm, particularly for large-scale scheduling instances.

Keywords: Flow shop problem, Crow search algorithm, Dynamic neighborhood structure, Diversification

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Implementation of the Approximate Factorization 2 (AF2) Method in Solving Heat Equation

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ABSTRACT

Numerical methods play a crucial role in solving two-dimensional partial differential equations. This study aims to apply the Approximate Factorization 2 (AF2) method to solve heat equation. The AF2 method factorizes a two-dimensional operator into the product of two one-dimensional operators, allowing a large system to be decomposed into two simpler tridiagonal systems. This approach provides second-order temporal accuracy and high numerical stability.

The simulation results show that the AF2 method produces stable and convergent solutions with a small relative error compared to the analytical solution of the heat equation. In addition, the AF2 method also has potential applications in computational aerodynamics, particularly for solving the Full Potential equation that describes inviscid and irrotational flow around an airfoil.

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Application of the Alternating Direction Implicit (ADI) Method to the Full Potential Equation

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ABSTRACT

The Alternating Direction Implicit (ADI) method is an efficient and stable numerical technique for solving two or multidimensional partial differential equations. The main advantage of this method lies in its ability to decompose a two dimensional system into two one dimensional stages, alternately solved in the x and y directions using an implicit scheme. This strategy produces a tridiagonal matrix system that can be efficiently solved using the Thomas algorithm, thereby reducing computational complexity without compromising stability and accuracy. In this study, the ADI method is applied not only to parabolic (heat) equations but is also extended to the Full Potential equation, which is widely used in aerodynamic analysis. The results demonstrate that the ADI method provides numerical solutions that closely approximate the exact ones, with very small error magnitudes, while maintaining numerical stability even over long time intervals. With these characteristics, the ADI method proves to be an effective and reliable general approach for solving various complex multidimensional partial differential equations, including aerodynamic modeling based on the full potential equation.

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Algorithm for Generating Signal-Like Interference in a Retransmitter using Autocorrelation Processing

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ABSTRACT

Synthetic Aperture Radar (SAR) systems are installed on both conventional aircraft and satellites. Owing to their significant advantages, they are increasingly employed for various Earth observation tasks, including surface mapping, detection of small objects, acquisition of high-resolution terrain images, and rapid cartographic updates. The implementation of new design principles and advanced signal reception and processing techniques in spaceborne SAR systems enables the formation of signals with a large time–bandwidth product, thereby achieving high spatial resolution. This, in turn, substantially enhances the jamming immunity of spaceborne SAR, particularly against active noise-masking interference generated by electronic countermeasure stations.

In this study, an algorithm is developed for generating retransmitted signals in a spaceborne SAR system that enables the estimation of the frequency–time parameters of the probing linear frequency-modulated (LFM) signals and the subsequent synthesis of signal-like interference based on these estimates. By incorporating autocorrelation processing of the received LFM signal, the proposed algorithm enables accurate parameter estimation of LFM signals across various SAR frequency bands, achieving an error of no more than 10% for frequency modulation rates at a signal-to-noise ratio greater than −10 dB. This approach enables the formation of signal-like interference within a retransmitter mounted on an unmanned aerial vehicle.

Scientific Exploration of Extra-Terrestrial planets and Analysis using Quantum Computing

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ABSTRACT

This research study presents a proof-of-concept model for a Mars exploration rover designed to integrate computer vision, in-situ spectroscopy, and preliminary quantum computing experiments into a unified planetary science platform. The computer vision subsystem is specifically engineered to process high-resolution Mars terrain imagery. It utilizes a combination of edge-based segmentation and advanced noise-reduction filters to efficiently detect and classify key geological features, such as rock formations, soil types, and mineral veins. This system achieved a robust detection and segmentation of high layered accuracy, as rigorously validated on a diverse set of annotated image datasets. For on-site chemical analysis, the scientific instrumentation module employs a laboratory-scale Laser-Induced Breakdown Spectroscopy (LIBS) system. This module is capable of analyzing the elemental composition of both geological and liquid samples. Experimental results demonstrate a 60%–65% identification accuracy when cross-referenced with established spectral databases. This performance, while promising, is currently limited by calibration constraints and the necessity for precise baseline correction. The quantum computing component is an exploratory investigation of two- and three-qubit circuit designs on the IBMQ platform. The primary goal of this research is to investigate stochastic behavior and explore potential applications for optimizing planetary data analysis and refining spectral classification tasks. This integrated prototype successfully demonstrates the feasibility of combining these advanced and distinct subsystems within a cohesive rover framework. The findings identify critical pathways for future improvements, ultimately aiming to enhance the overall accuracy, robustness, and scientific return of future Mars exploration missions.

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Multilayered conceptual modeling for the design, implementation and optimization of information security systems

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ABSTRACT

In this article, we examine the shortcomings of the use of legislative regulations and standards used in the design of information security systems. Taking into account these shortcomings, we propose a new method for designing and implementing information security systems, which uses different viewpoints to define the exact requirements for the information security system, to select proper methods for protecting information assets and to implement current technologies through which it is possible to fulfill the requirements for the system. The proposed method takes into account the viewpoints of various stakeholders and their requirements for the system. Based on these requirements, conceptual models are built and compiled, reflecting various requirements - regulatory, management, good practices, compatibility requirements, technological requirements, etc. A new multi-layer model is constructed from the relevant models, which unites these requirements, methods and technologies, allowing their optimization in order to maximally fulfill the initial requirements, optimizing efforts, resources, cost and the necessary human potential. The goal is to design an optimized system that meets the most important requirements for the organization.

Keywords: information, security, system, models, transformation, optimization

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Development of Graph Neural Network for Predicting Stress Field of Particulate Nanocomposite considering Interphase Region

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ABSTRACT

The presence of an interphase region between the matrix and nanoparticles significantly influences stress transfer mechanisms and overall stiffness. In this study, a Graph Neural Network (GNN) framework is developed to predict the microscopic stress field of particulate nanocomposites considering the interphase region. High-fidelity finite element simulations are conducted on representative volume elements (RVEs) to generate a comprehensive dataset for training and validation. The GNN architecture employs each finite element node as a graph vertex, with edges representing mechanical and spatial interactions. This matter enables efficient learning of local stress distributions from geometrical and material features. This work establishes a promising data-driven methodology for multiscale modeling of nanocomposites and the proposed model demonstrates high prediction accuracy and strong generalization capability across different microstructural configurations.

Keywords: graph neural network, finite element simulation, data-driven modeling, particulate nanocomposite, interphase region, stress field

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Lean Six Sigma driven process optimization for sustainable efficiency in small-scale toy manufacturing

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ABSTRACT

This study investigates the application of the Lean Six Sigma (LSS) methodology to enhance operational efficiency in a small-scale toy manufacturing enterprise in Brazil. Adopting the DMAIC (Define–Measure–Analyze–Improve–Control) framework, the research identifies and mitigates inefficiencies in the polyethylene finishing process through a structured, data-driven approach. Empirical evidence was collected via process mapping, semi-structured interviews, and time-based measurements, supported by analytical tools such as SIPOC diagrams, Pareto analysis, and Ishikawa cause–effect mapping. The implementation of preventive maintenance routines, operator training, and process control mechanisms led to a 66% reduction in average finishing time and significant annual cost savings. These results demonstrate that Lean Six Sigma provides a practical and scalable framework for optimizing operational performance, even within the constraints of small-scale manufacturing environments. Furthermore, the study highlights the potential of LSS to integrate with digital manufacturing and sustainability initiatives, aligning continuous improvement with the broader goals of operational excellence and sustainable production.

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Data-driven Lean Six Sigma optimization for sustainable robotic welding in agricultural machinery manufacturing

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ABSTRACT

This study presents the application of the Lean Six Sigma (LSS) methodology to optimize the operational efficiency of a robotic welding process in a Brazilian agricultural machinery manufacturing company. Addressing the empirical gap in LSS implementation within automated welding environments, particularly in the agricultural sector, the research applied the DMAIC (Define–Measure–Analyze–Improve–Control) framework to integrate process data with diagnostic tools such as the Ishikawa diagram and the GUT matrix for prioritizing improvement actions. Operational and quality data collected over an eight-month period revealed inefficiencies related to data integration, preventive maintenance, and workflow balance. Corrective measures, including cost-center segregation, digital downtime tracking, preventive maintenance scheduling, and layout reorganization, produced substantial performance gains, increasing efficiency from below 20 % to a stable 60–80 % range. Process capability indices ($Cp > 1.0$; $Cpk \approx 1.0$) confirmed improved stability and control. Beyond technical results, the initiative enhanced multidisciplinary collaboration and data reliability, fostering a culture of continuous improvement. The study contributes to the integration of Lean Six Sigma with digital manufacturing and sustainability principles under the industry 5.0 paradigm, offering a replicable and data-driven model for process optimization in automated production systems.

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Lean Six Sigma based optimization of barley waste management: mapping, root causes, and structured solutions for continuous improvement

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ABSTRACT

This study applies the Lean Six Sigma (LSS) methodology to improve waste management in the barley processing stage of a Brazilian food and beverage industry. The research identifies inefficiencies in the handling and disposal of barley residues and establishes a structured approach to reduce environmental and operational waste. Using the DMAIC framework, the study integrates qualitative and quantitative data to map the residual process, diagnose root causes, and implement improvement measures. Analytical tools such as Ishikawa diagrams, Pareto charts, and 5W2H planning were applied to prioritize actions and validate decision-making. The findings indicate that uncontrolled accumulation and inefficient reuse of barley residues led to productivity losses, noncompliance with sustainability indicators, and increased costs. After implementing LSS-based corrective actions, particularly in scheduling, process control, and residue classification, the company achieved a 32% reduction in total waste generation, improved process reliability, and enhanced environmental compliance. The introduction of standardized segregation procedures and digital tracking tools increased data accuracy and decision-making transparency. This research demonstrates that Lean Six Sigma is an effective and scalable framework for enhancing industrial sustainability, circular economy practices, and environmental performance. By combining process optimization with sustainable management, it reinforces the role of data-driven decision-making and digital tools in building eco-efficient manufacturing systems aligned with Industry 5.0 principles.

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International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

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Women at the helm: Analysing their influence in business strategy and culture

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ABSTRACT

Stronger social commitment and a more participatory leadership style are typically linked to the inclusion of women on management teams. An examination of women's influence at cooperative businesses, which have particular organisational and purpose traits, reveals that their influence boosts motivation and produces superior outcomes. Increased efforts to support work-family balance, which is critical for both national growth and raising families' standard of living, are one advantage of having more women in leadership roles. This study uses secondary data sources to examine how women impact corporate culture and business strategy in leadership roles. The study looks at how women leaders influence strategic decision-making, stimulate innovation, and create inclusive work cultures. It does this by utilising statistical data, case studies, corporate reports, and current literature. By reviewing and analysing organisational data and previously published research, the study examines the relationship between female leadership presence and key elements, including overall business performance, ethical governance, and employee engagement. The results show that companies with female leaders or more diverse top management typically exhibit greater adaptability, a more stakeholder-oriented strategic approach, and stronger cultural cohesiveness. However, enduring obstacles that prevent women from fully participating at the executive level include gender bias and restricted access to leadership networks. According to the study's findings, increasing gender diversity in leadership is not only an issue of equity but also a strategic necessity that enhances the performance and sustainability of organisations.

Keywords: leadership, Women Entrepreneurs**,** Employee Engagement, Leadership Style, Global Economy.

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Dual-Objective B.E.S.O.: Explicit Integration of Annual Daylight Autonomy into Structural Topology Optimization.

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ABSTRACT

Structural Topology Optimization iteratively subtracts the weakest elements until it reaches the optimized structural geometry. While this procedure indirectly affects the daylight performance in the interior of a space in a positive way, this research develops a modified Bidirectional Evolutionary Topology Optimization (B.E.S.O) algorithm to achieve explicit improvement in Daylight Autonomy (DA). This modification involves the introduction of annual daylight autonomy as a weighted factor into the interpolation scheme, which explicitly improves daylight autonomy of a space during the topology optimization. The results demonstrate a major improvement in the final geometries' daylight performance when com-paring the original B.E.S.O and modified B.E.S.O algorithms. This work established a dual-objective design framework, which integrates daylight performance in structural topology optimization and offers a sustainable design tool for architects and engineers.

Keywords: BESO, Daylight Analysis, Daylight Autonomy, Dual-Objective, Structural Optimization

Acknowledgment
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Multi-objective optimization of steel cellular beams using genetic algorithms

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ABSTRACT

Steel cellular beams are widely used in buildings and industrial constructions thanks to their superior advantages including long-span capability, lightweight, and the ability to run utility ducts directly through the web openings, consequently increasing the clear height. The structural behavior of steel cellular beams resembles a Virendeel truss comprising rigidly connected chords and web-post members, but lacking diagonal members. Consequently, these members are subjected not only to axial forces but also to significal shear forces and bending moments. The design of steel cellular beams necessitates check the overall flexure, the lateral-torsinal buckling, the vertical shear, the deflection as with traditional steel beams, and some specific failure modes such as Virendeel bending of tees, axial tension/compression of tees, horizontal shear and web-post buckling. Detailed design procedures are documented in publications like SCI P100 [1], SCI P355 [2], AISC Desig Guide 31 [3], and most recently, EN 1993-1-13 [4].

Cellular beams are typically fabicated by cutting the web of a hot rolled I-shaped profile by a semicirlular pattern, then shifting the two halves and welding them together with a full penetration butt weld. The process of designing a steel cellular beam involves selecting the I-shaped profile, opening diameter and opening spacing to minimize weight while satisfying all strength and serviceability requirements. This task can be formulated as a single-objective optimization problem, and it can be solved using metaheuristic algorithms like GA, PSO, DE, etc. This topic attracts the attention of many researchers around the world [5-7]. However, the practical design often requires the simultaneous balacing of two or more conflicting objectives, such as concurrently minimizing both beam weight and deflection, or minimizing weight while maximizing the opening size. This constitutes a multi-objective optimization (MOO) problem. MOO problems yield no single solution but rather a set of non-dominated solutions, which form the Pareto front.

This paper presents a study in which the MOO problem of steel cellular beams is solved using the Non-dominated Sorting Genetic Algorithm. The paper is structured into five sections. Section 1 provides an overview and the research objectives. Section 2 presents the design procedure for steel cellular beams according to AISC 360-16 and formulates the MOO problem. Section 3 briefly introduces the NSGA algorithms. Illustrative examples are carried out in Section 4, and conclusions are drawn in Section 5.

* The asterisk denotes the presenting author.

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Instructions for Preparing a one Page Abstract for the International Conference

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ABSTRACT

This paper introduces an advanced prediction model designed to accurately distinguish and assess the severity of COVID-19 infection in clinical settings. It serves as a valuable tool for clinicians, aiding in scientific and rational medical decision-making. Machine learning plays a crucial role in COVID-19 prediction by analyzing patterns in symptoms, medical history, and test results, with algorithms such as SVM, decision trees, and neural networks enhancing early detection and diagnosis. Feature selection is key to optimizing COVID-19 prediction using SVM, as it reduces complexity and prevents overfitting by focusing on critical factors like symptoms, demographic data, and laboratory results. Integrating Support Vector Machine (SVM) with Generative AI further improves prediction accuracy by combining classification with synthetic data generation. SVM effectively classifies COVID-19 cases based on essential clinical indicators, while Generative AI generates realistic synthetic data to enhance model training and generalization. This hybrid approach addresses data scarcity, strengthens feature extraction, and minimizes overfitting. By leveraging these technologies, healthcare professionals can achieve more reliable and early COVID-19 detection. Ultimately, this method enhances data-driven decision-making, improving diagnosis, prognosis, and resource allocation during pandemic management.

Key Words: SVM, Disease Prediction, Gen AI

Predictive Modeling of Student Academic Performance Using Continuous Assessment Data: A Case Study for Advanced Mathematical Methods Course

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ABSTRACT

The early identification of students at risk of academic failure is a critical objective for enhancing student success in higher education. This study, conducted at International Islamic University Malaysia (IIUM), aimed to develop and evaluate a predictive model to forecast students' final examination performance based on their continuous assessment marks (CAM). Utilizing an anonymized dataset from 68 students in the Advanced Mathematical Methods course, a multiple linear regression model was developed using scores from quizzes, a midterm examination, assignments, and a project as predictor variables. The dataset was partitioned, with 80% used for model training and 20% for validation. The model's performance was evaluated using the coefficient of determination (R^2) and Mean Absolute Error (MAE). The results demonstrated a strong predictive capability, with the model explaining a significant portion of the variance in final examination scores ($R^2 \approx 0.78$). Analysis of the model coefficients indicated that the midterm examination was the most significant predictor of final performance. The findings confirm that continuous assessment data provides a reliable foundation for building an early-warning system. Such a tool can empower educators to implement timely and targeted interventions, shifting from a reactive to a proactive student support paradigm and fostering improved academic outcomes.

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Simulation-Based Analysis of Electromagnetic Shielding in Polypyrrole Composites Using the ASTM D4935 Framework

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ABSTRACT

Electromagnetic interference (EMI) remains a challenge for reliable operation in optoelectronic and intelligent sensing systems. Traditional metallic or ferrite-based shielding materials provide strong protection but are heavy, rigid, and difficult to integrate into flexible or miniaturized platforms. Conductive polymers such as polypyrrole (PPy) offer a promising alternative thanks to their low density, ease of processing, and tunable electrical properties.

In this work, a MATLAB-based simulation framework is developed following the ASTM D4935 coaxial transmission-line standard to examine the shielding behavior of PPy composites. The model combines percolation-based electrical conductivity with a Debye dielectric relaxation description to capture frequency-dependent electromagnetic response, assuming non-magnetic characteristics ($\mu r \approx 1$). Reflection (S_{11}) and transmission (S_{21}) coefficients are calculated over the standard frequency range to estimate reflection and absorption losses.

This framework serves as a computational reference for correlating experimental results with theoretical predictions. By linking simulation outputs to measurable quantities from ASTM D4935 tests, it provides a reproducible path for improving model accuracy and understanding the mechanisms governing EMI attenuation in polymer-based composites.

Keywords: Polypyrrole (PPy) composites, electromagnetic interference (EMI) shielding, MATLAB simulation, ASTM D4935, smart sensors**.**

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Structural Reusability of Recycled Aggregate for Sustainable Concrete Development in Small Island Developing States: A Case Study of Mauritius

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ABSTRACT

This study examines the sustainable reuse of construction and demolition waste (CDW) through the production and evaluation of recycled concrete aggregate (RCA) as a substitute for natural coarse aggregate (NCA). The construction sector is a major contributor to global solid waste, with CDW often disposed of in landfills, leading to resource depletion and environmental degradation. In Mauritius, rapid industry growth has intensified this challenge, with minimal recycling practices in place.

To address this issue, five concrete mix batches were prepared: a control mix with 100% NCA and four mixes with RCA replacing NCA at 40%, 60%, 80%, and 100%. All mixes were tested under laboratory conditions in accordance with British Standards, and both natural and recycled aggregates were evaluated for their physical properties.

Results show that RCA, despite differences in physical integrity, can serve as a viable alternative when properly processed and proportioned. The findings highlight the importance of quality control and material preparation, while demonstrating RCA's potential to reduce landfill dependency and conserve natural resources, advancing circular construction practices in Small Island Developing States (SIDS).

Keywords: Recycled Concrete Aggregate (RCA), Construction and Demolition Waste (CDW), Sustainable Concrete, Circular Economy, Small Island Developing States (SIDS), Mauritius Construction Sector, Structural Performance

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Simulation-Based Optimization of Load-Bearing Structures in Ground-Floor Housing for Efficiency and Sustainability: Insights from Small Island Developing States (SIDS)

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ABSTRACT

Mauritian housing is predominantly characterized by reinforced-concrete (RC) residential frames, shaped by decades of cyclonic exposure and a design culture that prioritizes robustness. While this approach has proven lifesaving, it often results in over-dimensioned members with generous serviceability margins and considerable unexploited capacity. Consequently, material quantities, construction costs, and embodied carbon exceed those of code-compliant solutions.

This study investigates a standards-compliant optimization of a representative one-storey RC frame to reduce material use while maintaining compliance with British Standard strength and serviceability requirements. A baseline frame was modeled in STAAD.Pro under dead and live loads, using statutory design checks with C25 concrete and conventional residential proportions (spans of 3.2 m and 4.0 m; beams 400 × 200 mm; columns 200 × 200 mm; slab thickness 200 mm). An iterative size-reduction and layout rationalization workflow was applied, progressively reducing member sizes and re-analyzing until ultimate limit state (ULS) thresholds were satisfied. Key performance indicators (KPIs) included maximum service deflection, internal actions, total concrete volume, member utilization ratios, and constructability.

Results demonstrate clear efficiency gains: total concrete volume decreased from 3.00 m³ to 2.23 m³ (25.7% reduction), while maximum service deflection increased modestly to 2.092 mm (L/1910), remaining well within common residential limits (L/250–L/360). Utilization ratios approached unity but remained below 1.0, with no capacity violations or instability observed. Constructability was preserved, as members retained conventional RC sections.

These findings confirm that leaner, code-compliant frames are achievable for typical Mauritian housing through a transparent and replicable optimization workflow. Beyond immediate material savings, the approach offers significant opportunities for cost control and embodied carbon reduction. The study concludes by recommending integration of parametric optimization into standard practice, with extensions to multi-storey frames, lateral load considerations, and multi-objective optimization targeting both cost and carbon efficiency.

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Towards Resilient Rooftops in Small Island Developing States (SIDS): Assessing Waterproofing Membranes and Alternatives in Mauritius

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ABSTRACT

This study investigates the effectiveness of rooftop waterproofing techniques in Mauritius, with the aim of identifying the most reliable and cost-effective solutions for enhancing roofing resilience. The objectives include reviewing existing waterproofing systems, evaluating their performance and cost-efficiency, and identifying key factors influencing material selection, such as durability, ease of installation, UV resistance, maintenance requirements, and affordability.

The research also examines common challenges associated with waterproofing membranes, including limited longevity, improper installation, and inadequate maintenance. Potential remedies are proposed to extend service life and improve system performance. In addition, the study explores alternative roofing detailing methods that could reduce or eliminate reliance on conventional membranes, offering innovative and sustainable approaches for the construction sector.

A mixed-methods approach was adopted, combining quantitative survey data with qualitative insights from interviews with architects, engineers, and contractors. Survey results were analysed using the Relative Importance Index (RII), while thematic analysis of interviews revealed recurring patterns and stakeholder perspectives. Findings indicate a divergence in priorities: engineers and architects emphasize durability and maintenance, whereas contractors prioritize cost.

The results underscore the importance of balancing technical performance with economic viability to support sustainable decision-making in waterproofing system selection. By integrating survey-based evidence with professional insights, this study provides a comprehensive evaluation of waterproofing practices in Mauritius and offers recommendations to strengthen the resilience and sustainability of roofing systems in Small Island Developing States (SIDS).

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Digital Transformation and Customer Satisfaction: A CIS Framework for Urban Water Utilities

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ABSTRACT

Digital transformation in public enterprises has become a fundamental driver for enhancing service efficiency, transparency, and citizen satisfaction [4]. This study investigates the impact of the Customer Information System (CIS) on smart service satisfaction within PERUMDA Surya Sembada, a public water utility enterprise in Surabaya, Indonesia [5]. Unlike previous studies that merely assessed general service quality, this research integrates CIS adoption into the broader framework of smart public service innovation, aligning with the global movement toward e-governance and digital government transformation [1]. A quantitative approach was employed using purposive sampling, involving 101 active CIS users as respondents, with data collected through structured questionnaires and analyzed using SPSS to determine the correlation between CIS utilization and customer satisfaction levels [3]. The findings reveal that the CIS significantly enhances customer satisfaction by improving service accessibility, real-time information delivery, and interaction efficiency, reflecting the system's ability to facilitate data-driven decision-making and citizen engagement [2]. Furthermore, the study emphasizes that continuous feature development and user-centered design are crucial to maintaining digital trust and long-term engagement in public sector digital services [1]. The novelty of this research lies in positioning CIS not merely as a customer database but as a strategic enabler of organizational digital transformation, contributing to the modernization of public service ecosystems in developing economies [3]. The results also demonstrate that effective implementation of CIS fosters operational transparency, strengthens accountability, and supports sustainable digital governance initiatives, which are essential elements in achieving smart utility management [4]. Finally, this study recommends future research to include variables such as digital trust, user experience, and smart service quality metrics to enhance the conceptual model and provide a more comprehensive understanding of digital performance in public utilities [2]. Overall, the research contributes to both theory and practice by demonstrating how CIS can be leveraged as a catalyst for digital transformation and customer-centric service excellence in public enterprises operating under the Industry 4.0 paradigm and beyond [5].

Hand Hygiene Practices Among University Students: Insights from Hand Scanner Analysis Across Faculties

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ABSTRACT

This study examines hand hygiene practices among university students using a digital hand scanner (Semmelweis Scanner) to evaluate sanitizer application effectiveness. The research was conducted at Tashkent Medical Academy and Tashkent State Technical University from March 2024 to March 2025. The scanner detects insufficient sanitizer coverage and identifies commonly missed areas such as thumbs and wrists. Over 2,500 scans were analyzed, revealing that medical students achieved significantly higher hand cleanliness scores compared to technical students. However, frequent deficiencies were observed across all faculties in cleaning the thumbs and wrists. The findings highlight the scanner's potential as an educational tool for improving hygiene behavior and emphasize the importance of targeted interventions to reduce healthcare-associated infections. Integrating feedback-based technologies into training curricula can foster sustainable improvements in infection prevention practices among students.

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Business-IT alignment in cloud computing using process mining and LLMs tools

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ABSTRACT

Ensuring effective alignment between business objectives and IT infrastructures remains a persistent challenge in modern enterprises, particularly in dynamic, cloud-based environments. Our research proposes an intelligent and automated framework that enhances Business–IT alignment through the extension of the CloudSocket architecture [3], combining process mining, formal modeling (MDA), decision support, and Large Language Models (LLMs).

Our proposed framework [1] operates across five integrated layers: Design, Allocation, Execution, Evaluation, and Marketplace. In the Design phase, business processes are modeled using BPMN and ontologies, guided by process discovery from event logs. The Allocation phase automates resource mapping and service configuration using semantic reasoning and conformance verification. During Execution, cloud resources (SaaS, PaaS, IaaS) are deployed and monitored through CAMEL models and workflow orchestration. The Evaluation phase applies process mining techniques—discovery, conformance, validation, and enhancement—to measure alignment performance using real-time data. Finally, the Marketplace layer integrates service bundles, billing, and user feedback to continuously optimize cloud service offerings.

The innovative contribution of this framework lies in the integration of LLMs as an intelligent cognitive layer. LLMs enhance semantic interoperability and decision automation by interpreting unstructured logs, generating optimized workflows, and providing adaptive recommendations for resource allocation and alignment strategies. Their natural-language reasoning capabilities enable contextual insight extraction, anomaly detection, and predictive evaluation of alignment metrics, leading to greater process adaptability and autonomy.

Experimentally, the framework is designed to support continuous learning—each iteration refines the alignment model through new event logs, improving accuracy, efficiency, and scalability. By merging AI-driven reasoning, formal modeling, and process analytics, the approach represents a step toward self-

adaptive Business–IT alignment in cloud ecosystems. Expected benefits include reduced operational costs, improved service utilization, dynamic resource orchestration, and stronger strategic coherence between business goals and IT service delivery.

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The Role of Land Use Planning in Disaster Risk Reduction: The Case of Montagne Ory, Mauritius

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ABSTRACT

There is a global recognition of the need to address and mitigate the devastating effects of climate change. The erratic weather pattern, the violent cyclone, intense rainfall, last lasting droughts, coastal erosion are just some of the disasters that countries are facing and which are predicted to intensify and bring about severe destruction. Mauritius being a small developing island is more prone to these consequences. It was observed though the previous researches that Land Use Planning plays an important role in the Disaster Risk Reduction strategy. This research defines the role of Land Use Planning in Disaster Risk Reduction strategy and how Land Use Planning plays the role of predicting and taking corrective measures at source rather than dealing with the effects of the disasters after their passage. The region of Montagne Ory was chosen for this study. Montagne Ory was selected as it is one of the most sought regions in Mauritius to be developed for residential and commercial purpose. A qualitative research framework was used for the collection of data in this study. Interviews were performed with ten participants who are involved either directly or indirectly in the Land Use Planning and Disaster Risk Reduction process. The findings of the study indicate that the region of Montagne Ory is prone to the consequences of Disasters. The consequences of previous disasters have impacted on the area in terms of flooding, soil erosion on the mountain slope and along river reserve. The study highlighted the constraints such as illegal constructions, the release of large plots of land to be developed are being undertaken in environmentally sensible areas and sloping sites as well as legal framework not being adapted to the modern actual context which further burdens the effort to mitigate the Disaster Risk Reduction effort.

Thus, the research suggests the necessity of adopting an updated unified legal and institutional framework as well as a Multi-hazard Risk map which plays a critical role in the efforts to mitigate the effects of disasters. It promotes the involvement of the public as stakeholders in the decision-making framework. The central government should also allocate financial resources and guarantee that development activities are monitored and enforced as required. This study concluded by emphasizing the critical requirement for national adoption of Sustainable Urban Planning to bolster the Disaster Risk Reduction strategy.

* The asterisk denotes the presenting author.

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Assessing and Proposing a Resilient City: A Case Study of La Laura Mauritius

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ABSTRACT

This research explores the resilience of La Laura, a village in Mauritius, in the face of environmental and social challenges, particularly flooding. The primary aim of this study was to assess the factors influencing the community's ability to withstand and recover from such disasters, focusing on both infrastructural and social dimensions. A qualitative survey was conducted, involving interviews with key stakeholders, including local government officials, planning professionals, and residents. The findings highlight several challenges, including inadequate drainage systems, poor urban planning, and a lack of public awareness regarding flood risks. However, strong community networks and local knowledge emerged as critical assets for resilience.

The study proposes a set of recommendations aimed at improving La Laura's resilience, including upgrading infrastructure, enhancing community engagement, strengthening governance, and implementing nature-based solutions. By addressing these challenges and capitalizing on local strengths, La Laura can build a more sustainable and resilient future, better equipped to cope with the increasing risks posed by climate change. This research provides valuable insights into the multifaceted nature of resilience in small communities and offers practical strategies for enhancing resilience in similar urban contexts. The results can be extrapolated to other communities facing the same issues in the Island of Mauritius.

* The asterisk denotes the presenting author.

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Environmental Management in Cities Case Study of Central Flacq, Mauritius

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ABSTRACT

The purpose of the study is to examine the various environmental challenges in the region of Central Flacq, adopt measures and to improve the quality of life. In this study, the various aspects regarding Environmental Management (EM) that will make the environment of Central Flacq more sustainable in the future. 'EM is defined as the management of development process to take advantage of opportunities, try to avoid hazards, mitigate problems, and prepare people for unavoidable difficulties by improving adaptability and resilience' (Coppola, 2007).

The aim of this research was to examine the various environmental challenges in the region of Central Flacq, adopt environmental management measures, and to improve the quality of life. The objectives were to evaluate the environmental issues in Central Flacq, to study the existing concept of environmental management in cities in other countries and to apply the strategies studied to achieve the aim of the project. Maps and existing data from the outline planning scheme of that region were analysed. A quantitative method had been adopted for the research and the data collected through questionnaires helped to identify the opinion of the participants. An analysis had been carried out in order to assess how the participants reacted to the proposals that had been identified in the literature review. Subsequently, recommendations with regards to the various concepts were being designed in order to manage the environment in a sustainable way. These recommendations could be used for other urban areas and communities in Mauritius to make them more sustainable.

* The asterisk denotes the presenting author.

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International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

Jordan, December 18th - 20th 2025

The Role of Financial Technology in Enhancing Social and Financial Outcomes in Microfinance

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ABSTRACT

The financial services industry has undergone a considerable transformation due to the quick development of financial technology, which has created new opportunities for creativity, effectiveness, and inclusivity. FinTech offers microfinance institutions (MFIs) a promising way to fulfil better social goals, including financial inclusion, poverty eradication, and the empowerment of marginalised groups, while also improving financial sustainability. The study examined the impact of digital innovations on key metrics, including operational efficiency, profitability, cost per borrower, non-performing loans, outreach to the underprivileged, gender inclusion, and client welfare. These innovations include digital payments, mobile banking, alternative credit scoring, and automated decision support systems. The study's foundation was secondary data, which was examined through a thorough synthesis of current research from 2021 to 2025. The data is derived from industry research, pre-existing literature and the annual reports and performance metrics of specific MFIs. The findings demonstrate a favourable association between FinTech adoption and improved financial performance: improved risk management, higher loan throughput, and lower operational expenses all contribute to greater financial sustainability. FinTech also promotes social performance by enabling more financial inclusion, improved consumer happiness, and expanded outreach, especially to underserved or rural areas. The study reveals the following trade-offs: MFIs that rapidly scale with digital technology may limit their outreach or target less needy users in addition to confronting challenges like digital literacy, infrastructure constraints, upfront technological investment, and regulatory gaps.

Keywords: Microfinance Institutions, FinTech, Financial Performance, Social Performance, Operational Efficiency.

International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

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Integrating Machine Learning and GIS Techniques for Optimal Siting of Utility-Scale Solar Photovoltaic Systems in Maricopa County

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ABSTRACT

Rapid urbanization and energy demand in Maricopa County, Arizona, highlight the urgent need for optimal solar photovoltaic (PV) site selection using intelligent, data-driven approaches. Traditional GIS–based methods lack adaptive weighting and predictive validation. This study aims to develop a hybrid Machine Learning (ML) and Geographic Information System (GIS) framework to improve the spatial accuracy and reliability of solar PV siting. A GIS–MCDA–ML model integrating the Analytic Hierarchy Process (AHP) and Weighted Linear Combination (WLC) with Random Forest and XGBoost regression was applied to seven spatial criteria solar irradiance, slope, elevation, land use/land cover, proximity to roads and transmission lines, and exclusionary zones. ML-derived feature-importance values were combined with expert-based AHP weights to generate composite suitability maps. The model achieved $R^2 = 0.91$ and RMSE = 27 kWh kWp^{-1} yr^{-1}, confirming strong predictive reliability. Results indicate that while 97.8% of Maricopa County is technically viable for solar development, only 0.2% remains "Most Suitable" after applying exclusionary constraints. The highest suitability zones align with flat desert basins, transmission corridors, and low-slope agricultural plains, producing PV outputs exceeding 1,890 kWh/kWp/year. The feature-importance ranking revealed that solar irradiance (46%), slope (24%), and land use/land cover (11%) exert the greatest influence on siting decisions. Sensitivity and spatial cross-validation analyses confirmed model robustness and transferability. The proposed GIS–ML optimization framework strengthens spatial decision-making transparency, reduces land-use conflict, and supports sustainable, policy-aligned renewable energy expansion in arid and semi-arid regions. It offers a replicable and scalable model for guiding utility-scale solar development worldwide.

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Challenges and Opportunities of adopting the Agile Methodology in the banking sector for enhancing project management efficiency.

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ABSTRACT

The agile methodology is the framework of conventions and techniques and procedures that is being followed by a team for a given project or situation. It defines the requirement of the project by iteration where the use of the feedback loops is emphasised and this leads to reduced risk and uncertainty and also increase in flexibility, where traditional method is made up of different independent stages where for the next stage to start the previous needs to be completed with no feedback and the product is released only when it is deemed to be fully completed. The rigidness of traditional project management methods creates barriers for the companies.

For this study, the research has included the application of the "primary data collection method" to adequately address the specific research objectives. The primary data was collected through a questionnaire, interview, observation and others. An e-survey was conducted with 100 participants working in the Mauritian banking organizations consisting of the project managers, IT employees working in the banking firms based upon a sampling method, based around 22 questions. The questionnaire focused on the experience with digitalisation process how this could be enhanced by the agile methodology.

The findings revealed that participants were well aware of the benefits of the agile methodology, and the digitalisation was a step towards the agile methodology. The benefits of this methodology were considered as being particularly important in the banking sector, which is a very dynamic sector, where changes are fast happening to adapt to new technology and the changing needs of the customers. The study also highlighted that given that the banking sector operates under strong legislative framework, full implementation of the agile methodology will not be entirely possible, as the banking sector has to abide by the prevailing regulations.

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Project Intelligence: When AI is the project Manager in IT and communication services in Mauritius.

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ABSTRACT

As artificial intelligence evolves from a supportive to a strategic orchestrator, its use in project management necessitates a reevaluation of managerial model. This thesis highlights the concept of Project Intelligence: the execution of AI as an autonomous project manager via a qualitative study of the Mauritian tech sector, modeled as a microcosm of the global digital revolution.

Through thematic analysis of expert interviews with practitioners, the research identifies two interrelated themes: algorithmic efficiency and organizational adaptation. The results resonate with and build on earlier works on socio-technical systems (Bostrom, 2014; Brynjolfsson & McAfee, 2016), ethics of automation (Floridi et al., 2018), and digital leadership (Avolio et al., 2014), proving that AI not only improves operational precision and predictive capability but also challenges incumbent hierarchies and reconfigures human roles in decision-making.

Participants were ambivalent, balancing excitement for enhanced productivity with concerns about accountability, identity, and losing human-oriented leadership. The study argues that AI-based project management represents a cultural intonation point, more than a mere technological upgrade.

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Enhancing safety and productivity in the constructions sector through effective project management practices.

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ABSTRACT

The construction is one of the most risky industry in the world, and in Mauritius, the question of balancing employees' safety and productivity is a burning issue. This study addressed the impacts of project management techniques on safety and productivity. A survey was conducted to gather feedback from construction workers and the findings were analysed using descriptive statistics, mean score analysis, correlation analysis and timing frequency analysis.

The results indicated that it is important to give due consideration to planning, leadership and safety management systems as they were noted to be very closely associated with productivity. The study also noted that often human well-being was least prioritised but had the highest statistical impacts on the challenges faced during productivity. It was also noted that technological adoption was undervalued although this would have brought much benefits. Health and safety practices were found to be most effective when applied at the very start of the project and regularly enforced all throughout the execution of the project.

The study concluded that enhancing safety planning, leadership and formal management systems and technology adoption, are areas where companies need to focus, and these areas have directly impacts on productivity. Companies would benefit more if due consideration could be given to the well-being of workers wellbeing as this is a very crucial component which can to improve productivity in Mauritius.

Artificial intelligence in Smart Cities and IoT: Edge and Cloud Symphony of Urban Intelligence

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ABSTRACT

Implementation of Artificial Intelligence (AI) and Internet of Things (IoT) is reshaping the backbone of smart cities by creating the possibility of real-time decision-making and effective city management. This paper explores how a hybrid Edge-Cloud system can maximize the processing of data in the city, minimize latency, and increase the energy efficient of the whole IoT infrastructure. The use of AI-driven Edge-Cloud systems among city administrators, engineers, and technology professionals was analyzed by sending a structured questionnaire to 120 of them in order to determine the level of adoption, challenges, and benefits. Data were collected and analyzed using Python based analytical and visualization tools (Pandas, Matplotlib and Scikit-learn). Findings suggest that in relation to cloud-only deployments, hybrid architectures achieve much better system responsiveness (by 28 percent) and data reliability (by 21 percent). The paper will end with a proposal of an AI-enhanced orchestration model that will bring harmony between edge autonomy and cloud intelligence to offer a scalable framework of sustainable and adaptive urban ecosystems.

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The Impact of University–Industry–Research Collaboration on Corporate Financial Health in the Digital Era—Empirical Evidence from an AI-Based Financial Diagnosis Database

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ABSTRACT

In the digital era, university–industry–research (UIR) collaboration has become an important channel for firms to acquire external knowledge and technological resources, thereby enhancing innovation capability and competitiveness. However, the impact of such collaboration on corporate financial health remains insufficiently examined. Using data from the CSMAR AI-based Financial Diagnosis Database, this study employs a sample of Chinese A-share listed firms to construct a multidimensional evaluation framework of financial health and empirically investigates the effect of UIR collaboration. The results show that UIR collaboration significantly improves firms' overall financial health, mainly by enhancing profitability and growth capability, while it tends to reduce operational efficiency and has no significant effect on solvency. Further analysis reveals that regional digitalization and digital government development positively moderate the relationship between UIR collaboration and financial health. The findings remain robust to multiple tests. Moreover, the positive influence of UIR collaboration on financial information quality is more pronounced in state-owned and high-tech firms. This study uncovers the mechanisms through which UIR collaboration promotes firms' financial soundness and sustainable development in the context of digital transformation, providing new empirical evidence for corporate digital strategies and innovation policy design.

Keywords: Digitalization; UIR Collaboration; Financial Health; AI Financial Diagnosis

* The asterisk denotes the corresponding author.

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Effects of timeseries length in early warning tsunami systems using a spatio-temporal transformer

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ABSTRACT

Tsunamis are a phenomenon that causes great disaster. Thus accurate and fast prediction is needed. Artificial intelligence models can help predict those phenomena. In this study, the effects of physics-based models are tested to investigate their performance and accuracy. The model used is a physics-based spatio-temporal transformer paired with physics limitations according to the physics of the wave, such as arrival time and energy preservation. The model showed great performance in both predicting the time series of the speed and wave height on-shore and near-shore. Thus AI model with physics-based capabilities is a great solution to improve the performance of those models

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International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

Jordan, December 18th - 20th 2025

Investigating physics-based transformers in tsunami prediction

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ABSTRACT

Tsunamis are a devastating and unpredictable natural disaster that causes huge amounts of damage each year. In this paper, a spatio-temporal transformer is developed to be used as an early warning system. The model used 26 offshore stations near western Canada that have 3500 seismic scenario simulations from earthquakes varying from 8.2 to 9.2 Mw.. These scenarios are used as an input to train the model using the waveform recorded in offshore buoys, and predict the onshore time series of the speed and wave height of the wave. To assess the ability of the system to be used as an early warning system, the model is tested with different input sizes of the original waveform, e.g., 20%, 30% etc. The optimal waveform length is chosen by comparing the performance of each case and choosing the best one based on the shortest length with the best performance.

* The asterisk denotes the presenting author.

International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

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Neurodidactic and Cognitive Bases of Competency Clustering in Engineering Education: Mapping Trajectories and Interference Zones

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ABSTRACT

The transformation of engineering education requires systematic approaches to competency development that account for cognitive complexity and developmental dynamics. This article presents a comprehensive system for competency clustering based on the integration of trajectory analysis and interference theory within the Cognitive–Neurodidactic–Competency–Integrative (CNCI) model. The research addresses a critical gap in competency-based education by providing empirical evidence for how competencies develop and interact throughout the learning process. Using longitudinal data from 318 engineering students at Bukhara State Technical University tracked over a five-year period (2020–2025) across three disciplines—Mechanical Engineering, Electrical Engineering, and Software Engineering—six distinct competency clusters were identified through hierarchical clustering analysis. Each cluster exhibits unique trajectory characteristics and interference patterns that have significant implications for curriculum design and instructional practice. The clusters include: Fundamental Cognitive (linear progression, 18.4 weeks), Representational (nonlinear with two regressions, 34.6 weeks), Communicative (moderate rate with plateau, 28.2 weeks), Project–Creative (slow start with critical barrier, 42.1 weeks), Analytic–Evaluative (dependent on prerequisites, 22.7 weeks), and Dispositional–Professional (extended trajectory, 144 weeks). Five critical interference zones were identified with intensities ranging from 6.8 to 8.3 on a 10-point scale.

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UTAUT2 and Online Shopping Anxiety: Evidence from Electronic Purchase Decisions in Indonesian Marketplaces

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ABSTRACT

This research explores how constructs of the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) shape electronic product purchase decisions in Indonesian marketplaces, while also examining the moderating role of online shopping anxiety. Rapid e-commerce growth has made digital platforms such as Shopee, Tokopedia, Lazada, TikTok Shop, and Blibli the primary channels for electronic purchases, yet consumer concerns about product authenticity, delivery risks, and after-sales guarantees often trigger psychological barriers.

Using a quantitative design, data were collected through an online survey involving 410 respondents who had purchased electronic products in the past six months. The dataset was analyzed with Partial Least Squares–Structural Equation Modeling (PLS-SEM), ensuring robust measurement and structural model assessment.

The results indicate that performance expectancy, social influence, facilitating conditions, and price value significantly drive purchase decisions, whereas effort expectancy demonstrates a negative effect. In contrast, hedonic motivation and habit were not statistically significant. Moderation analysis further shows that anxiety amplifies the effects of performance expectancy, social influence, and price value, underscoring the pivotal role of psychological states in digital purchase behavior.

These findings extend the UTAUT2 framework by integrating an emotional dimension, offering both theoretical contributions and managerial implications. For practitioners, the study emphasizes the importance of transparency, trust-building, and consumer protection mechanisms to reduce shopping anxiety and foster sustainable e-commerce growth.

Keywords: UTAUT2, shopping anxiety, purchase decision, electronic products, e-commerce, Indonesia

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A Hybrid Approach Based on Machine Learning and Multicriteria Decision Analysis for Budget-Aware Chronic Kidney Disease Analytics

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ABSTRACT

Chronic Kidney Disease (CKD) is a prevalent, progressive condition associated with substantial morbidity, mortality, and health-system costs. Diagnosis and ongoing surveillance rely largely on laboratory measurements, yet the costs and patient burden of these tests vary across settings. In this context, Machine Learning (ML) can help by extracting useful signals from diverse CKD data-including laboratory indices, demographic factors, and prior health history to refine risk stratification and monitoring [1].

However, performance alone is not sufficient. In fact, models must be well calibrated, generalizable across populations, interpretable, and equitable. Moreover, they must be compatible with real-world constraints such as cost and feasibility [2]. Multi-Criteria Decision Analysis (MCDA) provides a principled and practical framework for balancing these competing objectives by explicitly weighting criteria (discrimination, calibration, equity). It achieves this by generating transparent rankings of alternative solutions and test configurations under varying budget scenarios. The alternatives evaluated are distinct model–test configurations and combinations of ML models paired with CKD biomarker panels and testing cadences, each with an estimated cost.

Taken together, CKD analytics, ML, and MCDA offer a budget-aware, ethically grounded decision-support pathway that can guide resource allocation, support adoption across diverse health systems, and inform policy and practice beyond metric-driven optimization. In this paper, we propose an integrated framework that couples CKD analytics, ML, and MCDA to produce budget-aware rankings of alternative models each balancing predictive performance, calibration, equity, cost, and feasibility. We will present and interpret some initial results of the proposed approach.

Keywords: Chronic Kidney Disease, Multi-Criteria Decision Analysis, Machine Learning.

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Design Optimization of a Washing Machine Spider Arm Considering Manufacturing Constraints

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ABSTRACT

Main drive system of a washing machine uses an electric motor to transfer torque to the pulley, which rotates the shaft and drum via the spider arm. The drum assembly is supported by springs and shock absorbers to minimize vibrations from unbalanced loads. However, higher rotational speeds aimed at improving drying performance increase the bending and torsional stresses in the spider arm [1,2], which increases the failure tendency of the drum structure.

In this study aimed to reduce the stresses on the spider arm, which currently fulfils all stress and life requirements, and accordingly to extend its service life. Firstly, the operating conditions of the washing machine were simulated using a flexible multibody model. Critical stress concentration areas were identified on the spider arm, which constitute potential failure regions for extended cycles. Design parameters were selected to reduce stress while minimizing geometrical changes to the casting mold and considering production costs. Due to constraints from the tapping spout, the cross-section thickness was increased. The final design resulted in an increase in mass of only 1.5 % (about 13 grams), while the maximum stress value was reduced by 25 %. The washing machine prototype using the final design was operated on the test bench at full load capacity and it was observed that the number of cycles increased by 2.5 times compared to the previous design.

* The asterisk denotes the presenting author.

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Intelligent triage of patients based on medical specialty in telemedicine: a Systematic Literature Review

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ABSTRACT

The rapid evolution of online medical services has reinforced the need to develop intelligent triage systems in order to improve access to care and reduce referral times [1]. However, the automatic analysis of textual descriptions of symptoms remains complex due to often imprecise or ambiguous information [2]. In this context, we are conducting a systematic review to identify the most relevant work on patient triage across different medical specialties. We conducted an exhaustive search on ScienceDirect, PubMed, IEEE Xplore and Springer, We focus on publications from 2020 to 2025. The analysis of the selected articles focuses on three main areas: the models used, the nature of the data and the classification tasks addressed. A total of 20 studies were selected, revealing a predominant use of pre-trained language models, notably BERT and its variants, for automatic classification tasks in the medical field, such as diagnosis, protocol recommendation and clinical decision support. We also examine how deep learning architectures have been used to address these issues. While these models show promising potential for automated patient triage by medical specialty, our analysis highlights several persistent challenges, including data quality and availability, lack of multimodal integration, and still limited generalizability. These shortcomings reduce the overall robustness of the models and underscore the need for further research to improve the reliability of automated triage.

Keywords: Medical specialty, BERT, Patient Triage, NLP, Deep Learning.

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Simulation of Intelligent Fire Protection System for Buildings and Spatial Visual Evacuation Design

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ABSTRACT

Against the backdrop of building intelligence, this paper explores the ant colony algorithm for building fire evacuation path planning. It points out traditional algorithms' limitations and the ant colony algorithm's merits [1]. An improved second-order ant colony algorithm is proposed to tackle issues in large-scale grid models, optimizing performance via direction parameters and parallel solution spaces. Parameter influence is analyzed for adjustment. Applied with fire detector layouts, it enables adaptive path adjustment. Experiments show it outperforms the conventional algorithm in convergence and path length, offering an effective solution for building evacuation.



Fig. 1. Optimize the grid method

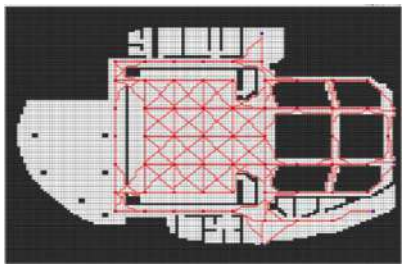


Fig. 2. Node layout

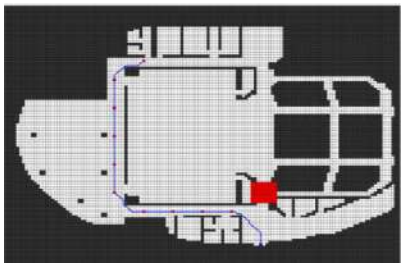


Fig. 3. Path planning with fire

The algorithm shows better adaptability than traditional ones in large-scale grid path search and outperforms other evolutionary algorithms in features. The improved second-order algorithm excels in convergence and path length for large-scale grids

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Comparative Analysis of 3D-Printed Smart Orthoses for the Dominant Upper Limb: Materials, Components, and Standards

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ABSTRACT

This study presents a comparative analysis of the design and fabrication of 3D-printed smart orthoses, with emphasis on the dominant upper limb. The research addresses three main axes: I) Device and component comparison: Active and passive orthoses are analyzed considering actuators, sensors, ranges of motion, achieved torques, employed materials, and relevant clinical observations. This comparison enables the identification of advantages and limitations in terms of adaptability, precision, and user comfort. II) Evaluation of materials for 3D printing: The use of polymers, composites, and recyclable materials in active and passive orthoses is contrasted, highlighting their mechanical performance, sustainability, and feasibility within additive manufacturing processes. Implications regarding durability, weight, strength, and energy efficiency are also discussed. III) Applicable norms and standards: International guidelines related to safety, ergonomics, and performance in orthoses and exoskeletons are synthesized, including regulatory frameworks for rehabilitation and medical devices. Although previous studies have addressed considerations for lower-limb orthoses [1], [2], further analysis is required for upper-limb applications. Indeed, recent works emphasize the need to deepen research on design, material evaluation, and standards specific to 3D-printed orthoses for the upper limbs.

Finally, the study includes a summary of limitations, objectives, and preliminary findings from related research on rehabilitation exoskeletons, emphasizing opportunities for improvement and remaining challenges. The findings suggest that the integration of optimized materials, intelligent sensors, and robust regulatory frameworks constitutes a pathway toward more efficient, safe, and sustainable orthotic solutions. This work is proposed as an initial contribution to guide future research and clinical applications, in alignment with the ADDOPT2025 objectives on additive manufacturing, sustainability, and digital transformation.

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Preventing The Obsolescence Of Residential Buildings Through The Integration Of Photovoltaic Solar Modules

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ABSTRACT

One of the most prioritized directions in the large–scale practical application of solar energy worldwide is the use of photovoltaic (PV) solar modules in urban development as an alternative source of energy. In developed countries, “the annual growth rate of electricity generation from renewable energy sources has reached 7%, with wind and solar energy accounting for 60% of this increase. By 2030, under the zero-emission scenario, more than 60% of total electricity production is expected to be generated from renewable energy sources.” In this context, particular attention is being paid to the installation of photovoltaic solar modules on urban residential buildings, the modernization of their adjacent territories, and the enhancement of energy efficiency based on the analysis and modeling of their energy performance. Leading research institutions around the world are conducting scientific studies on the design of photovoltaic modules used in solar energy systems, including the development of new configurations of uninterrupted power supply units and innovative methods for their calculation. Historically, a significant milestone in this field was the international congress titled “Solar Energy in the Service of Humanity” held in 1973 in Nigeria and Paris, which marked the beginning of global research initiatives aimed at harnessing alternative energy sources. Since then, extensive research has been carried out on advanced photovoltaic modules and their application in urban planning to generate clean and renewable energy. At the same time, increasing the operational efficiency of urban residential buildings through photovoltaic solar modules has become an urgent task. Today, issues related to energy efficiency in urban housing and the moral (functional and technological) obsolescence of residential areas relative to their location are becoming increasingly relevant.The purpose of this article is to develop recommendations aimed at reducing the amount of energy consumed from conventional energy sources in urban areas by utilizing photovoltaic modules to achieve energy efficiency, as well as to prevent the moral obsolescence of residential buildings.

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The Role and Development of Business Intelligence in the Banking Sector and Its Implications for AI Project Management Practices: A Systematic Literature Review

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ABSTRACT

In the digital economy era, the banking industry faces the challenge of transforming massive data volumes into strategic insights. Business Intelligence (BI) has emerged as a key solution for transforming data-driven banking strategies. This study aims to map and synthesize empirical and conceptual evidence regarding the application of Business Intelligence (BI) in the banking industry through the Systematic Literature Review (SLR) method. A primary literature search was conducted in indexed academic databases such as Scopus, Science Direct, ProQuest, SAGE Journal, IEEE Xplore, Springer Link, and ACM Digital Library spanning 2020-2025. Twenty articles were selected using predetermined query and criteria to be extracted and analyzed thematically to identify patterns, central themes, and relationships between concepts. This study highlights several things: First, the importance of using AI in developing BI/analytics projects. Second, project management practices strongly support the relationship between project success. Third, a strategic approach to BI implementation is crucial in the banking environment. This study also provides insights into future research and practical implications for banking stakeholders.

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Mechanism Analysis of Digital Infrastructure in Promoting Digital Finance Development

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ABSTRACT

Promoting digital finance constitutes an integral component of China' s financial system reform, while enhancing the integration and utilization mechanisms of digital infrastructure represents an urgent imperative for deepening this reform. Integrating digital infrastructure advancements into the progression of digital finance presents a critical area for scholarly investigation. Leveraging the quasi-natural experiment of China's "Broadband China" urban pilot policy, this study employs panel data from 280 cities between 2011 and 2021 and adopts a multi-period difference-in-differences approach to analyze the mechanisms, moderating effects, and heterogeneity of digital infrastructure's impact on digital finance. The findings indicate that: (1) Digital infrastructure development provides essential support for digital finance, though policy effects exhibit a time lag. (2) Digital infrastructure fosters digital finance primarily by elevating payment and credit indices, with the financial deposit-loan ratio, urbanization level, market scale, and technological advancement serving as significant moderators. (3) The influence of digital infrastructure on digital finance demonstrates regional heterogeneity, varying by geographic location, city size, educational attainment, and administrative rank. These insights offer valuable implications for the targeted deployment of digital infrastructure and the enhancement of digital finance capabilities in China.

Keywords: Digital Infrastructure; Digital Finance; Difference-in-Differences Model

International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

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Digital economy, market size and urban-rural income gap

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ABSTRACT

Based on the panel data of 259 prefecture-level cities in China from 2011 to 2022, this empirical study systematically examines the impact and mechanism of the digital economy on the income gap between urban and rural residents. The research finds that the impact of the digital economy on the income gap between urban and rural residents exhibits a U-shaped pattern, first narrowing and then widening. This nonlinear relationship reveals the dual effects of the digital economy on income distribution at different stages of development. The mechanism analysis shows that market size significantly shifts the inflection point to the right, playing a crucial moderating role. Heterogeneity analysis further reveals that the impact of the digital economy on the urban-rural income gap exhibits significant spatial heterogeneity. Based on these findings, this paper proposes corresponding policy recommendations from the dual objectives of promoting the development of the digital economy and narrowing the urban-rural income gap.

International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

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Ukrainian Regions in the Process of Entrepreneurial Virtualization: From Global Economic Turbulence to Benchmarking

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ABSTRACT

The current stage of global economic development is characterized by a high level of global turbulence, manifested in geopolitical instability, structural shifts in markets, digital transformation of the business environment, and the growing role of information technologies. Under conditions of military challenges, as well as energy and economic instability, Ukrainian regions have faced the necessity of rethinking traditional models of entrepreneurship and actively transitioning to virtualized forms of economic activity.

The processes of entrepreneurship virtualization represent not only the transition of business into the digital space but also the formation of new mechanisms for value creation, interaction among economic entities, and management of innovation and territorial competitiveness. For Ukrainian regions undergoing recovery, such processes create new opportunities for integration into global value chains, attracting investment, developing remote forms of employment, and fostering a service-oriented economy.

At the same time, global economic turbulence necessitates the search for benchmarks of efficiency and adaptability, which underscores the need to use benchmarking tools as a system for comparative analysis of best practices in regional and enterprise-level digital transformation.

Therefore, the study of entrepreneurship virtualization processes in Ukrainian regions in the context of global challenges and the implementation of benchmarking approaches is extremely relevant. It enables the formation of scientific and methodological foundations for digitally oriented regional economic development, the identification of effective management models, and the strengthening of Ukraine's competitive positions in the global economic arena.

Many contemporary studies are devoted to business virtualization and the corresponding advantages it provides in terms of implementation and efficiency. HAJDARI and MLINAKU analyzed the impact of innovative processes on the development of entrepreneurship, including the advantages and disadvantages of digital technologies [1]. Today, the virtualization of business processes significantly influences entrepreneurial development, with S. Somabutr paying particular attention to the issues of e-business [2]. Hanoum, S., Palalic, R., Durman, T.Y. et al., in their research,

examine the interdependent impact of e-commerce on small business performance and propose appropriate managerial solutions [3]. Iqbal, S., Tian, H., Akhtar, S. et al., in their study, emphasize the specific influence of green strategies on the development of e-commerce among enterprises in China's industrial sector [4]. The development of business virtualization largely depends on the regional environment, which shapes favorable conditions for innovation, digital transformation, and entrepreneurial activity. For instance, Veklych, O., Boiko, Y., Irtyshcheva, I., Kramarenko, I., and Kolmakova, V. analyze the effectiveness of business virtualization implementation, emphasizing the influence of the regional development climate, which includes economic, social, and infrastructural factors [5]. Stegnei, M., Kramarenko, I., Irtyshcheva, I., Ishchenko, O., Nod, O., and Neymet, V., conducting research on regional development, highlight the close interconnection between the dynamics of entrepreneurship growth and the level of inclusiveness of local communities, reflecting the interdependence of socio-economic processes at the territorial level [6].

The development of business virtualization is significantly influenced by global economic turbulence, as it determines the pace of innovation and digital technology implementation in regional and international business processes. Priyadarshi, P., Khare, A., Upman, S. et al. developed a combined crisis diffusion model using a practical mixed-methods approach that integrates event study analysis with qualitative thematic analysis [7]. Global economic turbulence leads to supply instability, which determines the efficiency of supply chain networks and significantly affects the rate of e-business development, particularly in the fields of logistics and online commerce [8]. Therefore, it is relevant to develop the scientific and methodological foundations of benchmarking to assess the readiness of regions for the implementation of business process virtualization, with the aim of improving the efficiency of managerial decision-making and enhancing territorial competitiveness.

The purpose of the study is to develop the scientific and methodological foundations for the digital transformation of the regional economy and to identify benchmarking opportunities that enable the evaluation of management model effectiveness, optimization of development processes, and strengthening of Ukraine's position in the global economy.

The proposed methodological approaches made it possible to identify that the highest progress in the development of information and communication technologies has been achieved in Kharkiv, Lviv, Kyiv, Dnipropetrovsk, and Vinnytsia regions, indicating the cumulative and multiplicative nature of IT sector development. The experience of these regions should be implemented in regions with lower concentrations of industry enterprises through the development of targeted regional programs, staff training, and the expansion of international and interregional cooperation.

Using the proposed approaches and the corresponding mathematical tools, integral indicators of e-democracy development in Ukraine's regions were calculated. The analysis results confirmed that a relatively high level of e-democracy development is observed in regions with high digitalization indicators, particularly in Dnipropetrovsk, Lviv, and Odesa regions. The vast majority of regions demonstrated integral scores above 3 points, while Vinnytsia, Chernivtsi, and Cherkasy regions remain lagging behind, with values below this level.

As the calculation results demonstrate, most regions of Ukraine have experienced a significant increase in the development and use of e-democracy tools. In certain regions – Dnipropetrovsk, Zakarpattia, Lviv, Odesa, and Kharkiv – the integral indicators nearly doubled. This growth has been driven, in particular, by the active efforts of the Ministry of Digital Transformation of Ukraine, aimed at mass enrollment of citizens in the "Diia" application, improving the accessibility of government online platforms, and implementing informational and educational initiatives that promoted the spread of digital practices for citizen participation in public governance.

The generalized results of the analysis indicate that Ukraine is gradually forming an effective information ecosystem for business virtualization, with human capital serving as its key resource. Under the conditions of wartime challenges, the priority tasks are preserving the existing IT capital, establishing institutional foundations for its further development, and continuing the digital transformation of a democratic society. These processes lay the groundwork for the rapid recovery of regions and sustainable business development in the post-war period, contributing to Ukraine's establishment as an active participant in the global digital economy.

Active distribution network voltage coordination control strategy based on multi-agent reinforcement learning

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ABSTRACT

To address the voltage stability challenges posed by the high proportion of renewable energy integration, this paper proposes an active distribution network voltage coordination control method based on Multi-agent Reinforcement Learning (MARL). By constructing a collaborative control framework with centralized training and decentralized execution and introducing a graph neural network to enhance topology awareness, adaptive coordination optimization of multiple distributed resources is achieved. Simulation results on the IEEE 33 bus system show that the proposed MARL strategy can significantly reduce the node voltage standard deviation to 0.004 p.u., lower the voltage exceedance rate to 0%, and reduce system network losses by more than 8.9%. Compared with traditional droop control and centralized optimization methods, this method improves dynamic response speed by nearly 50%, effectively suppresses voltage fluctuations within 12 seconds, and reduces the frequency of control equipment actions by approximately 44%. Experiments verify that the strategy has good adaptability and robustness in dealing with renewable energy fluctuations and load changes. This research provides an effective solution for real-time voltage control in active distribution networks and offers theoretical basis and practical reference for the in-depth application of artificial intelligence in power systems.

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Modular robot self-assembly interaction paradigm design for non-professional users

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ABSTRACT

Modular robot self-assembly technology has shown great potential due to its excellent adaptability in complex environments; however, its operational complexity severely hinders its widespread application by non-professional users. To address this issue, this study designed and implemented an intuitive interaction paradigm for non-professional users. This paradigm integrates a graphical user interface (GUI) with voice control commands, aiming to significantly reduce the cognitive load and operational difficulty for users. In terms of core technologies, we adopted a self-assembly path planner based on the $A*$ algorithm to achieve optimal motion trajectories and combined it with a hybrid vision system of template matching and convolutional neural networks (CNN) for real-time module recognition and precise pose correction. To evaluate system performance, we recruited 20 non-professional users for experiments. The results show that the operational difficulty index of the GUI interaction mode (48.3) is significantly lower than that of the voice control mode (62.1). In terms of self-assembly efficiency, the system only takes 32 seconds to assemble 4 modules with a positional deviation of 3.2 mm; even when the number of modules is increased to 18, the assembly time is controlled at 182 seconds, and the deviation remains stable at 5.8 mm, demonstrating the robustness of the system. User satisfaction surveys further confirmed that the graphical interface rating (4.7 or 5.0) was significantly higher than that of voice control (3.8 or 5.0). This study demonstrates the effectiveness of the proposed interaction paradigm in terms of usability, efficiency, and accuracy, providing a key human-computer interaction solution for modular robots to move towards ubiquitous computing.

Design and Motion Accuracy Compensation of Variable Curvature Continuum Robot Mechanisms Based on Conformal Geometry

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ABSTRACT

This paper addresses the problems of insufficient modeling accuracy and motion error accumulation in traditional continuum robots operating in complex spaces. A method for mechanism design and motion accuracy compensation of variable curvature continuum robots based on conformal geometry is proposed. First, a unified kinematic model of the continuum segment under varying spatial curvature is established using conformal geometry theory, achieving high-precision description of position and attitude under multi-curvature conditions. Second, a prototype continuum robot with adaptive curvature control capability is constructed by combining a modular mechanism design with a flexible drive unit. By introducing a conformal spatial error propagation mechanism, an end-effector error compensation mapping model is established, and an iterative accuracy compensation algorithm based on conformal constraints is designed. Experimental results show that this method reduces the end-effector position error from 2.37 mm to 0.48 mm and the attitude error from 1.2° to 0.18° in typical variable curvature tasks, improving the overall motion accuracy by approximately 79.7%. Furthermore, the algorithm converges within 0.4 s, verifying the efficiency and real-time performance of the proposed compensation strategy. This study provides a new geometric modeling and error correction framework for high-precision control of flexible continuum robots, which has important reference value for the design of minimally invasive surgical robots and flexible detection equipment.

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Data-driven prediction and uncertainty quantification of bearing remaining service life

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ABSTRACT

Bearing remaining service (RUL) prediction is a core technology for predictive maintenance of industrial equipment. However, existing deep learning prediction methods mostly focus on point estimation, ignoring the inherent uncertainty in the prediction and limiting their reliability in critical decision-making. To address this, this paper proposes a bearing RUL prediction model (CL-MCD) based on CNN-LSTM and Monte Carlo Dropout. This model extracts the time-frequency features of vibration signals through a convolutional neural network, models the temporal dependence of the degradation process using a long short-term memory network, and introduces the Monte Carlo Dropout method to quantify prediction uncertainty. Experiments on the PRONOSTIA and XJTU-SY datasets show that the model significantly outperforms the benchmark model in both prediction accuracy (RMSE=6.25, MAE=4.93) and uncertainty estimation quality (Pearson correlation coefficient 0.87). In particular, the model's output of 95% confidence interval achieves an actual coverage of 95.1% and maintains stable performance under different operating conditions. This study provides a solution for bearing life prediction that combines high accuracy with reliable uncertainty quantification, which is of great value for improving the reliability of predictive maintenance of industrial equipment.

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Multimodal perception-based robotic flexible assembly force control process and digital twin verification

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ABSTRACT

This paper proposes a force control method for flexible robot assembly based on multimodal perception and a digital twin verification framework. By fusing visual, force, and pose information, a feature-decision level fusion model is constructed to achieve accurate estimation of the assembly state. An impedance/hybrid adaptive force control strategy is designed, and its asymptotic stability is proven through Lyapunov analysis. A digital twin system built on the Unity 3D-Gazebo platform achieves real-time virtual-real mapping, with pose synchronization error <0.2mm and force control error <0.25N. Experiments show that compared with traditional methods, assembly time, stable contact time, and energy consumption are reduced by 14.8%, 26.1%, and 17.7%, respectively; force error is reduced by 41.7%; assembly success rate reaches 98.4%; and robustness index is improved to 0.95. This study verifies the effectiveness of multimodal perception and digital twin fusion in improving assembly accuracy and stability, providing a feasible technical path for intelligent manufacturing.

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Adaptive gripper design and grasping mechanics simulation based on variable stiffness soft robot

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ABSTRACT

This paper proposes a thermo-mechanical composite variable stiffness soft gripper, employing a low-melting-point alloy and a particle damping composite layer. Through phase transformation and compaction synergy, the equivalent modulus is rapidly adjusted from 0.4 to 5.2 MPa (response < 0.7 s). The three-finger gripper can stably grasp objects with diameters of 20–100 mm and weights up to 0.6 kg, with a maximum grasping force of 50 N and a success rate > 97%. The established finite element model shows that as the modulus increases from 0.5 MPa to 4.5 MPa, the grasping force increases from 8 N to 39 N, and the stability coefficient is optimized from 0.72 to 0.96. The model prediction error is < 5%, and $R^2 > 0.96$, providing an effective solution for achieving a balance between flexibility and high load capacity in soft robots.

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International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

Jordan, December 18th - 20th 2025

Transforming the Construction Industry: Evolution of Building Information Modelling Towards Modular Construction

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The global construction sector is under increasing pressure to mitigate its substantial environmental footprint and align with overarching sustainability goals. The article reviews the convergent potential of Building Information Modelling (BIM) and modular construction. It posits that their integration is not merely synergistic but fundamental to advancing a paradigm shift towards a more efficient and sustainable built environment. The review discusses how the digital capabilities of BIM—encompassing detailed digital prototyping, clash detection, and lifecycle data management—seamlessly bridge the gap between design intent and manufacturing precision in modular construction. The synergy is shown to minimize material waste, optimize resource use, and enhance overall project quality. Furthermore, the review examines how BIM acts as a foundational tool for enabling circular economy principles within modular projects by facilitating design for disassembly and managing material passports for future reuse and recycling. Key research advancements in automated fabrication and data-driven supply chain integration are highlighted, while also addressing challenges related to interoperability and industry-wide adoption. Ultimately, the review concludes that the BIM-modular construction nexus represents a critical pathway for reducing carbon emissions, promoting resource efficiency, and systematically progressing the industry toward its alignment with global sustainability goals.

International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

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Attenuating Heat Transfer through Residential Roof Assemblies: Evaluation of Bulk Insulation based on 6-Dimensional Building Information Modelling

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ABSTRACT

Residential buildings in hot climates receive solar radiation at high intensity for long periods. The excessive heat elevates the roof surface temperature to extreme levels. Heat transfer from the roof surface material through the roof assembly results in temperature increase in indoor spaces. Occupants in the spaces experience thermal discomfort that not only reduces productivity and sleep quality, but also long-term health. As residential buildings are predominantly low-rise, the roof surface has the highest amount of exposure to solar radiation as compared to other building envelope components. Therefore, impeding heat transfer through the roof assembly is a key strategy to minimize periods of thermal discomfort. Bulk insulation materials contain tiny, trapped air pockets that prevent the bulk movement of heated air hence their installation in the roof can attenuate heat transfer through its assembly. The present study evaluates the effect of different bulk insulation materials on temperatures throughout the residential roof assembly. The evaluation is performed based on 6-dimensional Building Information Modelling using Integrated Environmental Solutions <Virtual Environment>, employing ModelIT to create digital residential building models and ApacheSim to run dynamic thermal simulation on the models based on first-principle mathematical modelling of heat transfer. Analysis of simulation results is performed to determine the temperatures below the ceiling and in the attic. Findings indicate that bulk insulation significantly attenuate heat transfer through the residential roof assembly, accentuating mineral wool as the most effective material for thermal regulation, and expanded polystyrene as a viable alternative where moisture resistance and cost efficiency are prioritized.

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Closing the Loop: Circularity in Modular Construction Research

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The global construction industry, a significant contributor to resource consumption and environmental degradation, faces an urgent imperative to align with the ambitious targets outlined in the United Nations Sustainable Development Goals. In response, the concurrent adoption of two transformative paradigms—circular economy and modular construction—has emerged as a critical area of scholarly and practical investigation. A review of the state-of-the-art research exploring the synergistic potential of the intersection between the paradigms is presented. The review reveals that modular construction, with the principles of off-site manufacturing and standardized assembly, provides an enabler for circularity by supporting design for disassembly, adaptability, and material recovery, facilitating the closing of material loops, minimizing construction and demolition waste and reducing the reliance on virgin resources. Key advancements are explored, including the development of circular design frameworks for modular components, innovative business models that prioritize material stewardship over ownership, and integration of digital tools, such as Building Information Modelling and material passports, for tracking and managing building components across life cycles. Furthermore, barriers to widespread implementation, such as logistical complexities in reverse supply chains, upfront economic challenges, and the need for updated regulatory standards, are discussed. The significant capacity of integrating circular economy principles with modular construction to fundamentally reshape the built environment is underscored, fostering a regenerative system that actively contributes to global climate action and sustainable resource management.

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Improved Technology For Producing Fine-Grained Concrete Using Marble Waste: A Comprehensive Study

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ABSTRACT

This study presents a comprehensive investigation into innovative technology for producing fine-grained concrete using marble waste as a partial replacement for natural sand. The research evaluates mechanical performance, durability indicators, microstructural characteristics, environmental benefits, and economic feasibility of the proposed technology. Experimental mixes were prepared with marble waste content ranging from 0% to 50%, maintaining a constant water-to-cement ratio of 0.5. Tests included compressive and flexural strength, water absorption, frost resistance, sulfate resistance, scanning electron microscopy, and X-ray diffraction. The optimal substitution level was identified at 20%, resulting in a 15% increase in compressive strength, a 12% increase in flexural strength, an 8% reduction in water absorption, and an improvement of frost resistance by 12 cycles compared with the control sample. Microstructural analysis confirmed denser packing of particles and reduced porosity. Environmental assessment indicated a reduction in natural sand consumption and a 12% decrease in CO_2 emissions per cubic meter of concrete. Economic evaluation demonstrated a cost reduction of 8–10% in production and profitability growth of 5–7%. The research contributes to sustainable construction technologies by offering an efficient method for marble waste utilization and improving concrete performance. The findings support large-scale industrial adoption and underline the need for further long-term durability investigations.

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International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

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Research on the Impact of Digital Finance on Green Technology Innovation: A Quasi-Natural Experiment Based on the Pilot Program of Financial Technology Innovation Supervision

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ABSTRACT

Green technology innovation is essential for high-quality economic development and China's "Dual Carbon" goals. This paper utilizes China's "FinTech Innovation Regulatory Pilot" policy as a quasi-natural experiment. Using panel data from Chinese prefecture-level cities between 2014 and 2023 and applying a multi-period difference-in-differences (DID) approach, we empirically examine the impact of digital finance on regional green technology innovation. The findings indicate that the establishment of the FinTech Innovation Regulatory Pilot has significantly enhanced the development of regional green technology innovation capabilities. Accordingly, this study further employs a mediating effect model to investigate the mechanisms through which digital finance influences green technology innovation, specifically by optimizing the allocation of regional financial resources and stimulating innovation vitality among market entities. Additionally, heterogeneity analysis is conducted to explore the differential effects of this policy across cities with varying administrative levels and resource endowments, thereby revealing the contextual disparities in its impact. This study provides new evidence on the green economic impact of digital finance and offers insights for optimizing FinTech regulation to support the "Dual Carbon" goals.

International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

Jordan, December 18th - 20th 2025

The Impact of Digital Economy on Enterprise Core Technological Innovation

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ABSTRACT

The digital economy serves as a key driver of global economic transformation and industrial upgrading. It significantly influences how enterprises achieve breakthroughs in core technologies. Using data from Chinese listed companies, this study examines how digital economy development affects enterprise core technological innovation. Results show a strong positive effect of digital economy on core innovation. These findings hold after a battery of robustness checks and endogeneity corrections.This study confirms the digital economy's crucial role in driving technological revolution. It provides solid evidence showing how enterprises can build lasting competitiveness through core technological innovation. Furthermore, it offers valuable insights for designing effective innovation policies at the national level.

International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

Jordan, December 18th - 20th 2025

Can Digital Village Construction Enhance Financial Inclusion? ——A Quasi-Natural Experiment Based on the Digital Village Pilot Program

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ABSTRACT

Based on county-level panel data from China spanning 2014 to 2023, this paper treats the "Digital Village Pilot" policy as a quasi-natural experiment and employs a Difference-in-Differences (DID) approach to empirically examine the impact of digital village construction on financial inclusion. The study finds that the digital village pilot policy significantly enhances the level of digital financial inclusion in the respective regions, a conclusion that remains robust after a series of robustness tests. This research establishes a causal relationship between digital village construction and financial inclusion, constituting a foundational empirical contribution in this field of study.

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Copyright Protection of FDM Products via Controlled Line Deviations

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ABSTRACT

This paper presents a technology for 3D product protection based on G-code modification. It alters the filament deposition trajectory on the surface layer to embed a copyright protection pattern (a specific case of a digital watermark). In our recent paper [1], we introduced an algorithm that relies on controlled trajectory deviations of printed lines to form a digital watermark. In the current work, we introduce two other algorithms: one based on rotating the printed lines and the other on varying their line width.

In the first modification, the line width is increased within the watermark region, with the thickening applied gradually—becoming progressively more pronounced toward the center of the watermark. The second modification involves altering the orientation angle of the lines within the watermark embedding area.

Figure 1 illustrates an example visualization of both watermark embedding approaches applied to a diamond-shaped pattern. The proposed line deviations do not affect the structural features or strength of the product and are barely noticeable. Automated authentication of the product can be carried out by photographing it with a mobile digital camera and subsequently extracting the copyright information using Fourier analysis of the image. The experiments conducted have confirmed the effectiveness of the proposed technology.

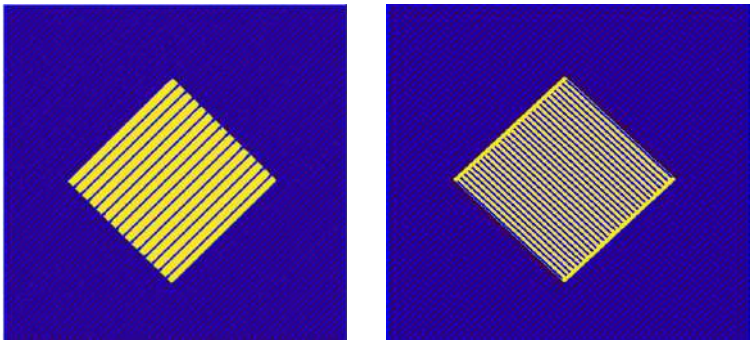


Figure 1. Example visualization of digital watermark embedding approaches: (1) line thickening, (2) line rotation

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Jordan, December 18th - 20th 2025

Digital economy, industrial restructuring and consumption upgrading

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ABSTRACT

As a new engine and driving force for boosting consumption, the digital economy plays a crucial role in promoting consumption upgrading. Based on this, using panel data from 259 prefecture-level cities in China from 2010 to 2023, this paper empirically examines the mechanism and economic effects of how the digital economy influences consumption upgrading. The results show that the digital economy significantly promotes consumption upgrading. Mechanism analysis reveals that industrial structure transformation serves as a mediator in the process of the digital economy affecting consumption upgrading. Threshold effect analysis indicates that the promoting effect of the digital economy on consumption upgrading exhibits a significant "U-shaped" characteristic. Heterogeneity analysis demonstrates that the digital economy has a stronger promoting effect on consumption upgrading in central, western, and less developed regions.

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Jordan, December 18th - 20th 2025

Can Artificial Intelligence Enhance Financial Inclusion? Evidence from a Quasi-Natural Experiment of China's New Generation AI Innovation and Development Pilot Zone

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ABSTRACT

The rapid development of artificial intelligence (AI) is reshaping the global financial landscape, making its influence on financial inclusion an important research topic. Using balanced panel data from 277 prefecture-level cities in China from 2015 to 2023, this study conducts a quasi-natural experiment based on the establishment of the National New Generation Artificial Intelligence Innovation and Development Pilot Zones to assess whether AI development enhances financial inclusion. The findings indicate that: (1) AI significantly improves financial inclusion by increasing the depth of use and digitalization of digital inclusive finance, while its effect on coverage breadth remains limited. (2) AI advances financial inclusion by fostering green technological innovation and increasing investment in education and science and technology. (3) Foreign trade dependence strengthens the positive impact of AI, whereas stricter environmental regulation weakens it. (4) AI has stronger effects in eastern, coastal, and urban-agglomeration cities, and its impact is more pronounced in non–provincial-capital, non–resource-based, and non–mega cities. The policy impact also declines with later batches of pilot zones. This research provides new evidence on the relationship between AI and financial inclusion and offers practical implications for policymakers.

Keywords: artificial intelligence; financial inclusion; quasi-natural experiment

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Research on the Effect of Digital Technology Promoting Agricultural Development — Based on Spatial Panel Regression Analysis

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ABSTRACT

As the core engine driving agricultural modernization, the spatial effect of digital technology has not been systematically revealed. Based on the panel data of 31 provinces in China from 2011 to 2023, this paper constructs a comprehensive evaluation system for digital technology development index and agricultural development, and conducts an empirical analysis using the Spatial Durbin Model (SDM). The results show that digital technology has a significant positive direct effect and spatial spillover effect on the agricultural development of the province itself. The spillover effect is mainly realized through the neighborhood demonstration effect — provinces leading in digital technology stimulate neighboring provinces to learn, imitate and achieve industrial chain coordination through the demonstration of smart agricultural models, the radiation of e-commerce platforms and technology spillover, thereby improving the overall regional agricultural development level. Heterogeneity analysis indicates that, divided by province, the indirect effect of the eastern sub-sample is significantly higher than that of the central and western regions. Divided by agricultural development level, the indirect effect of the high-level sub-sample is much greater than that of the medium-level and low-level sub-samples. This shows that the spatial spillover effect of digital technology is more significant in regions with a strong economic foundation and high agricultural development level. This study reveals the spatial transmission mechanism of digital technology promoting agricultural development, and provides empirical evidence for formulating differentiated digital rural policies and regional coordinated development strategies.

International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

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Graph-Based Modeling of Corrugated Boards for Local Stress Analysis During Compression

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ABSTRACT

This study introduces an image-driven, graph-based 2D frame (beam) modeling approach for analyzing the compressive behavior of corrugated boards. Frame-by-frame video recordings of compression tests are converted into geometric graphs [1], which are subsequently interpreted as networks of beam elements with orientation-dependent effective stiffness to approximate the anisotropy of paper. The resulting reduced-order finite-element model is implemented using the Python library Anastruct to compute internal forces, stresses, and displacements under quasi-static, linear-elastic assumptions.

The method reproduces the overall deformation trend of the corrugated structure, although it does not account for geometric nonlinearity or buckling, and therefore underestimates displacements and cannot capture the characteristic load drops seen in experiments. Despite these limitations, the framework provides a computationally lightweight and interpretable way to evaluate how experimentally observed geometrical imperfections influence deformation patterns. Its modular structure further enables straightforward integration with more advanced nonlinear or data-driven modeling approaches in future work.

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International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

Jordan, December 18th - 20th 2025

A Machine Learning Supported AHP–GIS Framework for Flood Risk Mapping in the Central Niger Delta

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ABSTRACT

Flooding in the Central Niger Delta has escalated due to rapid land-use conversion, hydrometeorological variability, and the region's naturally low-lying geomorphology. Recent machine-learning (ML) studies in the Niger Delta have demonstrated strong predictive performance for hydrological and environmental modeling, with Random Forest models frequently achieving >85% accuracy and identifying terrain and hydrological parameters as dominant predictors. Leveraging these insights, this study presents a machine learning–supported Analytic Hierarchy Process (AHP) and Geographic Information System (GIS) framework for flood-risk mapping in a data-scarce deltaic environment. Nine criteria Digital Elevation Model (DEM), slope, drainage density, flow accumulation, curvature, geology, land use/land cover (LULC), rainfall, and NDWI were standardized, reclassified, weighted, and integrated using a Weighted Linear Combination (WLC). ML-informed variable rankings were used to guide AHP pairwise comparisons, reducing subjectivity and improving consistency. The model achieved a consistency ratio of 0.03, confirming high reliability. DEM, slope, and drainage density contributed 60% of the total weight, aligning with published ML feature-influence metrics. Terrain and hydrological analysis revealed that 71.9% of the region lies below 14 m elevation, while NDWI classification showed over 85% high surface-water saturation, reflecting historical flood extents. The composite flood-risk map indicates that 55% of the study area (5,386 km²) falls within moderate to very high risk, including 16.3% high-risk and 1.7% very high-risk zones concentrated along major river channels and wetland depressions. By integrating transparent AHP decision rules with ML-supported prioritization, this framework provides an operational, scalable tool for early warning, disaster preparedness, and climate-resilient infrastructure planning in vulnerable deltaic regions

Keywords: Flood Risk, GIS, AHP, Machine Learning, Decision Support, Niger Delta.

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Core Outcomes of Artificial Intelligence for Product Design and Development: A Systematic Literature Review and Future Research

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ABSTRACT

The rapid evolution of artificial intelligence (AI) technologies in the entrepreneurial ecosystem has significantly impacted the innovation of product design and development; yet, a comprehensive understanding of these outcomes is still emerging. This research aims to explore the outcomes of AI technologies for product design and development by synthesising existing research through a systematic literature review using the PRISMA protocol. Data were collected from 39 peer-reviewed journal articles in Scopus, and the analysis was conducted using grounded theory, as outlined in the Gioia methodology, to categorise and interpret the findings. The review identifies four core outcomes, including performance & process enhancement, personalised and participatory design, predictive & proactive intelligence, and planet, people & policy alignment, emphasising AI's role in improving efficiency, user-centric design, and decision-making. The findings suggest that AI is integral to transforming product design, offering both operational and innovative benefits while addressing societal and environmental considerations.

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Towards recycling and promoting susttasinable nature-based solution for storm water capture using pervious pavement

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ABSTRACT

Nature-based solutions (NBS) for stormwater collection are a sustainable way to manage water while enhancing ecosystems and reducing flood risks. These solutions work with natural processes rather than against them, offering multiple environmental and societal benefits. NBS approaches include green roofs, permeable/ pervious pavement, rain gardens, bioswales, constructed wetlands and urban forests primarily. These solutions are gaining momentum as governments and communities recognize the need for climate-adaptive infrastructure that works harmoniously with nature. NBS also support the sustainable development goals (SDGs), particularly waste reduction and flood management and include SDGs 6, 9, 11, 12, 13,14 and 15, highlighting the quest for enhanced effort to promoting NBS in stormwater management. This research aims at incorporating plastic waste into porous bituminous/ asphalt pavement which has the potential to tackle multiple environmental issues simultaneously, reducing plastic waste, improving stormwater and flood management. The objectives include reviewing previous studies on plastic-modified asphalt to identify the best polymer blends; investigating the long-term performance of plastic-reinforced porous asphalt in various weather conditions; exploring the economic feasibility of integrating plastic waste into large-scale road projects in Mauritius and; assessing potential regulatory and environmental concerns**,** ensuring safe use without unintended consequences. High Density Polyethylene (HDPE) waste plastic was used to modify the bituminous/ asphaltic binder in varying percentages of 4%, 8% and 12% respectively. Marshall stability and flow tests were conducted on the open- grade bituminous/ asphalt mixes. A permeability test was devised and applied to the HDPE mixes using a physical model. The optimum percentage replacement was 4% HDPE, which was the ideal mix for balancing stability and performance**.** All the HDPE replacements satisfied drainage limit through the permeability test. The cost comparison between traditional open graded pervious pavement and that with 4% HDPE modified pervious pavement led to a slight decrease in cost; however, highlighting strongly the environmental advantages of supporting such climate adaptive measures.

Keywords: Nature- based solutions (NBS); stormwater; recycling; flood; management; plastic; waste; HDPE; cost.

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Stakeholders' perspective on sustainability, planning, restoration and management of the coastline of Mauritius: a thematic analysis approach

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ABSTRACT

This paper presents a contribution in furthering the understanding of the dynamics of the Integrated Coastal Zone Management (ICZM) framework of Mauritius in planning, restoration and management of the Mauritian Coastline. Despite its well-founded concept of balancing competing pressures to achieve economic, environmental and socially sustainable development, the practical implementation of ICZM raises considerable challenges. techniques were employed to gather in-depth information from stakeholders' experiences in order to pinpoint the challenges that interfere with the ICZM process in Mauritius. Specifically, semi-structured interviews were conducted to discern the perceptions of identified stakeholders. A thematic analysis approach was used to identify themes relevant to the overarching research aim. Through this analysis, findings illustrate that despite professed willingness from all concerned stakeholders, continued effort is absolutely needed to overcome the systemic challenges of the ICZM process with the government recognised as the central element in bringing about change and fostering engagement.

Keywords: Integrated Coastal Zone Management (ICZM), planning, restoration, environmental, sustainable, development

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Construction and demolition wastes (CDW) management in Mauritius for circularity in construction materials towards resilient cities

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ABSTRACT

The management of construction and demolition wastes (CDW) in Mauritius predominantly adopts a linear 'take-make-dispose' approach, with minimal recycling rate and most the wastes being disposed to landfill or dumped illegally. This study investigates the relationship between stakeholder engagement and circular management of CDW with the aim to establish a sustainable framework towards a circular management of the wastes. Using a mixed-methods approach, qualitative data were collected through expert interviews and quantitative data through a structured questionnaire. A thematic analysis of the interview was carried out to identify the challenges faced in managing CDW in Mauritius and to refine twelve (12) key CDW management strategies that can be implemented in the country. These management strategies were then linked to five key stakeholders - Government, Clients, Designers, Contractors and Recyclers - in a survey questionnaire. The quantitative findings indicated a strong correlation and a statistically significant relationship between stakeholder engagement and circular economy in CDW management. The quantitative data were further analysed to link the stakeholders with the identified CDW management strategies and to rank their level of importance. The government, being responsible for more than half of the management strategies, emerged as the important stakeholder. The latter is responsible to initiate actions that will drive the participation of the remaining stakeholders. To visually represent the relationship between stakeholder engagement and circular CDW management, a causal loop diagram was developed. It was found that a coordinated effort and engagement of the stakeholders helps in reducing the amount of wastes being generated and optimising their use by keeping the wastes within a closed loop. The study concludes that it is possible to achieve circular economy in CDW management in Mauritius through an enhanced stakeholder engagement, a robust governance and a strategic implementation of the twelve (12) CDW management strategies in the study. It provides valuable insights for decision-makers to understand and act on the interconnection between stakeholder engagement and sustainable waste management practices.

Keywords: construction, demolition, wastes, sustainability, stakeholders, engagement, strategies, circular, economy

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An Optimization led Design Framework and Global Case Studies for Post Disaster Recovery Shelters

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ABSTRACT

Post disaster shelters need to be resilient as well as rapidly deployable are necessary for not only long-term recovery but also for humanitarian response. However, majority of the current designs face continual challenges such as sustainability, deployment speed, adaptability, and economical to local conditions in the affected areas. This study will cover global real-world cases of post disaster recovery shelters, as well as present a framework for optimization led design on the basis of the lessons learned from not only the limitations but also the successes of the past ones. The case studies discussed here will contain modular shelter solutions which were developed after the occurrence of 2015 Nepal earthquake, prefabricated recovery housing in Turkey as well as Syria after the occurrence of 2023 earthquake, community led housing strategies after the occurrence of 2010 Haiti earthquake, in addition to typhoon resilient shelters in the country Philippines. Such case studies will be considered through the eyes of material efficiency, environmental sustainability, structural resilience, and cultural suitability. The study will highlight the persistent trade-offs between durability, speed, as well as affordability, but also the possible opportunities for additive manufacturing, digital construction technologies, in addition to Artificial Intelligence led optimization to cover such gaps. Then, published studies will be taken into account to talk about the gaps in the existing literature. Some graphical analysis will be performed to understand the future scope of the proposed post disaster shelters while considering humanitarian needs, engineering, as well as digital technologies as their basis in disaster prone regions in the world.
* The asterisk denotes the presenting author.

Keywords: Philippines Typhoon Shelters, Nepal Earthquake, Modular Housing, Recovery Shelters, Disasters

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Predictive Modeling of a Vacuum-Tube Solar Thermal System Using an LSTM Neural Network for Enhanced Energy Efficiency

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ABSTRACT

Improving energy efficiency across the European Union has intensified the need for advanced predictive tools capable of supporting intelligent control of solar thermal installations. Evacuated tube collector (ETC) systems represent a highly efficient solution for domestic hot water production; however, their performance is strongly influenced by rapidly changing meteorological conditions. Recent studies have demonstrated that deep learning methods—particularly Long Short-Term Memory (LSTM) neural networks—achieve superior accuracy in forecasting the behavior of nonlinear and time-dependent energy systems when compared to conventional statistical or feedforward neural network approaches [1 – 7].

This study develops an LSTM-based predictive model for forecasting the thermal dynamics and heat output of an ETC solar system using real experimental measurements. The model is trained on time-series data including solar irradiance, ambient temperature, inlet and outlet temperatures of the working fluid, and flow rate. Through hyperparameter optimization and robust error-minimization procedures, the proposed model demonstrates high predictive stability and accuracy, performing comparably to or surpassing published attention-LSTM and hybrid CNN–LSTM architectures [3 – 6].

The results confirm that LSTM networks effectively capture nonlinear temporal dependencies and seasonal fluctuations, making them a reliable tool for intelligent solar-thermal system management. The proposed methodology contributes to reducing energy losses and improving overall system efficiency, in line with the European Union's regulatory ambitions for sustainable energy consumption articulated in Directive (EU) 2023/1791 on energy efficiency [8]. This work provides a foundation for future extensions involving hybrid deep-learning models and real-time predictive control of solar thermal installations.

* The asterisk denotes the presenting author.

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Real-Time Controlled 3D-Printed Robotic Manipulator for Digital Engineering Training

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ABSTRACT

Real-time control of robotic systems requires a highly reliable hardware–software architecture capable of responding instantly to the dynamic conditions of modern manufacturing environments. Contemporary microcontrollers provide the necessary computational performance, extensive input–output interfaces, and robust timing characteristics, making them suitable for driving electric actuators, servomechanisms, and other applications with stringent temporal constraints.

This study presents a real-time control system for a 3D-printed robotic manipulator, developed as an educational platform for digital engineering and automation training. The proposed concept reflects principles used in industrial robotic systems by integrating multiple sensors, actuators, and control operations into a unified real-time loop.

The use of 3D printing enables rapid and cost-effective reproduction of mechanical components, thereby increasing the flexibility and maintainability of the training environment. In parallel, CAD-based simulations support the analysis of the manipulator's kinematics and mechanical structure prior to physical implementation. The developed prototype provides a hands-on learning environment closely aligned with real industrial robotic systems and supports the acquisition of key competencies in digital engineering, real-time control, and applied automation.

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Thin-Layer Drying Modeling of Red Beet Using Experimental Data, Page Kinetics, and Digital Monitoring

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ABSTRACT

This study investigates the thin-layer drying of red beet and develops a mathematical description of the process kinetics through a combined experimental–computational approach. Red beet is a rich source of betalains, phenolic compounds, and antioxidants [1], which highlights the importance of optimizing the technological drying conditions. Existing drying methods have a substantial impact on the qualitative and biochemical properties of the product [2], including structure, color, and the retention of bioactive compounds.

In this work, fresh red beet slices were dried at 60 °C using two complementary approaches: periodic gravimetric measurements and a digital monitoring system for continuous tracking of temperature and relative humidity. The obtained data were analyzed through the calculation of the moisture ratio (MR) and approximated using several widely applied thin-layer models reported in the literature [3–6]. The results demonstrate that the Page model provides the best fit ($R^2 = 0.998$), consistent with previous studies on red beet and other root vegetable materials [4], [7], [8].

The kinetic parameters (k and n) reveal that the process occurs entirely within the diffusion-controlled drying period, which is characteristic of plant-based biomaterials with complex structural organization [3], [5]. Additional research confirms that the choice of drying method (convective, vacuum, infrared, microwave) determines the extent to which the functional properties of the product are preserved [2], [7].

The novelty of the present study lies in combining two independent experimental techniques with high-precision parameterization of the Page model based on real process data, enabling simultaneous validation of the kinetic and thermodynamic characteristics of the drying process in real time—an integrated approach that is absent in the current literature [1–8].

The proposed methodology may serve as a foundation for the development of predictive models, digital twins, and intelligent control systems for drying installations.

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Shear Force in a Beam-Column Connection from a Linearly Distributed Load Occupying Various Possible Positions on a Cantilever Beam - Asymmetric Cross Section

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ABSTRACT

Earthquakes induce shear forces in beam-column connections of frame structures. They often lead to serious damage and even destruction of buildings. In the current Eurocode 2 [1], shear forces are determined capacitively based on the longitudinal reinforcing bars of the beam passing through the beam-column connection. This approach does not allow the forces that leave the beam and are part of the shear force to be determined as a result of the actual acting load, as well as to take into account the geometric and material characteristics of the beam. In this paper, a mathematical model of the beam is considered, which allows to take into account all these factors. This model allows to study the influence of each material characteristic, as well as each geometric dimension, on the magnitude of the shear force [2-5]. In the present study, a cantilever beam with an asymmetric cross-section, loaded with a linearly distributed transverse load occupying different possible positions, is considered. A solution is performed using Menabrea's theorem and the reactions of the side edges of the beam are determined along the height. The results are demonstrated for a beam with selected dimensions. The shear force is calculated with the exact forces determined with the newly derived formulas. To validate the results, the new shear force is compared with that determined by the approximate method recommended in the literature. The difference is up to 14%. A comparison is also made with the shear force determined according to Eurocode 2. The difference ranges from -50% to +46%.

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Reflection from the Type of Load on the Beam and Other Factors Significantly Influencing the Magnitude of the Horizontal Shear Force

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ABSTRACT

The beam-column connection is a particularly vulnerable element to cyclic lateral loads, such as earthquakes. Under such an impact, shear forces arise in the joints connection of frame structures. The main components of such forces are the forces that are transmitted from the beam to the column. A good knowledge of these forces will allow safe and accurate design of beam-column connections. In the current Evocode 2 [1], the forces from the beams are determined capacitively, based on the longitudinal reinforcing bars passing through the beam-column connection. However, this method does not take into account the participation of the concrete cross-section. Furthermore, this method cannot determine the forces transmitted from the beam to the column as a result of the actual applied load. Experimental studies conducted over the past few decades have shown the significant contribution of these two factors to the shear force. Analytical solutions of frame beams subjected to various types of loads [2-6] clearly demonstrate the significant influence of the load and the strength of the concrete. In this paper, numerical results obtained from analytical studies will be demonstrated, and conclusions will be drawn in support of experimental observations from the literature.

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International Conferences on Digital Technology Driven Engineering 2025 (ICDTDE2025)

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The Necessity of Bioengineered and Microbial Materials in the Field of Construction

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ABSTRACT

These days use of biological innovations being incorporated into construction, with the emergence of microbial as well as bioengineered materials as sustainable substitutes to the traditional infrastructure solutions. This study considers worldwide cases of microbial applications in the construction industry, focusing on not only practical execution but also their potential in the future. Such case studies will consist of microbial induced calcite precipitation trials for stabilization of soil as well as bio-cementation in the countries Singapore and India, self-healing bacterial concrete initiated in Netherlands, in addition to mycelium based lightweight construction materials used in USA and Denmark. Though these cases, the study will talk about how such materials could not only enhance environmental performance but also durability, which will minimize the repair costs, extend the life cycles of the structures, as well as reduce the carbon footprints in the process. Apart from technical performance, this study will also take cost barriers, long-term monitoring of biological activity, scalability, as well as regulatory acceptance, into consideration. These innovations within the broader framework of digital as well as sustainable construction could play a vital transformational step towards resilient infrastructure design and development, which will be covered by this study. Moreover, the existing gaps in literature through consideration of published studies will be discussed in this paper. Then, incorporating microbial solutions into digital manufacturing workflows like Artificial Intelligence optimized deployment, or 3D printing with bio-based binders could further expand their applications from narrower areas to mainstream engineering practices. Then, some graphical analysis will be performed to understand the future of these innovations in construction.
* The asterisk denotes the presenting author.

Keywords: Self-healing Bacterial Concrete, Bio-cementation, Bridges, Infrastructure, Bioengineering, Construction

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Temporal Refinement and ML-Driven Uncertainty Assessment of GEBCO Bathymetry in the Nigerian EEZ

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ABSTRACT

Reliable bathymetric data are fundamental for marine spatial planning, hazard assessment, and offshore resource development, particularly in data-limited regions such as the Gulf of Guinea. This study evaluates temporal refinements in the General Bathymetric Chart of the Oceans (GEBCO) models between 2019 and 2025 and applies a machine-learning framework to characterize spatial uncertainty within a representative section of the Nigerian Exclusive Economic Zone (EEZ). Depth values across the four GEBCO releases (2019, 2021, 2023, 2025) remain broadly consistent, ranging from ~−5 m nearshore to ~−4,900 m in deeper offshore zones, with stable mean depths (−2,450 to −2,465 m). Major physiographic units are preserved across datasets, with the continental shelf covering about 9–10% of the area, the upper slope roughly 19–20%, followed by extensive continental-rise and abyssal-plain regions. Hypsometric patterns show the expected rapid area increase toward the shelf break and gradual slope beyond −1,000 m, reflecting passive-margin architecture. Inter-release depth changes are generally small (mean $\Delta \approx -1$–2 m), indicating incremental updates rather than structural shifts. Localized variations linked to new multibeam inputs remain limited. A Gradient Boosting Machine (GBM) uncertainty model using slope, rugosity, depth variability, and source-provenance flags identifies moderate uncertainty concentrated along upper-slope gradients and areas with sparse survey coverage. SHAP values highlight slope and data-source lineage as dominant controls. Findings confirm progressively refined GEBCO products while emphasizing persistent spatial uncertainty patterns. This integrated geospatial–ML approach provides a practical framework for evaluating global bathymetric model reliability within the Nigerian EEZ.

Keywords: GEBCO, Bathymetry, Machine Learning, Uncertainty, Hypsometry, Nigerian EEZ, ocean mapping; GIS.

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Machine-Learning-Based Evaluation of Freeze–Thaw Durability in Lime-, Cement-, and ZT-Stabilized Expansive Soils

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ABSTRACT

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Expansive soils are particularly susceptible to freeze–thaw cycling, which degrades their structure, accelerates strength loss, and increases volume instability. Enhancing their durability under such environmental stresses is therefore critical for safe and reliable earthwork construction. This study evaluates the effect of up to 20 freeze–thaw cycles on the engineering behavior of expansive soil stabilized with lime, cement, and Zeolitic Tuff (ZT). Seventeen stabilizer combinations were prepared and tested alongside natural soil. Unconfined compressive strength (UCS) was measured after 0, 5, 10, 15, and 20 freeze–thaw cycles to assess long-term performance. All specimens experienced progressive strength reduction with additional cycles, yet every stabilized mixture consistently maintained higher strength than untreated soil. The incorporation of ZT, particularly in combination with lime or cement, significantly improved resistance to freeze–thaw deterioration, limited volume changes, and enhanced strength retention. Given that UCS testing is destructive, time-consuming, and sensitive to sample quality, the study also investigated indirect prediction of UCS using soil indices and machine-learning models. Parametric and non-parametric approaches were examined, including the M5 Tree model, k-nearest neighbors (KNN), and artificial neural networks (ANN). Models were trained on measured soil properties and UCS values obtained after freeze–thaw conditioning. The M5 Tree model achieved the highest predictive accuracy, followed by KNN, ANN, and regression. Overall, the findings demonstrate that incorporating ZT with traditional stabilizers markedly enhances freeze–thaw durability, while data-driven modelling offers reliable tools for estimating UCS and supporting the optimization of stabilization strategies.

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Systematic Review of Artificial Intelligence Roles for Product Design and Development: From Accelerating Innovation to Amplifying Sustainability

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ABSTRACT

Research on artificial intelligence in innovative product design and de-velopment within entrepreneurial ecosystems continues to expand; how-ever, the literature remains fragmented across technical, organizational, and socio-structural perspectives, leaving a gap in understanding how roles interact within real-world design ecosystems. This research aims to explore the roles of AI technologies for product design and development worldwide. The contribution of this work lies in offering an integrated synthesis that links AI's functional roles and multi-level future research needs in ways not addressed by previous reviews. A systematic literature review was conducted following the PRISMA protocol, utilizing Scopus as the sole database, and applying strict inclusion and exclusion criteria to evaluate 39 peer-reviewed, open-access articles published between 2021 and 2025. The analysis employed the Gioia grounded method. Findings show that AI technologies play key roles in four areas: acceler-ating product design and development, augmenting predictive intelli-gence and decision support, amplifying personalization and user experi-ence, and aligning sustainability and strategic innovation. The study concludes that AI's transformative potential remains contingent upon data readiness, system integration strength, and organizational ac-ceptance. Its implications emphasize the need for multi-scalar research connecting micro-level designer–AI interaction, meso-level workflow re-structuring, and macro-level regulatory and industry dynamics.

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Comparative Evaluation of SQP, GA, and PSO in Constrained Truss Design Optimization using MATLAB

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ABSTRACT

This paper presents a comparative evaluation of three optimization techniques, Sequential Quadratic Programming (SQP), Genetic Algorithm (GA), and Particle Swarm Optimization (PSO), for constrained truss design optimization using MATLAB. The objective is to minimize structural weight while satisfying stress and displacement constraints. The methods are applied to well-established benchmark problems, including the 10-bar, 17-bar, and 25-bar truss structures, enabling a systematic assessment under identical modeling assumptions and analysis procedures. SQP, representing deterministic gradient-based optimization, consistently achieved the lowest feasible weights with fast convergence and reliable constraint satisfaction. PSO demonstrated strong global search capabilities and high repeatability across runs, often identifying near-optimal solutions but occasionally showing sensitivity in constraint handling. GA exhibited greater variability and frequently produced infeasible or suboptimal designs due to premature convergence and limitations in its penalty-based constraint management. The comparative results highlight the trade-offs between deterministic and metaheuristic strategies, offering practical insights into their relative strengths, weaknesses, and suitability for structural optimization tasks. This study provides guidance for engineers selecting appropriate optimization algorithms for computationally efficient and constraint-sensitive truss design.

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Consumer Preference Modelling for Electric Vehicles in Indonesia: A Conjoint Analysis Approach

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ABSTRACT

The global transition toward sustainable transportation has prompted nations, including Indonesia, to promote the adoption of environmentally friendly vehicles such as electric vehicles (EVs), hybrids, and hydrogen-powered cars. Despite strong governmental support, the adoption rate of EVs in Indonesia remains low due to financial, infrastructural, and technological constraints. This study employs Conjoint Analysis to quantitatively identify the most influential attributes shaping Indonesian consumers' preferences toward electric vehicles. Eight key attributes were analysed: maintenance cost, maximum driving range, charging time, vehicle capacity and type, charging infrastructure, after-sales service and battery replacement cost, government incentives, and resale value. Data were collected through an online survey involving 511 respondents across Indonesia. The analysis reveals that maintenance cost, driving range, and government incentives have the highest relative importance in influencing purchase decisions. Findings emphasize that consumers are highly price-sensitive but also demand reliability and convenience in charging facilities. These insights provide evidence-based recommendations for policymakers and industry players to develop targeted strategies that align EV offerings with consumer expectations, thus accelerating market growth and supporting Indonesia's pathway to sustainable mobility.

Keywords: conjoint analysis, consumer preferences, electric vehicles, Indonesia, sustainable transportation

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Three-Dimensional FLAC3D Modeling and Support System Optimization for Irregular Foundation Pit Excavations

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ABSTRACT

Excavation work has become an essential part of urban development, especially in cities where construction activity is increasingly pushed into dense and highly constrained areas. Its role in maintaining structural safety and controlling construction costs is well recognized. Yet, the approaches traditionally used to design excavation support systems still rely heavily on engineering experience and simplified two-dimensional analyses. These methods struggle to capture the level of complexity found in many current projects.

The limitations become more apparent when excavations are located next to older or heavily loaded buildings, or when the site itself has an irregular geometry that does not conform to typical analytical assumptions. Under these conditions, predicting how the soil and surrounding structures will respond during excavation becomes considerably more difficult. As a result, important changes in mechanical behavior may go unnoticed until they develop on site, increasing the likelihood of unexpected deformation, construction delays, or even failures.

In many rapidly developing cities, excavation work now takes place in older districts where several generations of buildings and utilities are already packed together. Projects in these areas often involve awkwardly shaped lots or boundaries that do not follow a simple geometric pattern—mostly because land is scarce and redevelopment tends to happen in fragments rather than large parcels. These site conditions make it difficult to judge, ahead of time, how soil and adjacent structures will respond once excavation begins.

To take a closer look at these situations, this study uses FLAC3D to build a three-dimensional numerical model that reflects the actual geological layers and the loads imposed by the surrounding buildings. The simulation tracks how deformation develops step by step during the excavation sequence, instead of only

comparing the initial and final states. This approach helps identify where the support system may be critically stressed or where the geometry of the site causes unusual mechanical behavior.

The results offer engineers a more grounded reference for designing support systems in irregular or densely built urban sites. Beyond its technical findings, the study also relates to broader issues in urban renewal, since reliable excavation is one of the foundations of safe and sustainable redevelopment in aging city districts.

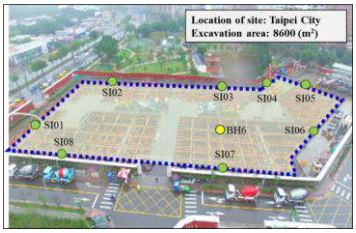


Figure 1: Site Conditions and Monitoring Setup for the Case Study



Figure 2: Deformation and Failure Characteristics of the Irregular Foundation

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Cross-Device Perception of LiDAR-Based Digital Twin Virtual Tourism: A Comparative Study Using a Heritage Fort Environment

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ABSTRACT

Virtual tourism has increasingly adopted high-fidelity Digital Twin models generated from LiDAR scanning, especially for architectural heritage sites where accurate geometry and material detail are crucial for cultural interpretation. While such rich visual information is commonly presented across devices ranging from smartphones to immersive VR headsets, little is known about how display characteristics influence users' ability to perceive LiDAR-derived textures, interpret descriptive text, and experience the spatial qualities of heritage environments. These cross-device differences are particularly relevant when presenting Digital Twin reconstructions of historic forts, where the legibility of masonry textures, weathering patterns, and defensive spatial layouts is essential for educational and interpretive value.

This study examines perceptual variations across four device types—a 17-inch laptop, an 11-inch tablet, a 6.1-inch smartphone, and a VR headset—using the same LiDAR-scanned Digital Twin of a historic coastal fort as the virtual tourism scenario. Participants were randomly assigned to one device condition and completed a structured questionnaire measuring (1) recognition of fine-grained visual details (e.g., stone textures, façade irregularities), (2) recognition of textual information embedded in the Digital Twin environment, and (3) perceived spatial attractiveness and presence.

Results show strong device-dependent effects. Laptop and tablet users demonstrated higher accuracy in recognising detailed textures and textual descriptions compared with smartphone users, with text recognition showing the greatest performance gap. VR participants exhibited the strongest spatial presence and were most effective at identifying large-scale architectural features of the fort, highlighting the role of immersive displays in interpreting Digital Twin environments. Smartphones consistently led to the lowest recognition scores and weakest spatial impressions.

These findings underscore the importance of device characteristics in shaping visual comprehension and experiential quality within LiDAR-based Digital Twin virtual tourism. The study provides practical

guidance for designing cross-platform heritage content that maintains clarity and interpretive value, and suggests adaptive presentation strategies to ensure consistent user experience across diverse display modalities.



Figure 1. Cross-Device Interaction with a LiDAR-Based Digital Twin of the Heritage Fort



Figure 2. XR-Based Interaction with the LiDAR-Derived Digital Twin of the Heritage Fort

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Applying Digital Twin and XR in a Real-World Residential Renovation: A Workflow for Spatial Understanding and On-Site Decision Support

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ABSTRACT

Digital Twin (DT) and Extended Reality (XR) technologies have gradually made their way into the AECO industry, yet they are rarely applied in small residential renovation projects. Most home renovations still depend on manual measurements, 2D drawings, and repeated site visits to clarify design details. These conventional steps are workable, but they leave plenty of room for misinterpretation and on-site corrections.

In this study, I explored a DT–XR workflow intended for interior renovation and tested it on a real apartment project. The process began with LiDAR scanning of the existing space, followed by the creation of an as-built Digital Twin model. This model was then reviewed through several XR devices to assist with design coordination and construction planning. Observations and informal discussions with designers and contractors were used to understand how the workflow influenced their decision-making and communication.

The case showed several practical benefits. Visualizing the space in XR made it easier to judge material combinations, layout adjustments, and spatial limitations that are not obvious in drawings. During coordination, potential installation conflicts surfaced earlier, reducing the number of on-site revisions. While the workflow is not a cure-all, it does help tighten the connection between design intent and construction execution. The experience from this project suggests that DT and XR can serve as a useful layer of support for renovation work, particularly when accuracy and communication are critical.



Figure 1. Data Acquisition and Pre-Modeling Workflow for Residential Renovation

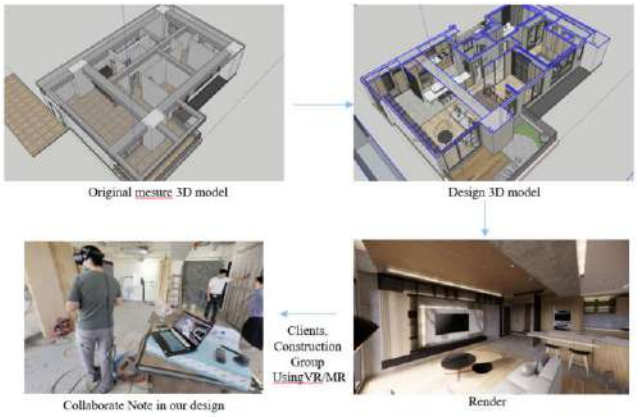


Figure 2. Digital Twin Workflow from As-Built Modeling to XR-Based Design Review

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Pilot Assessment of Digital Health Communication via WhatsApp Business and Its Impact on Purchase Intention at Edelweiss Hospital Indonesia

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The rapid growth of digital communication technologies has reshaped how healthcare providers interact with patients, especially through fast, efficient, and personalized messaging platforms. Edelweiss Hospital Bandung utilizes WhatsApp Business as part of its digital communication strategy to enhance service accessibility and strengthen patient engagement. This study aims to examine the influence of visibility, interactivity, and authenticity of WhatsApp Business on purchase intention through perceived value and perceived trust, using the Stimulus–Organism–Response (S-O-R) framework. In this model, WhatsApp Business functions as the stimulus, patient perceptions as the organism, and purchase intention as the response.

A pilot test was conducted to evaluate the validity and reliability of the research instrument before administering the full-scale study. Respondents involved in the pilot had previous experience interacting with Edelweiss Hospital via WhatsApp Business. The validity test results indicated that all questionnaire items met the required correlation thresholds, demonstrating strong construct validity. Meanwhile, reliability testing using Cronbach's Alpha showed that all variables achieved acceptable internal consistency, confirming that the indicators reliably measured each construct.

Additionally, the pilot test provided preliminary insights into respondent perceptions. Visibility aspects—such as clarity of information and completeness of service details—received positive evaluations. Interactivity indicators were also well perceived, with users appreciating responsive communication and ease of interaction. Authenticity dimensions similarly showed encouraging results, particularly regarding message sincerity and transparency.

Overall, the pilot findings confirm that the measurement model is appropriate for full deployment and suggest that WhatsApp Business holds strong potential as an effective digital communication channel for influencing patient purchase intention.

Keywords: Digital Health Communication, WhatsApp Business, Perceived Value, Perceived Trust, Purchase Intention

* The asterisk denotes the presenting author.

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The Role of Virtual Influencers in Building Brand Trust Through Consumer Engagement: A Cultural and Consumer Trust Perspective

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ABSTRACT

The rapid advancement of Artificial Intelligence (AI) has introduced Virtual Influencers (VIs) as a transformative force in digital marketing. These AI-generated personas offer brands new opportunities to create engaging narratives, enhance consumer interaction, and maintain full control over brand messaging. Despite these advantages, concerns regarding authenticity and transparency continue to pose challenges, particularly in shaping consumer trust and long-term brand relationships. This study aims to analyze the role of Virtual Influencers in building Brand Trust (BT) through Consumer Engagement (CE), while examining the moderating effects of Cultural Context (CC) and Consumer Trust (CT).

Using a quantitative approach, this research employs Structural Equation Modeling (SEM) to test relationships within the proposed Virtual Influencer Trust and Engagement Model (VITEM). The model integrates Perceived Authenticity (PA), Disclosure Transparency (DT), Virtual Influencer (VI), Consumer Engagement (CE), Consumer Trust (CT), Cultural Context (CC), and Brand Trust (BT). Data were collected through an online survey targeting Indonesian social media users who have interacted with Virtual Influencers.

This study contributes to AI-driven digital marketing literature by offering a comprehensive, integrative framework for understanding the mechanisms through which VIs shape engagement and trust. Practically, the findings are expected to guide marketers in designing ethical, transparent, and culturally adaptive strategies when utilizing Virtual Influencers. As VIs become increasingly prevalent in global and Indonesian markets, understanding how consumers perceive authenticity, transparency, and cultural alignment becomes essential for sustaining brand trust in the AI era.

Keywords: Virtual Influencer, Perceived Authenticity, Disclosure Transparency, Consumer Engagement, Consumer Trust

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The effect of correlations among random member properties on structural design: Investigation based on Robust Design Optimization

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ABSTRACT

This paper is concerned with the influence that correlations among random member properties have on structural design. The overall input uncertainty for a structure with uncertain properties is jointly described with a multivariate probability distribution; each marginal of the joint distribution describes the randomness of a structural property for a member or group of members of a structure, while the correlation matrix specifies the degrees of interdependence among the random member properties. The correlation values modeling the dependences among the properties of individual members or groups of members depend on the way these members are constructed at site or manufactured at a factory, the sources of their raw materials, the countries/regions the members and/or the raw materials are taken from, etc.

The random member properties of real-world structures are not either uncorrelated or fully correlated (as usually assumed for convenience); they are partially and unequally correlated, therefore a tool capable of handling arbitrary correlation values and patterns is needed. Herein, multivariate uncertainty is effectively handled with a Monte Carlo (MC) simulation procedure, which is used to compute average values and variances of structural response quantities without restrictions on how the marginal member properties are distributed and correlated. A specialized two-step heuristic sampling approach is employed to generate multivariate random samples and induce arbitrary intercorrelations for the MC simulations [1]. The numerical results obtained for elastoplastic steel frames in [2] demonstrate that varying the correlation values and patterns of random member properties can have a significant effect on probabilistic structural analysis results (the variation range of the results may be even more than two orders of magnitude).

To enrich the available knowledge regarding the influence of correlations among random member properties, a Robust Design Optimization (RDO) framework is employed. Specifically, a bi-objective design optimization procedure is implemented that considers as criteria the average value and the variance of the collapse load of elastoplastic steel frames. The numerical examples tested reveal the significance of the proposed optimization approach and the drastic effect of correlations among random member properties.

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Modeling Smart Furniture Publication Dynamics: A Design-Driven Management Approach Using a Weighted Multi-Model Ensemble

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ABSTRACT

The rapid expansion of smart furniture research—driven by growing demands for design intelligence, embedded sensing, sustainability performance, and entrepreneurship-oriented innovation—has produced a scattered body of annual publications whose long-term trajectory remains insufficiently modeled. This study aims to forecast annual scholarly output in the smart furniture domain using a multi-model analytical strategy. The contribution of this research lies in integrating diverse forecasting techniques into a weighted ensemble that outperforms individual classical and machine-learning models, offering a more reliable methodological benchmark for design- and innovation-driven technology fields. Using a Scopus dataset of 356 documents published between 1996 and 2024, the modeling process employed polynomial regression, exponential growth, poisson regression, SVR with RBF kernel, Holt linear trend, and a refined weighted-averaging ensemble that synthesizes the strengths of the top-performing models. Findings show that exponential growth and poisson regression consistently deliver superior standalone accuracy, while the proposed ensemble—combining exponential growth, poisson regression, and SVR—achieves an R^2 of 0.9586, RMSE of 2.573, MAE of 1.928, and MAPE of 24.17%, preserving the precision of the strongest models and stabilizing the volatility inherent in SVR outputs. These results indicate a steadily accelerating research landscape, reflecting increasing global attention to sustainability-oriented product design and entrepreneurial innovation embedded in smart furniture ecosystems. The study provides a methodological pathway for future scholars to anticipate publication dynamics in emerging design-technology fields, enabling more strategic planning in research, investment, and innovation policy.

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A Hybrid Systematic Review and Delphi Study on the Internet of Medical Things in Entrepreneurship: Roles, Challenges, and Future Directions

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ABSTRACT

The rapid advancement of the Internet of Medical Things (IoMT) presents significant opportunities and challenges within the entrepreneurship landscape, yet a comprehensive understanding of its roles and obstacles remains limited. This study aims to systematically explore the roles and challenges of IoMT in entrepreneurship worldwide. Distinct from previous research, this study employs a rigorous systematic literature review (SLR) using the PRISMA protocol, focusing on peer-reviewed articles published between 2014 and 2024, sourced from the Scopus database. Thematic structuring and analysis, guided by the Gioia method, reveal four aggregate dimensions describing the 3I roles of IoMT in entrepreneurship: innovation and digital transformation, investment and business expansion, and impactful healthcare solutions. Similarly, 4I key challenges emerge: innovation and system scalability, information security and privacy, industry regulations and market entry, and investment and business sustainability. A Delphi method engaged health-technology and entrepreneurship experts to iteratively validate and refine the emerging themes, providing consensus-based confirmation of their practical relevance. These findings highlight the dual nature of IoMT as both a driver of entrepreneurial growth and a domain fraught with technological, regulatory, and financial complexities. The study concludes that addressing these challenges is crucial to harnessing the full potential of IoMT in entrepreneurial ventures. This research contributes to the literature on entrepreneurship and health technology by providing a structured synthesis of the multifaceted impact of IoMT, offering valuable insights for academics, practitioners, and policymakers seeking to foster innovation in healthcare entrepreneurship.

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Entrepreneurship Enablers in Civil Infrastructure: A Systematic Review and Delphi-Validated Synthesis

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ABSTRACT

Entrepreneurship in the civil engineering sector has gained increasing attention as infrastructure systems confront rising demands for resilience, sustainability, and technological advancement. Yet, despite its strategic relevance, the enabling conditions that stimulate entrepreneurial activity in civil infrastructure remain conceptually underdeveloped, leaving a research gap in understanding the field's theoretical consolidation and global trajectory. This study aims to identify the primary enablers of entrepreneurship in the civil infrastructure industry and to map future research directions. Its contribution lies in presenting a clarified, theory-driven model that articulates four interrelated aggregate dimensions offering a more structured lens on how entrepreneurship materializes in an engineering-dominant environment, distinguishing this work from previous reviews. Using a systematic literature review following the PRISMA protocol, thirty-nine Scopus-indexed open-access journal articles (2021–2025) were analyzed and coded through a grounded theory Gioia approach, followed by expert validation via the Delphi method. The results indicate that entrepreneurial activity is shaped by the interplay of these four "C" dimensions: the generation of innovative solutions (Creative Capabilities), cross-sector partnerships (Collaborative Capital), opportunity-recognition and decision-making skills (Cognitive Competencies), and regulatory, economic, and sustainability-driven forces (Contextual Conditions). The study consolidates current knowledge while offering a structured explanation of how entrepreneurship and innovation emerge in civil infrastructure. The findings carry significant research and practical implications by guiding scholars, policymakers, and industry leaders in cultivating environments that reinforce innovation-driven and sustainable infrastructure entrepreneurship.

A Systematic Literature Review and Delphi Study on Entrepreneurship Roles in Civil Infrastructure: Toward a Future Research Agenda

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ABSTRACT

Entrepreneurship has increasingly shaped civil engineering practice, yet its roles in advancing innovation and sustainability across the civil infrastructure sector remain insufficiently mapped, leaving a conceptual and empirical gap in current scholarship. This study aims to clarify and categorize the key roles of entrepreneurship in civil infrastructure and to identify corresponding future research directions. Its contribution lies in offering a theoretically grounded, empirically validated framework that distinguishes this study from prior work, which has typically examined entrepreneurship in infrastructure only through fragmented or sector-specific lenses. Using a Systematic Literature Review (SLR) based on the PRISMA protocol, 39 Scopus-indexed open-access journal articles published between 2021–2025 were analyzed. The roles of entrepreneurship were inductively developed through a Gioia-based grounded-theory procedure, producing four aggregate dimensions—Catalyzing Innovation, Coordinating Collaboration, Configuring Sustainability, and Cultivating Capability. These emergent dimensions were subsequently evaluated and refined through a Delphi Method involving expert panels in civil engineering, infrastructure management, and entrepreneurship. The findings indicate that entrepreneurship performs multiple interconnected roles that collectively enhance innovation capacity, sustainability performance, adaptive project delivery, and strategic value creation within civil infrastructure. The study also identifies a set of future research avenues that highlight the need for cross-disciplinary models, longitudinal assessment of entrepreneurial impacts, and deeper exploration of sustainability-driven innovation ecosystems. Entrepreneurship acts as a multidimensional driver that expands the technical, managerial, and societal contributions of civil infrastructure. This study offers a clarified four-dimension framework that can guide researchers and policymakers in strengthening innovation- and sustainability-oriented infrastructure development.

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Design and Optimization of a Multiband Patch Antenna for Mobile Communication Devices

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ABSTRACT

This study presents a straightforward method for designing multiband microstrip patch antennas. The microstrip patch antenna is designed to function over many frequency bands: 0.9 GHz, 1.5 GHz, 1.8 GHz, 2.1 GHz, and 2.45 GHz. The microstrip patch antenna is designed for operation at a single frequency band, and by including several L-slots, the antenna's properties may be improved to function over various bands. The methodology is straightforward, and the configuration of the multiband microstrip patch antenna comprises a microstrip patch antenna including four slots integrated atop the radiating patch. A microstrip patch antenna is a low-profile radio antenna that may be affixed to a flat surface. This is a narrow-band, wide-beam-fed antenna constructed by etching the antenna element pattern into a metal trace adhered to a dielectric substrate, such as a printed circuit board, with a continuous metal layer affixed to the other side, creating a ground plane. The primary objective of this project is to design, construct, and evaluate a printed circuit antenna (microstrip patch antenna) appropriate for the L-band frequency range of 1-2 GHz. The co-axial feed approach was used, and the feed point's position inside the radiating patch was adjusted to identify the site of minimal return loss. This article reviews multiband microstrip patch antennas using various design methodologies and operating principles, along with their attributes and combinations. Multiband antennas are appealing because they provide a single solution for various applications across many frequency bands. This document offers a comparative analysis of several multiband antennas, detailing their operational principles, relevant characteristics, and applications concerning frequency bands. This study also emphasizes the characterization of the manufactured antenna concerning factors such as VSWR, antenna efficiency, axial ratio, gain, and radiation pattern. The antenna was developed and simulated with Ansoft HFSS 13.0 software.

Keywords: Microstrip patch antenna, Multiband, HFSS and Patch antenna parameters.

The Impact of Financial Inclusion on Economic Growth : Case of Tunisia

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ABSTRACT

This research studies the impact of financial inclusion on economic growth in Tunisia during the period 2004–2023. After presenting the theoretical background of this relationship, which mostly points to a positive effect, we tested it empirically in Tunisia using the ARDL model. By considering the different dimensions of financial inclusion (access, availability, and utilization), the results confirm the existing literature. They show both positive effects (Bank Accounts « BA », Bank Branches « BB », and Bank Deposits « BD ») and negative effects (Automated Teller Machine « ATM » and Domestic Credit to the Private Sector « DCPS »). However, the positive effects are stronger than the negative ones, and they are more significant in the short term than in the long term. These findings lead to policy implications from the government and national financial sector actors, such as banks and the Central Bank of Tunisia.

Keywords : Financial inclusion, economic growth, Tunisia, ARDL.

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Success Factors of IoT-Enabled Digital Tools in Entrepreneurship: A Systematic Review Integrated with Delphi Validation

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ABSTRACT

The rapid diffusion of IoT as a digital tool within entrepreneurship has intensified the need to understand why some ventures successfully harness this technology while others fall behind, yet existing research remains scattered and lacks an integrated, theory-driven explanation of its success factors. This study aims to identify the primary success factors enabling IoT adoption in entrepreneurship and map future research directions. Unlike prior reviews, this article contributes a systematically derived and Delphi-validated synthesis that unifies conceptual, empirical, and expert perspectives into a more rigorous explanatory structure. Using a PRISMA-guided SLR of 23 Scopus-indexed open-access journal articles (2021–2025) combined with a Delphi process, the study applied the Gioia methodology to construct a multilevel model capturing four aggregate dimensions: strategic alignment, structural readiness, skill-based capability, and sustainability-driven value creation. These dimensions illustrate how IoT, as a technology-enabled digital tool, supports entrepreneurial innovation, operational adaptability, and long-term sustainability. The Delphi panel confirmed the clarity, coherence, and practical resonance of the model. The study concludes that IoT-enabled entrepreneurship succeeds when ventures simultaneously reinforce strategic, structural, skill-related, and sustainability elements. The findings offer meaningful implications for researchers and practitioners seeking to advance IoT-based entrepreneurial innovation and sustainable digital transformation.

Neural Network Constitutive Modeling of Soil for Resilient and Sustainable Design

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ABSTRACT

In this research an advanced neural network (NN) architecture is presented to model the constitutive behavior of geomaterials for resilient and sustainable geotechnical engineering. Typical classical models fail to capture the highly nonlinear, path dependent and history dependent responses of materials like soil under different loading conditions limiting their predictive reliability. We correct this deficit by developing and training NN models on large experimental and numerical datasets, including monotonic and cyclic loading protocols. The models incorporate internal state variables to replicate hysteretic energy dissipation and plastic strain accumulation necessary to model strength degradation and liquefaction potential. The axial compression behavior of Earth structures and cyclic shear loading typical of seismic events are examples where NN predictions agree well with reference experimental data. This approach is envisioned as a flexible and computationally efficient tool for integrating high-fidelity material performance prediction in routine geotechnical analysis and optimization workflows. This methodology aims at designing resource-efficient, resilient and sustainable earth structures by enhancing the accuracy of soil behavior modeling.

Acknowledgments

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Cellular Manufacturing's Impact on JIT and Lean Outcomes: A Literature-Driven Analysis

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ABSTRACT

Faced by strong competition resulted from globalization of market, manufacturers are persistently seeking ways to lower costs, shorten lead times, and improve quality. To achieve these objectives, improvement of the manufacturing system has a major role to play. In this regard, Toyota Production System (TPS) has long been promoted as a model for its "lean" production and superior performance. Researchers have revealed a large number of unique characteristics and principles of TPS, but the findings regarding the effectiveness of them are inconsistent. This makes it difficult for manufacturers to figure out which practices would definitely bring positive results. This study solves this problem by identifying cellular manufacturing as the heart of TPS, i.e. the primary contributor to high performance production. We demonstrate why the implementation of cellular manufacturing will bring about most important elements of TPS and make a system almost as lean and high performing as TPS. The findings will provide guidance to manufacturers about the way to improve their systems, thereby reducing waste, improving quality, and saving costs.

* The asterisk denotes the presenting author.

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An Enhanced MILP Model for Efficiently Solving the Reentrant Flexible Job Shop Problem

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ABSTRACT

The reentrant flexible job shop problem is a highly complex scheduling problem due to its allowance for jobs to revisit machines. However, the problem has received considerable attention in academic research due to its broad industrial applicability. Most existing methods focus on obtaining feasible solutions quickly, but optimal solutions are often necessary for evaluating the quality of heuristic-driven solutions or minimizing the objective function in real industrial environments. This study develops and analyzes three mixed-integer linear programming (MILP) formulations for the reentrant flexible job shop problem, each distinguished by the dimensionality of its binary variables. The first model employs a traditional five-indexed decision variable, while the second reduces this structure to four indices. The third and main contribution of this study is an enhanced formulation based on a compact three-indexed binary variable, which significantly reduces the computational burden. Extensive computational experiments demonstrate that the three-indexed formulation is able to achieve optimal solutions for relatively large problem instances, i.e. instances consisting of more than 10 jobs, each with 5 to 15 operations, 3 to 7 workstations, and 1 to 6 parallel machines per workstation, with about 50% jobs reentering machines. The results highlight the critical importance of decision-variable design in improving the tractability and efficiency of MILP models for solving complex scheduling problems.

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Quantum Microprocessor Architectures: Scalability and Error Correction Benchmark

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ABSTRACT

This research looks at different designs of quantum microprocessors and compares their scalability, speed, and ability to fix errors in order to show ways to make quantum processing more fault-tolerant. The study looked closely at superconducting, trapped-ion, and photonic platforms and found that superconducting qubits have the best scalability (Unified Scalability Index (USI) = 0.68 ± 0.12). On the other hand, trapped-ion systems have better gate fidelities (99.97± 0.02%), but they operate more slowly. The study found a "error correction cliff" at 79 ± 4 physical qubits per logical qubit. This shows that implementing surface code can be hard because it uses a lot of resources. The study finds three important things that must be true for scalable quantum computing by combining the analysis of materials, patents (312% growth since 2018), and models of quantum circuits: (1) working together to make hardware and methods that can handle errors, (2) making cross-platform standards more consistent, and (3) creating cold control systems to get around problems with integration. The 1.7 annual drop in the error rate points to evolution along the lines of Moore's Law, but for this to be useful, progress needs to be made in both mixed quantum-classical processes and topological security at the same time. These findings show how important it is for people from quantum engineering, materials science, and photonics to work together. They also give researchers and other interested parties a way to plan for the difficult transition from Noisy Intermediate-Scale Quantum (NISQ) devices to fault-tolerant quantum computers.

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Comparative analysis of quantum technology and classical computing: advantages and drawbacks

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ABSTRACT

Something is being looked into that compares the good and bad points of normal computers and quantum computers. A look at how the two kinds of computers could work together in business and science is also included. The pros and cons of quantum technology will be found by looking into how it works, how it is different from other technologies, and how technologies are change over time. It was checked for errors with book reviews, case studies, and models, among other things. The information from ScienceDirect and IEEE Xplore was examined using NVivo. Quantum computing can handle more data and do hard tasks like encryption and optimization more quickly and better, they got these results. It does have problems, though, because it often gets wrong, is hard to understand, and needs special reading aids. Though quantum computing hasn't replaced regular computers yet, these results show that mixed models may be the best way to get the most out of it. To make these technologies more useful in real life, modern society need to get better at post-quantum security, make standards more uniform, and learn more about quantum error correction. These technologies can be used in AI, health, and safety, for example. Collaborations between different fields should also be pushed. Design efficiency and scaling in real-world settings should be looked into in more study in the future.

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Formation Control Design for Multi-UAV Systems under Linear Disturbance Estimation

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ABSTRACT

Cooperative behaviors in multi-UAV systems demand reliable information exchange across the communication network [1,2]. In real-world environments, unknown and time-varying disturbances can pose substantial obstacles to reliable cooperation, particularly when the vehicles interact over directed communication graphs, which are typical in practical deployments. This work addresses these challenges by first introducing a lightweight linear disturbance estimator that reconstructs disturbance signals in real time. The estimator is then integrated into a distributed formation controller that enables a UAV team to track a prescribed formation despite directed interactions and disturbance variations. A rigorous Lyapunov-based analysis establishes explicit sufficient conditions guaranteeing closed-loop convergence to the desired formation. Comprehensive numerical studies and UAV platform simulations validate the proposed framework, demonstrating its robustness, accuracy, and suitability for deployment in real-world multi-UAV coordination tasks.

* The asterisk denotes the presenting author.

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Attack Design on Consensus of Second-Order Multi-Agent System

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ABSTRACT

This work investigates an adversarial strategy that reshapes the consensus behavior of sencod-order multi-agent systems. In contrast to typical denial-of-service or deception attacks, which generally disrupt communication or injecting corrupt local information into individual agents, the proposed approach injects an attack dignal that forces the group to evolve along an attacker-defined trajectory [1, 2]. The malicious signal is generated by a dedicated exosystem whose internal dynamics are tailored to produce the targeted consensus evolution. To determine the required attack signal, a robust H_∞-based synthesis method is employed to compute the regulated injection matrix, which ensures that the altered system continues to operate in a stable and well-defined manner. The effectiveness and accuracy of the adversarial construction are demonstrated through numerical simulations, illustrating its capability to impose precise trajectory shaping on multi-agent consensus behavior.

* The asterisk denotes the presenting author.

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Unknown Input Observer–Based Estimation of Steering Rack Force in Steer-by-Wire Systems

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ABSTRACT

The Steer-by-Wire (SbW) architecture represents a major technological advancement in automotive steering by replacing the traditional mechanical linkage with a fully electronic actuation pathway [1, 2]. This structural shift provides substantial gains in flexibility, safety, and control capability, thereby accelerating the adoption of SbW in next-generation vehicles. A key functional requirement of SbW systems is the compensation of tyre aligning torques, which manifest as steering rack forces. However, direct and reliable measurement of these forces is often impractical due to the cost, durability limitations, and integration challenges associated with dedicated sensors. To address the critical importance of rack-force information in vehicle dynamics and steering control, this study introduces a novel unknown input observer that simultaneously estimates the steering rack force and system states in real time. The estimation performance is further supported through the incorporation of a linear disturbance estimator. The proposed methods are rigorously validated using software-in-the-loop experiments under multiple ISO standard driving cycles, demonstrating their accuracy, robustness, and suitability for real-time automotive applications.

* The asterisk denotes the presenting author.

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Compact Dual-Circularly Polarized Patch Antenna for Drone Communication Systems

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ABSTRACT

This research introduces a highly compact dual-circularly polarized (dual-CP) patch antenna specifically designed to meet the strict spatial limitations of drone communication systems. A primary technical contribution is the significant size reduction achieved through a novel loading structure that incorporates multiple capacitive gaps and shorting vias. This structural innovation effectively lowers the resonant frequency, allowing the antenna to maintain stable radiation characteristics while occupying a minimal footprint of approximately one-quarter of the effective wavelength, which is critical for space-constrained wireless platforms. To ensure versatile operation, the system employs a hybrid coupler-based dual-feed network capable of exciting both right-hand and left-hand circular polarizations with high isolation and a low axial ratio. Simulation results validate the efficacy of this design across the 5.52 to 5.61 GHz frequency range, demonstrating impedance matching lower than -10 dB, isolation better than 10 dB, and an axial ratio of less than 3 dB. Additionally, the antenna maintains symmetrical radiation patterns around the broadside direction with gain variation between 3.0 and 3.8 dBi, proving its suitability for high-performance UAV applications.

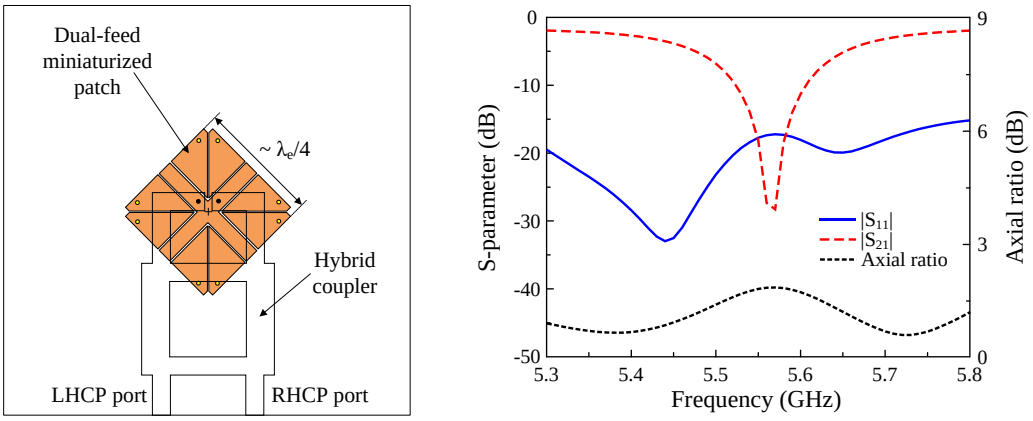


Figure 1. Configuration and simulation results regarding S-parameter and axial ratio of the proposed antenna

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Jordan, December 18 th - 20th 2025

Design of a Compact Wideband 8-Port MIMO Antenna using Dual-Polarized Radiators for C-Band Applications

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ABSTRACT

A design methodology is proposed for realizing a compact, wideband 8-port Multiple-input Multiple-output (MIMO) antenna system targeted C-band applications. The study's main contribution is a unified radiator architecture that supports both circular polarization (CP) and linear polarization (LP) operations. Unlike conventional designs that depend on multiple single-polarized elements, this approach employs four dual-polarized radiating elements to construct the 8-port configuration, thereby achieving improved integration density and space efficiency. The base radiators are implemented using truncated corner patch and crossed-patch structures configured for dual-CP and dual-LP excitation, respectively. To enhance performance, parasitic elements are strategically introduced in close proximity to the driven radiators to improve impedance bandwidth and inter-port isolation. The four dual-polarized antennas are arranged in a 2 × 2 array topology and further isolated using shorting via structures. Full-wave electromagnetic simulations verify the effectiveness of this design approach, confirming that it achieves wideband performance and satisfactory isolation characteristics for both CP and LP MIMO configurations.

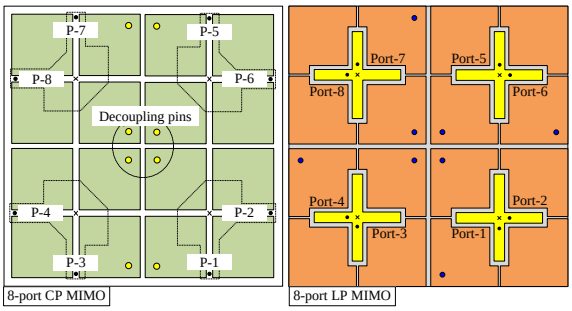


Figure 1. Configurations of the proposed 8-port MIMO antennas

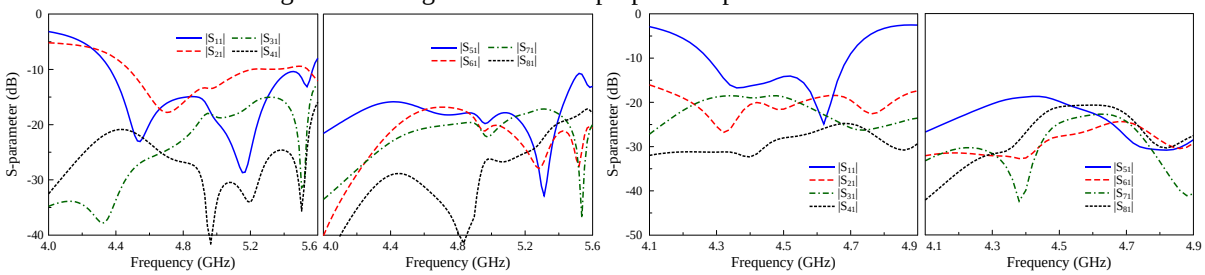


Figure 2. Simulated S-parameters 8-port MIMO antennas

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Compact Sub-6 GHz Patch MIMO Antenna with High Isolation for Handheld Devices

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ABSTRACT

This research presents an innovation in antenna technology for handheld devices by developing a compact, self-decoupled 2-port multiple-input multiple-output (MIMO) patch antenna operating in the TM_{01} mode. The primary contribution addresses the dual challenges of size reduction and port isolation. To achieve miniaturization, the design incorporates increased capacitance on the radiator, effectively reducing the antenna's electrical size to approximately a quarter-wavelength. A distinguishing feature of this miniaturized patch is its ability to generate extremely low cross-polarization radiation, a critical factor that differentiates it from conventional quarter-wavelength patches. Leveraging this low cross-polarization property, the proposed MIMO configuration realizes exceptional isolation better than 35 dB without requiring complex external networks, which are typically needed to mitigate strong mutual coupling in similar setups. Physically, the antenna is highly space-efficient, occupying a footprint of just 0.33λ × 0.15λ, yet it sustains a 40-MHz bandwidth spanning from 4.36 to 4.4 GHz. Within this operational range, the device exhibits stable performance with broadside gain varying between 4.0 and 4.8 dBi and isolation peaking at better than 38 dB. Additionally, the system ensures high-quality signal diversity, evidenced by favorable Envelope Correlation Coefficient and Diversity Gain metrics, making it a robust solution for compact sub-6 GHz communication interfaces.

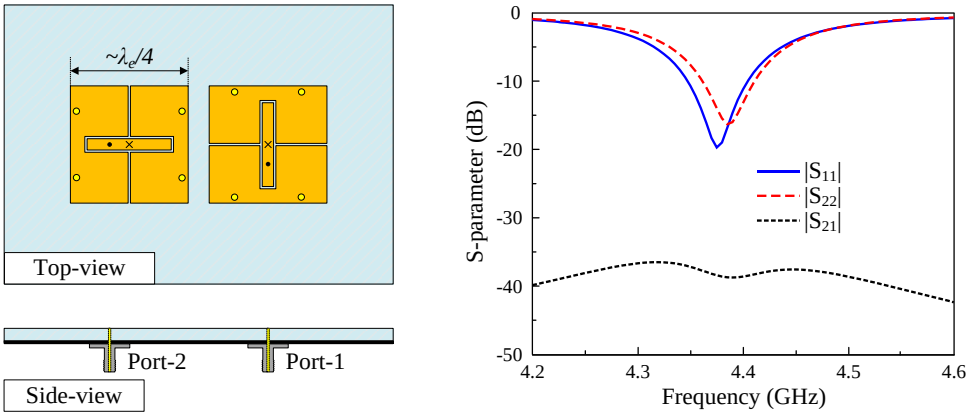


Figure 1. Configuration and simulated $|S_{11}|$ of the proposed antenna

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Integrating Digital Tools and Business Intelligence to Overcome Data Fragmentation in SMEs Manual Recording Processes

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ABSTRACT

Small and Medium-sized Enterprises (SMEs) are a vital component of the economy, yet they often struggle with innovation data-driven decision-making. A key challenge hindering the effective adoption of Business Intelligence (BI) is sales data fragmentation, especially arising from manual recording processes. This occurs when information is scattered across multiple, disconnected sources, such as manual records, spreadsheets, and disparate digital tools, leading to data inconsistencies and inaccuracies. This study aims to identify the root causes and operational impacts of data fragmentation in the SMEs environment. Using a qualitative, multi-case study approach, data was collected through semi-structured interviews with five SMEs owners from various sectors. Thematic analysis revealed that fragmentation stems from a combination of unintegrated tools, reliance on error-prone manual input processes, and delays in recording due to time constraints. The impact of this inaccurate data is significant, leading to flawed strategic decisions, such as product promotion and investment errors, financial losses, and a loss of trust in data, forcing owners to rely on intuition. This study proposes a "Data Fragmentation Cycle Model" that illustrates how resource constraints create a cycle that perpetuates poor data and intuition-based decisions. These findings imply that solutions for SMEs cannot only focus on technology, but must also include process improvements and increased data literacy.

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A review of Goals of sustainable economic growth, creativity, and infrastructure aligned with SDG 9

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ABSTRACT

Developing nations need investments in infrastructure, and sustainable and innovative industrial approaches to achieve the goal of sustainable development. Sustainable Development Goal 9 emphasizes on three pillars of sustainable industrialization, innovation, and infrastructure development. As a critical component of the United Nations' 2030 Agenda, SDG 9 addresses the pressing need to harmonize economic growth, creativity, and infrastructure to achieve sustainable development. This paper provides an in-depth review of Sustainable Development Goal 9 (SDG 9), which focuses on building resilient infrastructure, promoting inclusive and sustainable industrialization, and fostering innovation.

Infrastructure, one of the pillar of SDG 9, serves as the foundation for economic activity by providing essential services, supporting industries, and connecting communities. Sustainable infrastructure development is critical for addressing climate change and reducing environmental impacts. However, challenges such as high costs, governance issues, and limited access to green financing hinder its progress. Inclusivity and resilience are essential considerations, as infrastructure projects must cater to marginalized populations and withstand economic and environmental shocks.

This paper concludes by highlighting research gaps, including the need for sustainable approaches, and a broader exploration of creativity's role beyond technology. By addressing these gaps and fostering synergies among SDG 9's pillars, this review provides actionable insights for sustainable development. The findings underscore the necessity of inclusive and innovative strategies to achieve the ambitious targets of SDG 9 and ensure equitable global progress.

Keywords: Sustainable Development Goals, SDG, SDG's 9, Industry, Innovation, Infrastructure, gender equality.

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Industry 5.0 as a Catalyst for Resilient Poverty Reduction Policies

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ABSTRACT

The necessity to meet Sustainable Development Goals (SDGs) to have a substantial societal transformation has become a need for the world. Industry 5.0 catalysis resilient poverty reduction policies by integrating human-centric approaches and technological innovations. This paradigm shift emphasizes the collaboration between humans and machines, enhancing productivity and sustainability in various sectors. Challenges such as high initial implementation costs and the absence of global sustainability standards hinder the widespread adoption of Industry 5.0 Aligning Industry 5.0 along with Sustainable development goals for poverty alleviation promotes sustainable infrastructure and resilient industrial practices which are essential for long-term poverty alleviation. Industry 5.0 represents a transformative shift towards a more human-centric and sustainable industrial paradigm, directly aligning with Sustainable Development Goal 1 (SDG 1), which aims to end poverty in all its forms everywhere. The human-centric perspective of Industry 5.0 prioritizes human needs in manufacturing, fostering inclusivity and equity in industrial processes. Collaborative robots exemplify the integration of technology and human labor, enhancing productivity while allowing humans to focus on creative tasks. Many automotive manufacturers are exploring 'intelligent factories' to improve human-robot interaction and production flexibility. Robust training programs are necessary to ensure effective collaboration between humans and machines, addressing both technical skills and ethical considerations.

This paper focuses on Industry 5.0 and its alignment with the Sustainable Development Goal of poverty alleviation. While Industry 5.0 offers significant opportunities for enhancing productivity, it also faces challenges such as the need for new skills and adapting existing policies. According to the recent reports published by Niti Aayog, Goal 1- no poverty index improved by 12 points from the year 2020-21 to 2023-24, advancing from performer to Front runner category. In the last four years since the adoption of the SDGs in September 2015, India has demonstrated its strong commitment to the global goals given the success of the SDGs at the global will to a significant extent depend upon the success of its implementation in India. In this context, this paper will focus on the major areas that help in the improvement of score along with the role of Industry 5.0 in achieving the goal.

Keywords- SDG, Industry 5.0, Industry 4.0, Sustainable Development Goals, Poverty reduction

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Eco-Friendly Tourism and Hospitality: Balancing Growth with Environmental Responsibility

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ABSTRACT

Eco-friendly tourism and hospitality are essential for achieving global sustainability goals, particularly those outlined in the United Nations' Sustainable Development Goals (SDGs). Balancing growth with environmental responsibility requires a paradigm shift in how tourism and hospitality businesses operate and also leads to green construction. Construction industry moving towards more sustainable and environmental building. This includes adopting green technologies, implementing waste reduction strategies, and promoting eco-conscious behaviour among travellers. Moreover, the involvement of local communities is essential to ensure that tourism benefits are equitably distributed and culturally sensitive. Eco-friendly tourism and hospitality represent a critical nexus where economic growth and environmental sustainability intersect. By aligning industry practices with SDG goals, stakeholders can create a more sustainable future for both the environment and local economies. This research contributes to the growing body of knowledge on sustainable tourism by identifying practical solutions and highlighting the need for a collective effort to address global challenges. The paper explores how these sectors can effectively balance economic growth with environmental protection. It focuses on SDG 8 (Decent Work and Economic Growth), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action). The study examines real-world success stories, reviews existing research, and analysis emerging trends to analyse the gap and focus areas. The findings highlight practical strategies, such as adopting greener policies, promoting community-driven tourism initiatives, and integrating technology to create sustainable operations would be effective to achieve the desired results.

Keywords- Sustainable Development Goals, SDG, Green Construction, SDG, Sustainability, Sustainable Tourism.

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Building Sustainable Communities: CSR Contributions to Affordable Housing, Mobility, and Resilience under SDG 11 in India

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ABSTRACT

Sustainable Development Goal 11 (SDG 11) emphasizes the creation of inclusive, safe, resilient, and sustainable communities an urgent imperative for India's rapidly urbanizing landscape. As Indian cities confront escalating challenges related to affordable housing shortages, inadequate mobility systems, climate-induced vulnerabilities, and rising social inequities, Corporate Social Responsibility (CSR) has emerged as a strategic instrument capable of supplementing state-led urban development efforts. Institutionalized under the Companies Act 2013, CSR mandates have mobilized substantial private-sector investments, yet their targeted contribution toward urban sustainability remains underexamined. This study evaluates how CSR initiatives are influencing three core dimensions of SDG 11 which includes affordable housing, sustainable mobility, and urban resilience using a systematic review of CSR expenditure data (2014–2023), case analyses of leading Indian corporations, and policy linkages with national urban missions.

Findings indicate that firms are increasingly allocating CSR funds toward low-cost housing projects, transit-oriented mobility solutions, last-mile connectivity, road safety, climate-risk mitigation, urban greening, disaster preparedness, and community resilience-building. While these interventions demonstrate significant potential, the study reveals gaps in scale, geographic distribution, and alignment with SDG 11 indicators. Many CSR projects remain piecemeal, compliance-driven, and insufficiently integrated with municipal planning processes. To address these gaps, the paper proposes a CSR–Urban Sustainability Integration Framework that emphasizes collaborative governance, outcome-based monitoring, ESG-aligned CSR strategies, and multi-stakeholder partnerships with urban local bodies.

By situating CSR as a deliberate and catalytic instrument in strengthening India's urban transformation agenda, the study underscores its transformative potential in bridging funding gaps, accelerating sustainable mobility transitions, advancing affordable housing access, and enhancing community resilience. The paper concludes with actionable recommendations for corporations, policymakers, and urban planners to optimize CSR contributions and drive measurable progress toward SDG 11 across Indian cities.

Keywords: Sustainable houses, sustainable cities, sustainability, Corporate Social Responsibility, SDG11

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Artificial Intelligence Tools Driving Innovation and Advancements in Audit and Assurance: Towards Intelligent Risk Management and Transparency

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ABSTRACT

Artificial Intelligence (AI) is redefining the landscape of audit and assurance by fundamentally transforming how risks are identified, assessed, and monitored in real time. Traditional audit approaches—characterized by manual procedures, retrospective testing, and sampling-based verification—are increasingly inadequate in addressing the complexity, velocity, and volume of modern organizational data. In contrast, AI-enabled tools integrate machine learning (ML), natural language processing (NLP), deep learning, anomaly detection algorithms, and robotic process automation (RPA) to provide auditors with continuous, predictive, and data-rich insights that significantly enhance audit quality and assurance reliability. This paper provides a comprehensive examination of the technological evolution of AI within auditing, illustrating how automated data ingestion, intelligent analytics, and cognitive interpretation are reshaping core audit tasks such as risk assessment, substantive testing, fraud detection, and internal controls evaluation. Through case studies from leading global audit firms—including Deloitte's Argus, KPMG's KPMG Clara, PwC's GL.ai, and EY's Helix—the research demonstrates how AI adoption reduces human error, accelerates decision-making, and supports end-to-end audit lifecycle optimization. The methodological framework elaborated in this study outlines the integration of AI into existing audit models, highlighting tools for predictive modelling, exception reporting, document review automation, and continuous assurance. The paper also critically analyses challenges related to algorithmic bias, data privacy, cybersecurity vulnerabilities, interpretability of AI outputs, and gaps in regulatory frameworks such as ISA, PCAOB, and ICAI guidelines. Special emphasis is placed on emerging needs such as explainable AI (XAI), auditor–AI collaboration models, ethical safeguards, and competency development. In addition, the study explores the rising demand for AI-enabled sustainability audits, ESG reporting assurance, and real-time monitoring of climate-related financial risks—positioning AI as central to the next generation of transparent and responsible corporate governance. Overall, findings indicate that AI-driven audit ecosystems not only strengthen risk management and fraud detection capabilities but also enhance trust, accountability, and resilience in a rapidly digitalizing global economy.

Keywords—Artificial Intelligence, Audit, Assurance, Machine Learning, Robotic Process Automation, Risk Management, Fraud Detection, Continuous Auditing.

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Decadal Trends and Comparative Dynamics of CSR Spending by PSUs and Non-PSUs in India: Statistical Insights and Forecasts for Sustainable Development

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ABSTRACT

Over the past decade, Corporate Social Responsibility (CSR) has emerged as a transformative instrument in India's socio-economic development landscape, driven significantly by the mandatory CSR framework under Section 135 of the Companies Act, 2013. CSR gained this significance in India, particularly after making CSR mandatory for companies crossing the threshold. Companies crossing the threshold has to spend a portion of their net profits on CSR activities. This regulatory push has transformed CSR from a voluntary philanthropic activity into a statutory obligation for eligible companies. Understanding the spending patterns and contributions of different sectors, specifically Public Sector Undertakings (PSUs) and non-PSUs, is crucial for evaluating the effectiveness of the CSR mandate and its impact on socio-economic development in the country. This study provides a comprehensive, data-driven examination of CSR expenditure patterns among Public Sector Undertakings (PSUs) and Non-PSUs from FY 2014–15 to FY 2023–24. Applying a mixed-methods quantitative approach the historical trajectory and future direction of corporate spending behaviours is captured under this study.

The study discusses the broader implications for CSR strategy development, policy refinement, and collaborative models for development financing. It emphasizes the role of corporate India particularly non-PSUs in driving progress toward the Sustainable Development Goals (SDGs), especially in areas such as education, health, climate action, livelihood generation, and community development. By presenting empirical evidence and forward-looking insights, the research contributes to ongoing debates on the effectiveness, equity, and sustainability of CSR contributions in India. The findings will be valuable for companies in formulating their CSR strategies, for policymakers in refining regulations and incentives, and for stakeholders interested in the role of corporate India in achieving sustainable development. The findings reveal distinct and evolving patterns across the decade.

Keywords: Sustainable Development, Corporate Social Responsibility, Sustainability, Public sector Undertaking, Private Sector Undertakings.

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Structural credentials of Wire-arc Additive Manufacturing fabricated Nano-reinforced Aluminum Alloys

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ABSTRACT

Aluminum alloys possess a combination of favorable mechanical properties such as high strength-to-weight ratio, durability, and corrosion resistance, justifying their adoption for lightweight structural applications. Extrusion has been the predominant alloy forming technique, enabling the production of complex and intricate profiles; however, it is limited by high tooling cost and reduced flexibility for customized structural components. Wire-arc additive manufacturing (WAAM) has emerged as a promising alternative capable of rapidly fabricating large-scale aluminum alloy elements with high precision and on-site adaptability. Despite its promising potential, this emerging technology faces printing-related challenges such as hot cracking and direction-dependent mechanical properties, preventing its wider adoption at the moment. Titanium carbide nanoparticle reinforcement has demonstrated promising solutions to the above issues, since it has been shown to mitigate hot cracking and enhance isotropy. However, the cross-sectional and structural behavior of such nano-reinforced WAAM members intended for load-bearing structural applications remains largely unexplored. This study presents a preliminary structural assessment of nano-reinforced WAAM 6061 alloy members through cross-sectional investigation and frame analysis under wind loads and nominal seismic action. The results demonstrate significant increases in ultimate bending moment resistance along with moderate reductions in lateral displacements at the structural scale when the optimized WAAM-fabricated sections are used as columns. These findings validate the potential of WAAM for generating structurally efficient aluminum members, supporting future research on more intricate 3D-printed geometries and full-scale 3D analysis frameworks.

Keywords: 3D-printing, Wire-arc additive manufacturing, Aluminum alloys, Cross-sectional investigation, Structural analysis.

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Synergistic Wear–Corrosion Interaction in Al–Si/Al_2O_3 Composites: Microstructural, Electrochemical, and Tribological Assessment

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ABSTRACT

This study reviews the wear, corrosion, and tribocorrosion behaviours of Al-Si alloys reinforced with 3.5 wt.% Al_2O_3 ceramic particles. percent NaCl environment. Microstructural studies confirmed that Al_2O_3 was uniformly distributed in the matrix, which made it harder and enabled it to support weight. Wear tests indicated that the degree of abrasive damage and loss of volume material was significantly minimised, and the most significant improvements were observed at higher reinforcement levels. Electrochemical analysis revealed that the material was less susceptible to corrosion, exhibiting high Ecorr values, low icorr values, high polarisation resistance, and low corrosion rates. Despite these improvements, localised pitting at the particle-matrix interfaces remains a problem. The tribocorrosion experiments exhibited a clear synergistic interaction, as the joint action of mechanical and electrochemical degradation overcame the summative effects of wear and corrosion. Although tribocorrosion became less serious with the addition of Al_2O_3, all the composites retained a positive synergy factor. This indicates that the primary methods of removing material are sliding and chloride attack. Overall, the findings indicate that Al_2O_3 can be useful in enhancing the tough service performance of Al -Si alloys. They also emphasised that further optimisation is necessary to fully prevent localised degradation mechanismsReferences [1,2].

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Dynamic Characterization of Layered ground from Vibration Measurements

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ABSTRACT

This paper presents an inverse dynamics-based framework to characterize a single-finite layer on the top of a half-space to estimate the ground parameters such as the depth of the layer, Elastic moduli (of the top layer and the half-space), and Poisson's ratios, using vibration measurements (numerically generated reference responses) recorded at a receiver embedded at 1 m depth. This work has the potential to provide a non-invasive and practical alternative to in-situ testing, especially for sites with restricted access. The proposed approach can be eventually used to support more informed design and assessment of infrastructure.

The dynamic response calculated due to a harmonic load applied at a fixed location on the surface in the frequency domain using a dynamic-stiffness and wave-based formulation are then used to characterize the ground. The unknown parameters, i.e., the elastic modulus and Poisson's ratio of each layer and the associated first layer thickness, are treated as decision variables in an optimization problem that minimizes the misfit between numerically simulated and measured responses at selected receiver locations. Two different approaches have been used in this paper, the first based on least square regression LSR and the second based on the use of Genetic Algorithms GA.

Each optimization scheme was applied independently, and both were able to recover the five parameters with very small relative errors. LSR yielded a consistent global minimum solution but required a relatively long computation time, whereas GA reached comparable accuracy with shorter runtimes. The results highlight the potential of these algorithms as a building block toward soil "digital twins", opening the door for more adaptive and resilient geotechnical design practices.

AI-Driven Project Performance Management System for Engineering and Infrastructure Projects

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ABSTRACT

The research develops an AI-based system which helps engineers and infrastructure professionals make better decisions during their projects. The system aims to enhance cost and time and risk management through real-time project data analysis with machine learning models. The system depends on supervised learning algorithms to analyze past project data for detecting patterns that lead to delays and cost increases and resource waste. The system consists of three functional sections which handle data processing and prediction and decision-making operations. The system employs gradient boosting and neural networks to forecast project performance indicators through changes in project conditions. The decision-support system uses optimization rules to analyze multiple scenarios which produce recommendations that help users optimize resources and minimize risks. The system achieved better than 20% improvement in project prediction accuracy through its case testing with actual construction project data against conventional project tracking methods. The research demonstrates that AI tools produce reliable performance deviation alerts which project managers can apply to stop minor problems from developing into major issues. The system produces better project stability through its ability to enhance planning and scheduling and resource allocation efficiency. The research shows that AI technology enables engineering management transformation through its ability to make decisions based on data analysis. The upcoming development will bring digital twin functionality which allows real-time project simulations to run in real-time.

Optimization-Based Decision Framework for Resource Planning and Operations Management in Engineering Projects

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ABSTRACT

The research presents an optimization system which helps engineers plan resources and operate their large-scale construction projects. The research creates mathematical solutions to optimize resource distribution for projects by using task-based resource allocation which follows project rules and constraints. The system uses linear and multi-objective optimization methods to discover suitable resource distribution solutions which fulfill operational needs and budgetary limits. The research team created a mixed-integer programming system to model project tasks and their resource requirements and time constraints and dependencies. The model underwent evaluation using both artificial project data and actual construction and infrastructure management datasets. The optimization system produces better results than conventional planning methods because it decreases resource downtime by 18% and enhances schedule compliance by 12%. The model shows stability through sensitivity tests which prove its ability to respond to different resource availability levels and project task duration changes. The research demonstrates that optimization methods help managers create better resource plans which achieve performance targets at reduced costs while minimizing potential risks. The system allows project managers to assess different strategic choices while giving them instant ability to modify their resource allocation. The framework establishes digital transformation patterns in engineering management as its foundation to support AI-based forecasting systems which will be studied through future research.

Digital Twin–Enabled Risk and Productivity Management for Construction and Industrial Operations

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ABSTRACT

The research develops a digital twin-based system which enhances construction and industrial site risk management and operational performance tracking. The system aims to merge current data streams with computational models to generate an updated digital model of site conditions and equipment performance and project advancement. The digital twin system detects problems and evaluates risks through sensor data analysis with scheduling systems and simulation tools which enable operational modifications. The system consists of three connected modules which perform real-time data collection and risk evaluation and productivity measurement. The system used sensor-based monitoring to track equipment operation and worker activities and environmental elements. The risk model conducted probabilistic analysis to evaluate both safety risks and schedule-related uncertainties. The simulation engine evaluated productivity through performance comparisons between actual results and planned targets. The pilot project implementation showed that the system delivered 25% enhanced productivity data and 15% reduced unexpected equipment breakdowns. The research findings show digital twins create an efficient system which enables real-time risk management and ongoing production optimization. The system delivers immediate site information to managers who can use this data for better decision-making and improved operational stability. The research shows how digital engineering technologies enable construction and industrial managers to create new operational methods. The research will implement AI forecasting capabilities into the system which will operate with enterprise resource management platforms.

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Comparative Feasibility Analysis Of Hyperloop Technology Versus Conventional Ferry Operations For Cross-Lake Freight Transport: A Case Study Of Lake Van (Eastern Turkey)

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ABSTRACT

This study examines the techno-economic feasibility of Hyperloop technology as an alternative to the existing Tatvan-Van railway ferry service on Lake Van, a critical transit point on the Asian railway corridor. The study compares TCDD's operational data for the 2022-2024 period with Hyperloop performance metrics from the literature, analyzing them comparatively in terms of travel time, transport capacity, energy efficiency, and investment cost. Methodologically, two different Hyperloop route scenarios, an underwater tunnel and a lake perimeter route, were evaluated considering the region's depth of up to 451 meters, high seismic activity, and challenging hydrogeochemical structure. The analysis findings show that the Hyperloop system reduces the 90.6 km crossing time from 240 minutes to approximately 8 minutes, resulting in a 97% time saving. However, considering the performance increase provided by the new generation ferries that entered service in 2018, it was determined that the high-speed theoretical capacity offered by Hyperloop would create inefficient "over-capacity" by far exceeding the current and projected load demand for the lake crossing (local line) alone. In terms of cost, compared to the estimated €200-300 million investment for the digitalization and modernization of the ferry fleet, the calculated initial investment cost of €8.3-16.8 billion for Hyperloop was not considered sustainable. Consequently, in light of current economic realities, it was concluded that Hyperloop is not a rational investment in the short term; in the long term, in order to maintain the system's speed advantage and justify its high cost, it should be integrated not as a stopover point at Lake Van, but as a "non-stop" route for a long intercontinental journey.

Keywords: Hyperloop, Lake Van, Ferry Operations, Feasibility Analysis, Freight Transport, Cost-Benefit Analysis

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Data-Driven Torque and Temperature Estimation in PMSM Drives Using NARX Neural Networks

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ABSTRACT

Accurate estimation of electromagnetic torque and internal temperatures—including coil and winding/magnet temperatures—is critical for the safe and efficient operation of permanent-magnet synchronous motor (PMSM) drives. Direct sensing of these quantities is often constrained by cost, robustness, and installation limitations. Thermal overstress can accelerate insulation aging and reduce machine lifetime, while excessive magnet temperature may cause irreversible demagnetization, making precise internal monitoring essential for derating, protection, and predictive maintenance. Conventional electro-thermal models, such as lumped-parameter or finite-element approaches, require detailed design data and are sensitive to parameter uncertainty and varying cooling conditions. In this work, a physics-informed NARX (Nonlinear AutoRegressive with eXogenous inputs) neural network is developed as a virtual sensor to estimate torque, coil temperature, and winding/magnet temperature using readily available PMSM drive signals (current, speed, voltage, torque) combined with engineered loss-related and thermal-history features. Simulation and experimental validation demonstrate that the trained estimator provides excellent agreement with measured torque and accurately tracks both coil and winding/magnet temperatures, capturing transient dynamics and maintaining small steady-state errors. These results highlight the capability of NARX-based observers to provide robust, real-time electro-thermal monitoring while reducing dependence on intrusive thermal sensing.

Keywords: PMSM drives, Torque estimation, Temperature monitoring, NARX neural network, Virtual sensor, Electro-thermal modeling, Predictive maintenance, Machine learning for electrical machines

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A blockchain-enabled deep learning framework for privacy-preserving cloud forensics in healthcare

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ABSTRACT

The rapid adoption of cloud computing in healthcare has enabled efficient storage, real-time access, and remote analysis of sensitive medical data. However, the multi-tenant and distributed nature of cloud infrastructures introduces significant challenges for forensic investigation, including data integrity, privacy preservation, and regulatory compliance. This review explores the integration of blockchain and deep learning for privacy-preserving cloud forensics in healthcare, providing a comprehensive overview of state-of-the-art techniques, frameworks, and models. Blockchain's decentralized and immutable ledger ensures data traceability, auditability, and tamper-proof evidence, while deep learning approaches—including convolutional, recurrent, and hybrid models—enhance anomaly detection, evidence classification, and threat mitigation. The study also discusses privacy-preserving techniques such as encryption, differential privacy, federated learning, and secure multiparty computation, along with their integration with blockchain for secure healthcare data management. Comparative analyses highlight the strengths, limitations, and research gaps in current frameworks, offering insights for designing scalable, transparent, and efficient cloud forensic systems. The review concludes by outlining future directions for blockchain-enabled deep learning frameworks, emphasizing energy-efficient consensus mechanisms, explainable AI, and compliance with regulatory standards to safeguard sensitive healthcare data.

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Adaptive and real-time intrusion detection system using lightweight deep learning and optimized feature engineering

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ABSTRACT

The growing growth of IoT, platforms for cloud computing, and key infrastructures has increased cybersecurity concerns, making signature-based IDSs ineffective against zero-day assaults and changing malware. High-dimensional traffic on the network, resource constraints, and continuous processing demands hinder intrusion detection, reducing accuracy and increasing false alarms. This review examines adaptive, real-time IDS architectures that use compact deep learning and optimal feature engineering to overcome these issues. Recent methods use Autoencoders, CNNs, RNNs, LSTMs, RBMs, DBNs, ensemble models, and efficient feature selection and compression methods like Boruta, PSO, pruning, and quantization. These approaches are tested on benchmark datasets to improve identification precision, adaptability, and processing speed. Compact deep learning models reduce latency and resource usage yet preserve high quality of detection, making them suited for edge and IoT contexts. Optimized feature engineering reduces redundancy and increases model interpretability, improving generalization. Effective deep learning and optimization of characteristics enable adaptive IDS solutions that can detect sophisticated cyber attacks in dynamic, real-world networks.

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Trajectory Tracking of an Ackermann-Driven Unmanned Ground Vehicle Using Lyapunov-Based Nonlinear Kinematic Control

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ABSTRACT

This paper presents the simulation and analysis of a Lyapunov-based trajectory tracking controller for an Ackermann-steered unmanned ground vehicle (UGV). The proposed control approach stabilizes the vehicle's motion along a predefined closed-loop rectangular path using nonlinear kinematic control laws. The simulation incorporates realistic vehicle geometry, inverse kinematics for steering and wheel speed computation, and forward kinematics for actual motion estimation. Numerical experiments are conducted using MATLAB to evaluate the convergence of tracking errors and the adherence of linear and angular velocities to reference commands. Results demonstrate that the control strategy ensures asymptotic convergence of position and orientation errors while maintaining bounded control inputs. The proposed method offers a simple yet effective framework for ground robot trajectory tracking and can be applied to autonomous navigation tasks in structured environments.

Keywords: Unmanned ground vehicle, Ackermann steering, Trajectory tracking, Lyapunov control, Nonlinear kinematics, Autonomous navigation, MATLAB simulation

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What neural networks may be used to analyze trend lines for management decision-making?

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ABSTRACT

The research is based on the principle of Evidence-Based Management [1,2]. According to this principle, management decisions should be based on data that can be verified, reproduced, and explained. Trend lines provide this support. Neural network tools enhance this approach. Instant calculations allow one to see how stable a trend is, where noise begins, and where management actions can change the trajectory.

In this context, Artificial Intelligence (AI) is becoming a working tool [3], reducing uncertainty and providing speed where previously the problem was limited by the quantity and quality of human resources. This is how new management practices are emerging, using AI tools to analyze big data and construct trend lines. This is the level of quality that managers can rely on today.

The purpose of this study is to evaluate the consistency of three AI models in calculating key statistical indicators used in management analytics. The paper presents the results of five trendline analyses using three neural networks: ChatGPT 5.1, DeepSeekMath, and Gemini 3. For example, Example 1 compares the results of linear trend analysis performed by different neural network models, as well as built-in Windows statistics tools. A high degree of consistency is observed across all calculations: Windows Statistics (**R^2 = 0.9768),** ChatGPT 5.1 (**R^2 = 0.9768),** DeepSeekMath (**R^2 = 0.968),** Gemini 3 (**R^2 = 0.9766).**

The analysis results demonstrate that neural network models are becoming a fully-fledged tool for evidence-based management: they confirm statistical inferences, accurately reproduce trend line parameters, and provide robust coefficients necessary for engineering and economic solutions. Empirical data demonstrate that neural networks are creating a new standard framework for informed management actions. In this combination, theory, data, and computational models work as a unified system, providing the level of accuracy and reliability required in high-tech industries today.

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Integrating Artificial Intelligence into medical imaging to enhance diagnostic accuracy through multi-stream attention-based CNNs while effectively addressing multi-modal data challenges to improve overall clinical outcomes

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ABSTRACT

The integration of AI & one it techniques, especially, CNNs—into medical imaging is examined in this paper. Conventional image method viz., MRI, CTs, and X-Ray have proved essential for non-invasive diagnosis; nevertheless, they necessitate a great deal of manual processing, which is laborious and prone to human error. The article highlights CNNs' revolutionary effects, especially their ability to automate the interpretation process and improve diagnosis efficiency and accuracy. The greatest potential of CNNs is to greatly lessen radiologists' workload and enhance diagnostic results, which is demonstrated by instances such as tumor segmentation in MRI scans and pneumonia diagnosis from X-rays. CNN use in therapeutic contexts is not without its difficulties, but due to their differences in imaging techniques and equipment, but, it is difficult to generalize these networks across multiple datasets, and models trained on one source of data frequently performing poorly when applied to others. Furthermore, multi-modal data—which is commonly required for thorough diagnostics—is difficult for conventional CNN architectures to handle. The research suggests a unique Multiple Streams Attention Dependent CNN (CNN with MSA) architectures which uses different CNN streams to handle several imaging modalities in order to overcome these problems.

Keywords: MRI, Biomedical, Healthcare, Image, CNN.

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Characterization and Anisotropy of 3D Printed Mycelium

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ABSTRACT

Over the last decade the use of mycelium (the root-like structure of fungi) as a raw material has become a highly discussed topic on material science, and rightfully so. The properties of mycelium-based composites (MBC), along with its low-cost production and fully circular economy make it a favorable substitute to inert materials, such as plastic or even cement under certain conditions. In recent studies an extrudable bio-ink has been successfully developed, opening the path for combining the novelty of mycelium-based materials with the advantages additive manufacturing. However, as this is a very recent practice, the knowledge we have about the MBC's behavior, although valuable, is mostly application-oriented. In this study, we follow a more fundamental approach. We examine a plethora of parameters, from both the cultivation of mycelium (substrate content, duration and conditions of first and second colonization) and the process of 3D printing itself (printing orientation, infill density and pattern, and others), and their effect on the final material's mechanical behavior. Then, for the combination with the best performance we expand the characterization on other properties studied on the bibliography.

To our knowledge, this is the first time that such a thorough characterization is conducted for 3D printed MBC. We aim to gain a better and deeper understanding of this highly promising material, with the ultimate goals being to find out the rest of its advantages compared to conventional materials, as well as its limitations, opening up the discussion on how they can be overcome.

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Implementation of a Prediction Model Based on Naïve Bayes and Bag of Words (BoW) in Assessing ESG as a Supporting Factor for the Green Economy

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ABSTRACT

This study aims to develop a predictive model using the Naïve Bayes algorithm and the Bag of Words (BoW) method to classify Environmental, Social, and Governance (ESG) information from unstructured text documents in support of green economy practices. Data were collected from annual reports, sustainability reports, and corporate news, followed by text preprocessing, BoW representation, and classification using the Multinomial Naïve Bayes algorithm, with model performance evaluated through accuracy, precision, recall, and F1-score metrics. The results show that the model achieved an accuracy of 83%, with precision, recall, and F1-score values ranging from 0.82–0.84, while keyword analysis revealed distinct linguistic patterns, where support and provide were more dominant in class 0, and community and energy were more influential in class 1, demonstrating the model's practicality and efficiency for ESG assessment. However, the model remains limited in capturing semantic context due to the simplicity of the BoW method, suggesting that future research should employ more advanced text representation techniques such as Word2Vec or BERT to enhance classification accuracy and contextual understanding.

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5G-enabled digital twins: A governance framework for equitable smart urban transformation

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ABSTRACT

When 5G wireless technology and urban digital twins (UDTs) come together, they could change the way smart cities are run and how services are provided. But the research that has been done so far is mostly made up of scattered case studies. There is no real-world proof to back the supposed 5G-UDT synergy, and the effects on government and equality are not given enough attention. Because it uses a lot of different methods to look into 12 smart cities; it does this with the help of data about users, data about regions, network tests that are 3GPP-compliant, and ISO-standard map validation. They show that when mmWave 5G is used, latency can be less than 8ms, which makes it possible for UDT synchronization to work with centimetric geometric accuracy and cuts simulation lag from 22 seconds to less than 3 seconds. The study adds four main things: (1) a set of technically sound benchmarks for mission-critical UDTs; (2) a tried-and-true hybrid governance model that strikes a balance between interoperability and innovation; (3) a new way to make sure that cities are fair places to deploy technology; and (4) a plan for policymakers to follow when putting the new ideas to use. This means that investing in fair government and the skills of institutions is just as important as building the right infrastructure for cities to have a fair and sustainable digital future.

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Optimizing the Strengthening Efficiency of Double Skin Tubular Beams using Sustainable Hybrid LRS FRP System

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ABSTRACT

The efficiency of utilizing a hybrid strengthening system composed of sustainable material was examined in this study using the nonlinear finite element analysis (NLFEA) method. The flexural behavior of double skin tubular beams (DSTB) of rectangular cross section was investigated. Beams were composed of inner hollow circular steel tubes of finite thickness and strengthened with sustainable FRP material with improved ductility due to its large rupture strain (LRS) characteristics. In this study, three strengthening systems are investigated, and their efficiency is presented to help engineers optimize their design in terms of weight, cost, ductility, strength, and sustainability. The three systems were as follows: the first is composed of a laminate positioned at the tensile fiber of the beam in the longitudinal direction, the second one is a wrapped FRP covering the whole beam perimeter and length, and the final one is a hybrid system combining the laminate and the wrapped LRS FRPs. Results will be presented and compared to reach clear conclusions regarding the optimized use of the LRS FRP in improving the flexural behavior of DSTBs.

* The asterisk denotes the presenting author.

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NLFEA Study on the Flexural Behavior of Double Skin Tubular Beams Strengthened with LRS FRP System: Inner Steel Tube Eccentricity Effect

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ABSTRACT

There is an increasing necessity to increase the ductility of essential structural members, such as beams, along with mitigating any possible unfavorable environmental sources consumption, and keeping the strength-to-weight ratio as high as possible. Therefore, this study adopts the nonlinear finite element analysis (NLFEA) method to simulate the flexural behavior of a double skin tubular beam (DSTB) positioned at different concentric and eccentric locations with respect to the geometrical centroid of the rectangular beam cross-section. In addition, beams were reinforced with one large rupture strain (LRS) FRP sheet of 1 mm thickness positioned at the bottom of the beam (tensile region) and another one wrapped along the perimeter of the beam. The position of the inner steel tube was selected to represent the following eccentricity percentages (-40%, -20%, 0, 20%, and 40%). Results are presented in terms of different structural characteristics, including strength, ductility, and recommendations were given for selecting the best parameters included in the beam design to reach the target structural values.

* The asterisk denotes the presenting author.

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The Extent Effect of Concrete Material on the Flexural Performance of Solid and Hollow Double Skin Tubular Beam

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ABSTRACT

Double skin tubular beams (DSTB) were introduced in the field of civil engineering to be used in different structural members, such as beams and columns. However, several advantages were provided upon the utilization of DSTB, including the reduced weight and high strength. On the other hand, this study introduces an effective solution for improving the beam's ductility upon the utilization of large rupture strain (LRS) FRP sheets; one wrapped along the beam's cross section, and the other lies at the bottom tensile side of the beam. This study examines the extent effect of concrete material on the flexural behavior of DSTB in two main directions. The first pillar was to simulate the beams with an inner hollow and solid concrete, and the other pillar was to simulate the effect of concrete compressive strength (20 MPa, 35 MPa, and 50 MPa). The study outcomes were accomplished using the nonlinear finite element analysis (NLFEA) methodology, where results were introduced to represent design guidelines for designing and rehabilitation of structural components. The conclusions of the study cover wide structural performance indicators, including weight, cost, strength, and ductility.

* The asterisk denotes the presenting author.

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Parametric statistical scheme for tracing the transmission of total harmonic distortion between a power network analyzer and an oscilloscope

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ABSTRACT

Nonlinear loads represent a challenge for several organizations due to their impact on power quality parameters, especially total harmonic distortion (THD) [1]. One of the main objectives in the energy supply is to deliver to the final consumer a wave that meets the parameters established in regulations, the voltage THD being one of them [2]. Electrical network analyzers are the leading equipment to perform these measurements. However, access to ISO/IEC 17025 calibration is a significant problem [3]. On the other hand, it is possible to calibrate oscilloscopes nationally and internationally. The article proposes a parametric statistical scheme to deform the voltage sine wave, obtaining several THDv points. The measurement system was subjected to a numerical analysis to guarantee its stability at a confidence level of 95%, obtaining satisfactory results. An uncertainty estimation model is presented that allows the transmission of traceability from an oscilloscope to a power quality analyzer. Finally, a calibration exercise is carried out through a direct comparison at several points, observing the feasibility of its implementation

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Evaluation of Success Factors in Determining the Impact of Biomedical Engineering on Neurosurgical Operations

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ABSTRACT

Biomedical engineering application plays a critical role in neurosurgical operations. Physicians, who are well-trained in biomedical devices, can significantly reduce surgical risk. This directly contributes to improved surgical performance and reduces the risk of complications. These applications contribute to achieving precise and safe results, thereby improving the quality of patient's healing process. This study comprehensively examines the factors affecting the success of biomedical engineering applications in neurosurgical operations. For this purpose, twenty-eight criteria are identified based on literature review and expert input. To evaluate the relationship between these criteria and their influence among each other Spherical Fuzzy DEMATEL (Decision Making Trial and Evaluation Laboratory) method [1] is used. The pairwise comparison data are collected through a survey, administered to physicians in a public hospital for evaluating the influence among these criteria. The results show that among the identified criteria, test accuracy and surgical decision reliability, preoperative clinical simulations, device calibration, and standardization are identified as having the highest impact. The results obtained from this study support the argument that biomedical engineering solutions are indispensable for the success and safety of neurosurgical operations. By understanding the biomedical systems and technological criteria that contribute most to surgical success, experts in healthcare systems can make more informed and confident decisions regarding device selection. Thus, the systematic approach proposed in this study can be used to select the appropriate device for the appropriate surgery.

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A Study of Fully Soft Fuzzy Assignment Model involving Soft More General Class of Linear Octagonal Fuzzy Numbers

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ABSTRACT

Since the advent of operational research techniques, assignment problems have become an integral part of almost every activity. In these problems, we must determine the optimal allocation in order to either maximize overall profit or minimize total cost. A More General Class of Linear Octagonal Fuzzy Numbers was introduced by Amalore Arumica and Felbin C. Kennedy [1] in 2023 and have several applications in operations research problems. Soft More General Class of Linear Octagonal Fuzzy Number valued information system was introduced by Felbin C. Kennedy, Arul Roselet Meryline, Amalore Arumica [2] and employed it as a tool in modelling imprecise in-depth information related to decision making problems.

In this research work, we develop a Fully Soft Fuzzy Assignment Model (FSFAM) involving Soft More General Class of Linear Octagonal Fuzzy Numbers (SMGLOFNs). Theoretical concepts related to the model, mathematical formulation and a procedure are proposed to solve the assignment problem, that optimizes the objective function. A trending case study with in-depth imprecise information collected from a firm is considered and modelled as FSFAM wherein the qualitative matrix associated with agents and tasks are quantified using SMGLOFNs.

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A Study of Fully Fuzzy Transportation Model involving More General Class of Linear Octagonal Fuzzy Numbers

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ABSTRACT

Transportation problems have long served as foundational tools in operations research, enabling the optimal allocation of resources with the objective of maximizing profit or minimizing cost. With the increasing presence of uncertainty in real-world systems, fuzzy extensions of classical models have become essential. The More General Class of Linear Octagonal Fuzzy Numbers (MGLOFNs), introduced by Amalore Arumica and Felbin C. Kennedy (2023), provides a flexible and robust framework for representing imprecise parameters in optimization problems.

In this research, we develop a Fully Fuzzy Transportation Model (FFTM) formulated using MGLOFNs to more accurately capture vagueness in supply, demand, and transportation costs. The study presents the theoretical foundations of the model, its mathematical formulation, and a systematic solution procedure designed to optimize the fuzzy objective function. A hypothetical numerical example is provided to illustrate the applicability of the proposed method, and the resulting solution is analysed and compared with existing approaches. The findings demonstrate the effectiveness and improved representational capability of incorporating MGLOFNs in fuzzy transportation problems.

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A Study of Fuzzy Correlation Coefficient in a Soft Fuzzy Environment

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ABSTRACT

Fuzzy Correlation [1] plays a vital role in analysing the relationship between aspects that are qualitative in nature. Soft fuzzy number valued information system ($\widetilde{IS}$) [2] introduced by two of the authors captures qualitative information describing aspects based on attributes and parameters. In this paper the problem of measuring soft fuzzy correlation coefficient for attributed aspects involving parameters is studied. A method is proposed to compute the same which is validated using a problem of measuring academic stress among a group of college students due to various factors in a soft fuzzy environment. Soft fuzzy correlation coefficient between education and social media factors related to academic stress is obtained using the proposed method.

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Multiscale Stress Based Topology Optimization using local constraint enforcement

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ABSTRACT

A robust multiscale formulation for stress-based topology optimization aimed at designing lightweight and structurally resilient components will be presented. Unlike the classic Topology Optimization formulation, which may result in topologies unable to support applied loads, the stress-based Topology Optimization approach minimizes structural volume while enforcing local stress constraints in all the design domain. In our approach, a dual-scale framework integrates macro-structural optimization with periodic unit cells, using the Homogenization method to connect the two scales. To address the computational challenges arising from the numerous local stress constraints, an Augmented Lagrangian strategy is implemented which is based on polynomial vanishing constraints. The resulting optimization algorithm is accurate and scalable, supported by a detailed sensitivity analysis and adjoint-based gradient computation. Optimal results of the formulation are presented for test cases in the 2d space.

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Automated quantification of pronuclear dynamics and embryo ploidy

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ABSTRACT

This work investigates whether automatically quantified pronuclear (PN) dynamics on day 0 of development are associated with embryo ploidy and can provide predictive information beyond maternal age. We focus on the timing and spatial behavior of the two pronuclei (PN1 and PN2) in time-lapse microscopy (TLM) sequences and their relationship with preimplantation genetic testing for aneuploidy (PGT-A) outcomes.

We developed a fully automated, two-stage computer vision pipeline for PN segmentation and tracking in bright-field TLM images. First, a U-Net model was trained on manually annotated frames to detect the combined PN region. Second, a geometric circle-fitting procedure was applied to these joint PN masks to synthetically separate overlapping pronuclei and generate a large weakly labeled dataset of individual PN masks. A MiT-based U-Net was then trained on this expanded dataset to directly segment PN1, PN2, and the embryo in each frame. The final model, trained exclusively on data from a single clinic (Cohort 1), was applied to time-lapse sequences from two independent IVF clinics with linked PGT-A results.

From the resulting PN masks, we constructed PN time series and extracted quantitative features describing (i) PN appearance and disappearance times, (ii) asynchrony of disappearance, (iii) PN size, (iv) inter-PN distance, and (v) radial PN position relative to the embryo center. PGT-A outcomes were harmonized to a binary euploid/aneuploid label per embryo. Gradient-boosted tree models were trained with patient-level grouped cross-validation under three predictor sets: maternal age only, PN features only, and age plus PN features.

PN-only models achieved performance above chance but inferior to age-only models, indicating that day-0 PN dynamics contain real but modest information about ploidy. Combining age with PN features consistently improved discrimination compared to age alone, although the gain in AUC was small. The most influential PN-derived predictors involved PN timing, size, and radial position. However, PN-based models trained in one clinic transferred poorly to the other, highlighting sensitivity to cross-site domain shift.

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