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EVALUATION OF PURCHASING COLLABORATION USING A SIMULATION APPROACH

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Abstract
This paper investigates a case study involving the purchasing models of raw materials in an industry centre. The evaluation compared outcomes under non-collaborative and collaborative procurement models. Purchasing collaboration (PC) was developed by aggregating demand across industries using the Common Replenishment Epoch (CRE) principle. A designated agent determined the optimal basic replenishment for centre members, allowing purchases to be aggregated to receive the supplier's discount. The collaborative model with inventory centralisation reduces total procurement costs by 7.26 %. Subsequently, this model was implemented within the manufacturing process and assessed through simulation using Flexsim software. Profitability increased by an average of 32.13 % since employing the collaborative model. Sensitivity analysis reveals that the selling price and quantity of sales have a substantial impact on profitability. These findings highlight the strategic advantage of adopting a coordinated procurement system in industry centres. This study offers valuable insight for decision-makers aiming to enhance cost efficiency through supply chain collaboration. 30 refs.
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Key Words: *Collaboration, Flexsim, Inventory Centralisation, Purchasing, Simulation*

Pages 401-412

THREE-STAGE OPTIMIZATION APPROACH USING NONLINEAR PROGRAMMING AND SIMULATION

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Abstract
Problems involving patient scheduling and resource sizing are common in healthcare environments. Since the variability is higher in healthcare processes, procedure times, patient arrivals, and recovery times are critical factors for decision-making. Therefore, we propose an Operating Room scheduling optimization and resource management in a Surgical Centre (SC). Then, it aims daily scheduling planning to better assist patients linked to decrease SC's overtime and increase the financial results. For this, a three-stage approach was proposed to split the problem due to its high complexity. Firstly, Nonlinear Programming was used to prioritize the procedures to be performed, since it was not possible to perform all of them due to time constraints. Moreover, a Discrete Event Simulation model of the SC was built, and through the Simulation-based Optimization approach, we carried out other two-optimization stages, aiming to obtain the optimal procedure scheduling and the optimal resources sizing, respectively. It was possible to analyse the SC performance considering different decisions about overtime. 20 refs.
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Key Words: *Operation Room Scheduling, Nonlinear Programming, Simulation-Based Optimization, Discrete Event Simulation*

Pages 413-424

SIMULATION-BASED POWER STRATEGY OPTIMIZATION IN A DIESEL HYBRID VEHICLE

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Abstract
This study includes comparing fuel-energy consumption, consumption cost, and vehicle dynamic performance of a diesel hybrid electric vehicle created by combining virtual diesel and electric vehicle models in MATLAB/Simulink and correlated with real-world driving data. In the diesel hybrid vehicle model, electric power initiates the acceleration until the hybrid mode transition threshold speed, and after, the diesel traction system maintains the motion. The hybrid mode transition threshold speeds were determined as 10 km/h, 15 km/h, 20 km/h, and 25 km/h. The virtual tests were repeated according to different vehicle masses as 3500 kg, 4000 kg, 4500 kg, and 5000 kg. As a result, this study achieved the best dynamic performance and the lowest total energy consumption with the hybrid mode transition threshold of 10 km/h. Also, diesel hybrid combinations mostly showed better dynamic performance than pure diesel and battery electric vehicles. 23 refs.
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Key Words: *Electric Vehicle, Diesel Hybrid Vehicle, Simulink, Power Strategy, 1D Simulation*

Pages 425-436

ERP-DRIVEN SIMULATION FOR PRODUCTION PLANNING AND CONTROL IN THE INDUSTRY 4.0: A REVIEW

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Abstract
In the context of Digital Transformation and Industry 4.0, Enterprise Resource Planning (ERP) systems are crucial for improving Production Planning and Control (PPC) and supporting simulation projects. This Systematic Literature Review (SLR) analyses studies from Scopus® and Web of Science® to examine how ERP systems aid decision-making in PPC. The findings highlight key benefits such as real-time data integration, enhanced predictive analytics, and improved production scheduling. ERP systems also support cross-functional optimization and better supply chain coordination. However, challenges remain, including model validation, integration complexity, and data requirements. Since 2017, there has been growing interest in discrete-event simulation (DES) and digital twins to enhance ERP-driven PPC. This review emphasizes the need for further research into simulation-based ERP models to improve adaptability and decision support in manufacturing environments. 35 refs.
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Key Words: *Production Planning, ERP Systems, Simulation Modelling, Digital Transformation, Decision-Making*

Pages 437-448

SIMULATION OPTIMISATION OF ULTRASONOGRAPHY RESOURCE SCHEDULING WITH MACHINE LEARNING

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Abstract
This study proposes a decision-support framework to optimize radiologist staffing in the ultrasonography department. Patient arrival rates were forecast using Light Gradient Boosting Machine (LightGBM) with feature expansion, achieving 99.99 % accuracy over one-month period. A discrete-event simulation model was subsequently used to determine the number of radiologists required to meet target waiting times. Based on the simulation results, hourly radiologist requirements were identified, and an optimized schedule was generated. By integrating machine learning, simulation, and scheduling, this framework supports data-driven planning and can be applied to other healthcare services and facilities facing demand uncertainty. 30 refs.
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Key Words: *Machine Learning, Discrete-Event Simulation, Resource Scheduling, Healthcare Systems, Health System Resources*

Pages 449-460

EMERGENCY DECISION SIMULATION FOR URBAN RAIL TRANSIT DURING RAINSTORM FLOODS

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Abstract
Forty fundamental disaster events were extracted from 52 typical flood disaster cases in urban rail transit operations in China. The evolution network and topology of rainstorm and flood disasters were then constructed based on the complete network model. Next, the characteristic parameters of nodes and connecting edges were calculated, and the chain-type evolution laws of disasters explained. Finally, complex network efficiency E and average clustering coefficient C were taken as evaluation indexes, and a simulation experiment of random and deliberate attacks was designed aiming at the nodes and connecting edges. Eventually, the critical nodes and basic events influencing the disaster network vulnerability were revealed. Results show that deliberate attacks are better than random attacks in disrupting the network during rainstorm and flood disasters. Specifically, the network is influenced significantly by deliberate attacks on nodes with high PageRank values. In the attack on edges, obstructing basic events with high PageRank values can reduce network density by up to 30.2 %. 26 refs.
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Key Words: *Urban Rail Transit, Rainstorm and Flood, Complex Network Analysis, Network Attack, Decision Simulation*

Pages 461-472

SIMULATION OF EMERGENCY EVACUATION IN DENSE-OCCUPANCY HIGH-RISE BUILDINGS

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Abstract
To enhance the efficiency of emergency evacuation in high-rise buildings and formulate scientifically sound evacuation strategies, five strategies were designed in this study: no-command evacuation, downward evacuation, nearest refuge floor evacuation, speed-priority evacuation, and elevator-assisted evacuation, based on crowd evacuation dynamics theory. Using Pathfinder simulation software, the evacuation times associated with these strategies were compared, taking a typical 37-story residential building layout as an example. The strategy yielding the shortest evacuation time was identified. Results show that under the no-command evacuation scenario, the evacuation time was 248.8 seconds. Implementation of the nearest refuge floor strategy reduced the time to 232.0 seconds, a decrease of 6.7 %. With the speed-priority strategy, the evacuation time was further shortened to 215.8 seconds. When elevator-assisted evacuation was employed, the evacuation time decreased markedly to 193 seconds. These findings offer decision support and a theoretical reference for the development of emergency evacuation plans and the conduct of evacuation drills in high-rise buildings. 19 refs.
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Key Words: *High-Rise Buildings, Emergency Evacuation, Pathfinder Simulation, Evacuation Strategy Comparison*

Pages 473-484

THE USE OF SIMULATION IN OPTIMIZATION OF AIRPORT BAGGAGE SORTING SYSTEM

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Abstract
This paper aims to optimize baggage sorting through simulation modelling. Using Tecnomatix Plant Simulation software, manual sorting methods, which create bottlenecks, were analysed. The goal is to transport luggage swiftly, synchronize with passenger travel times, and minimize transport duration using simulation tools. Results reveal delays and capacity constraints inherent to manual sorting. The proposed automated system integrates RFID tracking, baggage diverters, and sensors for real-time monitoring, tested through simulations. This model demonstrated operational and economic benefits, enhancing sustainability. Findings emphasize the importance of simulations in improving accuracy, efficiency, and scalability of baggage handling. Practical recommendations are offered for transitioning to automated systems to streamline operations and boost airport competitiveness. By combining predictive analytics and simulations, airports can better anticipate peak periods, optimize processes, and achieve significant operational improvements. 31 refs.
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Key Words: *Optimization, Simulation, Airport, Automated Baggage Sorting, Modelling*

Pages 485-496

SIMULATION ANALYSIS OF CREEP EVOLUTION PROCESS IN SOFT-HARD COMPOSITE COAL SEAMS

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Abstract
To address the coal and gas outburst risks in the soft-hard composite coal seam, a three-dimensional (3D) model of the soft-hard composite coal seam of Hudi Coal Mine in China was constructed, incorporating coal creep effects. The influence of punching parameters (diameter, spacing, direction, and creep duration) on stress-damage evolution, pressure-relief range, and gas seepage behaviour in the coal seam was analysed. Results revealed that under the viscoelastoplastic model, creep deformation in soft coal zones expanded the pressure-relief range by approximately 30 % compared to elastoplastic models, with more stable gas seepage pathways. Directional punching along the maximum principal stress direction induced oriented fracture propagation, improving pressure-relief efficiency by over 25 %. Key parameter findings include: a critical punching diameter of 1.5 m (beyond which collapse risks increase), optimal spacing of 6.0 m, and stabilized pressure-relief effects after 40 *d* of creep. This study provides a theoretical basis for enhancing hydraulic punching efficiency and gas drainage performance in soft-hard composite coal seams. 19 refs.
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Key Words: *Soft-Hard Composite Coal Seam, Tectonic Coal, Directional Hydraulic Punching, Creep, Numerical Simulation*

Pages 497-508

DYNAMIC ANALYSIS OF ROTOR AND MACHINE STRUCTURE IN ULTRA-HIGH-SPEED PMSM

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Abstract
This paper presents a comprehensive dynamic analysis of a 15 kW ultra-high-speed permanent magnet synchronous motor (HSPMSM) operating at 100,000 r/min. An equivalent bearing modelling method is proposed to effectively simplify and enhance computational accuracy. The intrinsic frequency and vibration characteristics of the motor under both free and operational modes are examined using Finite Element Method (FEM), and the validity of this modelling method is confirmed experimentally. Additionally, frictional and frictionless rotor contact scenarios are comparatively analysed to determine modelling accuracy across a wide range of rotational speeds. Using Campbell diagrams, the critical speeds of the rotor are identified, and resonance phenomena are analysed by the superposition method to establish a safety factor. Experimental verification under various operational conditions demonstrates that the frictional contact modelling provides superior accuracy, particularly at higher rotational speeds. The insights and methodologies presented in this study provide valuable guidance for the mechanical design, modelling, and safe operation of ultra-high-speed PMSMs. 17 refs.
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Key Words: *Simulation Modelling, Modal Analysis, Rotor Dynamics, Finite Element Method*

Pages 509-520

CFD-EXPERIMENTAL STUDY ON THERMOFLOW IN RICE HULLER CHAMBER

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Abstract
To optimize the design of the hulling chamber structure in rubber-roller paddy hullers and reduce broken rice rate during hulling processing, this study takes a rubber-roller paddy huller as the research object. First, experiments were designed and conducted to analyse the temperature and airflow distribution within the hulling chamber. Second, numerical simulations of the temperature field and flow field inside the hulling chamber were performed based on fluid dynamics principles. Subsequently, comparative analysis between numerical simulation results and experimental data was conducted to validate the turbulence model, mesh generation, and boundary condition settings. This verification ensures the accuracy and rationality of the numerical simulation methodology for temperature and flow fields. The comparative results demonstrate temperature errors within 13.5 % and velocity vector errors within 15 %, confirming the feasibility and rationality of the proposed numerical simulation approach for temperature and flow field analysis. 17 refs.
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Key Words: *Numerical Simulation, Temperature Field, Flow Field, Experiment, Rubber-Roller Paddy Huller*

Pages 521-532

RESEARCH ON LIGHTWEIGHTING OF KEY COMPONENTS OF LIGHT VEHICLE DRIVE SHAFTS

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Abstract
As a critical component of the vehicle power transmission system, the structural design and performance analysis of the drive shaft significantly influence the fuel economy, performance, and safety of the vehicle. This study focuses on the lightweight design of the drive shaft for light vehicles. By modelling the geometric parameters of the drive shaft, defining material properties, and utilizing Finite Element Analysis (FEA) software, the relevant performances such as stress, strain, and displacement of the component structure were comprehensively analysed. Based on the stress distribution results, an optimized design of the drive shaft structure was conducted to enhance its load-bearing capacity and service life. Through this optimization process, the lightweighting of the drive shaft for light vehicles was achieved while ensuring sufficient strength. The mass of the flange fork and universal joint fork components of the drive shaft was reduced by 4.31 % and 11.47 %, respectively, thereby improving the fuel economy and overall performance of the vehicle. 19 refs.
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Key Words: *Automobile Drive Shaft, Lightweighting, ANSYS, Static Force Analysis*

Pages 533-544

SIMULATION-DRIVEN EXPLAINABLE AI FOR QUALITY PREDICTION AND CONTROL

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Abstract
Manufacturing quality management faces persistent challenges such as data silos, small sample sizes, black-box models, and delayed control. To overcome these issues, this study proposes a closed-loop framework integrating simulation, data, AI, and control. A multi-scale, multi-physics digital twin generates mechanistic data, which are fused with event logs into a dynamic relationship matrix. A physics-constrained Transformer enables interpretable quality prediction, while reinforcement learning implements a predict–diagnose–adjust strategy for adaptive control. Simulation experiments in a CNC milling scenario demonstrate improved prediction accuracy, transparent mechanism tracing, and enhanced robustness against disturbances. The main innovations include: (a) multi-physics digital twin modelling of the full manufacturing process; (b) a discrete–continuous data fusion method; (c) an interpretable Transformer-based model with physical constraints; and (d) a predictive-control closed-loop mechanism. This framework provides a practical pathway for advancing smart manufacturing toward proactive and sustainable quality management. 20 refs.
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Key Words: *Full Manufacturing Process, Simulation-Driven, Explainable AI (XAI), Transformer Model, Reinforcement Learning, Quality Prediction and Control*

Pages 545-556

NUMERICAL IMPLEMENTATION OF TRANSITIONAL ELEMENT-BASED PD-FEM COUPLING MODEL

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Abstract
The coupling of Peridynamics (PD) and FEM offers a promising approach for addressing discontinuities in continua by leveraging the strengths of both methods. However, its numerical implementation remains a key challenge for practical applications. Building upon our previously proposed PD-FEM coupling model based on transitional elements, this paper focuses on the numerical realization of the approach. The coupling method comprehensively considers modelling, computation, and post-processing, making it highly suitable for numerical implementation. The entire model is formulated in a unified finite element framework, where different regions are computed using native Abaqus elements or user-defined element subroutines (UEL), with post-processing and visualization performed through the UMAT subroutine. Implemented entirely in Abaqus, this approach offers a significantly more straightforward and practical solution compared with other methods. Comparisons and case studies confirm the model's accuracy, effectiveness, and capability in tracking complex crack propagation, highlighting its engineering potential. 21 refs.
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Key Words: *Peridynamics, FEM, Transitional Element, Coupling Model, Numerical Realization*
