Pages 5-15

MODELLING THE IMPACT OF KEY ORGANISATIONAL FACTORS ON EMPLOYEES' AND PROCESS PERFORMANCE

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Abstract
In today's business environment, business success is dependent on an organisation's ability to efficiently leverage information and communication technologies (ICT) to support processes and improve employee performance. Previous studies have shown a significant positive relationship between these factors; however, they emphasise the need for further work to include external ecosystem variables and key determinants of business process management (BPM). To address academic calls, this study examines the relationships among these factors in the mediating context of the Performance Management System (PMS). The study is conducted on a cross-sectional sample of 167 production and service organisations. For data collection, a custom questionnaire was developed and tested. For model testing, a variance-based (PLS-SEM) approach was used, given the exploratory nature of this study. The study results point to a statistically significant, fostering power of ecosystem variables. Such power produces a substantial positive impact across the research constructs, highlighting the importance of PMS's mediating role in the process and in employees' performance. 35 refs.
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Key Words: *Industrial Engineering and Management, Production and Service Systems, Business Process Management, Performance Management, PLS-SEM*

Pages 16-27

SIMULATION ANALYSIS OF DYNAMIC PROPERTIES OF MOC-SLP AFTER FREEZE-THAW CYCLES

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Abstract
To reveal the dynamic mechanical properties of magnesium oxychloride cement-stone powder (MOC-SLP) after freeze-thaw cycles under high strain rates, a computational model of the split Hopkinson pressure bar was constructed using ANSYS/LS-DYNA. The dynamic impact process under different impact velocities was simulated, combined with the variable of 0-20 freeze-thaw cycles. The dynamic stress-strain response, energy absorption characteristics, and failure morphology evolution were analysed. The entire dynamic damage process of specimens was tracked also. Results show that MOC-SLP exhibits significant strain rate hardening effects. MOC-SLP still maintains strain rate sensitivity after freeze-thaw cycles, but the hardening amplitude decreases, reflecting the dynamic load-bearing potential of damaged specimens. As the number of freeze-thaw cycles increases, the failure mode of specimens transforms from axial tensile failure to shear-tensile composite failure, with aggravated brittle failure characteristics and more fragmented failure morphology. This study provides the theoretical support for their application in impact and explosion protection environments. 26 refs.
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Key Words: *Magnesium Oxychloride Cement, Stone Powder, Strain Rate Effect, Numerical Simulation, Failure Mode*

Pages 28-39

PERFORMANCE OF PRODUCTION CELLS WITH SCRAP AND REWORKS: ANALYTICAL AND SIMULATION APPROACH

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Abstract
This study proposes an analytical framework for evaluating manufacturing systems subject to random failures and quality disruptions, where each defective part may be scrapped or reworked for a specific number of times. System behaviour is modelled using a discrete-time Markov chain, allowing the derivation of several key performance indicators (KPIs) including throughput, efficiency, yield, and the required raw material. A simulation model complements the analytical approach, validating the results and offering deeper insights into system behaviour. The close agreement between simulation and analytical results confirms the model’s accuracy, with negligible errors across diverse scenarios considering discrete and continuous distributions of the system lifetimes and repairs. The present research also demonstrates that, in contrast to the majority of studies in the literature, which estimate the quality rate by the yield, this substitution results in a significant overestimation of the system throughput by up to 25 %, which has severe effects on budgeting, production planning, and customer satisfaction. 28 refs.
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Key Words: *Unreliable Manufacturing Cell, Multi-Rework, Predefined Number of Rework Attempts, Scrapped Parts, KPIs Measures, Analytical-Simulation Modelling*

Pages 40-51

SIMULATION ANALYSIS OF THE SPLASH LUBRICATION OF THE MAIN GEARBOX FOR UNMANNED HELICOPTERS

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Abstract
The main gearbox of unmanned helicopters operates under complex, high-speed, and variable conditions, making lubricating oil behaviour under splash lubrication difficult to characterize and churning power loss mechanisms unclear. In this study, a computational fluid dynamics (CFD) model of the main gearbox was established to investigate lubricant flow behaviour and power dissipation in the helicopter main transmission. In particular, a numerical model was built via the moving particle semi-implicit (MPS) method. The distribution pattern of the lubricating oil in the gearbox, and the characteristics of the churning power loss under different conditions were evaluated. Results demonstrate that lubrication characteristics are influenced by the splashing effect caused by gear rotation and the fluidity of the lubricant. Churning power loss increases with gear speed and initial oil quantity, while it decreases as lubricating oil temperature rises, exhibiting a nonlinear trend overall. The proposed method provides a theoretical basis for optimizing the splash lubrication scheme and improving the energy efficiency of the main gearbox of unmanned helicopters. 29 refs.
(Received in October 2025, accepted in January 2026. This paper was with the authors 2 weeks for 2 revisions.)

Key Words: *Main Gearbox, Unmanned Helicopters, Moving Particle Semi-Implicit Method, Splash Lubrication, Churning Power Loss*

Pages 52-62

FLEXURAL BEHAVIOUR IN PRESTRESSED RUBBER CONCRETE SLEEPERS WITH RECYCLED AGGREGATE

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Abstract
This paper investigates the structural performance and mix optimisation of prestressed concrete sleepers incorporating recycled concrete aggregate (RCA) and crumb rubber (CR). Nine mix proportions of full-scale sleepers were tested in four-point bending under three regimes including centre positive, rail-seat positive, and rail-seat negative. Load-deflection responses were processed to obtain ultimate load, initial stiffness, energy absorbed to peak, and deflection at peak. Quadratic response-surface models were fitted to RCA and CR contents and combined with a multi-response desirability approach to identify compromise-optimal mixtures balancing capacity, stiffness, toughness, and sustainability. Results show that increasing RCA causes modest, smooth reductions in strength and stiffness, with no abrupt thresholds up to 50 % replacement, while peak deflection remains largely unchanged and absorbed energy follows the strength trend. CR introduces a controlled strength-ductility trade-off, enhancing toughness and peak deflection at moderate penalties to capacity and stiffness. Optimisation highlights a practical corridor centred on 25 % RCA with 4 % CR across all regimes. 24 refs.
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Key Words: *Recycled Aggregate, Crumb Rubber, Prestressed Concrete Sleeper, Response Surface Methodology*

Pages 63-74

USING TAGUCHI METHOD TO ANALYSE THE DESIGN PARAMETERS OF A DISC TYPE OF MAGNETIC CIRCUIT

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Abstract
This study investigated the effects of coil wire diameter (d), disc thickness (w), and holding gap (x_t) on the response times and energy consumption of a flat-faced disc type of magnetic circuit. The design of experiment (DoE) was created using the Taguchi L18 orthogonal array approach, with two levels for x_t and three levels for d and w. Then, for each configuration in the DoE, the opening time (t_o), the energy consumption (E_o), and the closing time (t_c) of the magnetic circuit were determined using the MATLAB/Simulink model validated with test data. Signal-to-noise (S/N) analysis was applied according to the smaller-the-better performance criterion to obtain the optimal parameter combination and priority order that would individually minimize t_o, t_c, and E_o. The percentage contribution of each parameter was also evaluated using the variance analysis (ANOVA). In all cases, the most effective parameter was found to be wire diameter (d), and the optimal combinations for each target differed from one another. Therefore, grey relational analysis (GRA) was applied to the DoE results to derive the optimal combination for multiple requirements. 22 refs.
(Received in October 2025, accepted in January 2026. This paper was with the author 1 week for 1 revision.)

Key Words: *Flat-Faced Disc Type of Magnetic Circuit, Coil Wire Diameter, Holding Gap, Disc Thickness, S/N Analysis, ANOVA*

Pages 75-86

SIMHEURISTIC FRAMEWORK FOR OPTIMIZING URBAN MOBILITY AT SIGNALIZED ROUNDABOUTS

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Abstract
Managing high traffic volumes and traffic congestion at signalized intersections remains a critical urban challenge. Appropriate traffic signal timing (TST) and phase sequencing are essential for ensuring smooth traffic flow. This study presents a microscopic simulation-based heuristic optimization (Simheuristic) framework using the Genetic Algorithm (GA) for optimizing the TST of Four-Legged Two-stops Signalized Roundabouts (FLTSR). The framework is tested using the actual traffic flow through a microscopic simulation model developed in Simulation for Urban Mobility (SUMO). Within this framework, the integrated GA searches for the green TSTs to minimize vehicular queue lengths, while SUMO is used to evaluate those timings. Additionally, four different phase sequence settings are evaluated to find the efficient configuration. The proposed approach is benchmarked against Webster's method and the existing TST plan. In the best-case scenario, the proposed framework improves vehicular flow by mitigating the average time loss, average waiting time, and the average number of vehicles in a queue at the FLTSR up to 35.83 %, 51.91 %, and 50.97 %, respectively, compared to the current setting. 30 refs.
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Key Words: *Signalized Roundabout, Phase Sequence Settings, Simulation-Optimization, Traffic Signal Timing, Genetic Algorithm, SUMO*

Pages 87-98

DIGITAL TWIN MODELLING VIA INTEGRATION OF SIMULATION AND DATA-DRIVEN METHODS

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Abstract
Digital twins – high-fidelity digital counterparts of physical assets – are increasingly used to solve real-world problems across industries. Building a high-quality digital twin requires an integrated stack spanning IoT, data processing, modelling & simulation, 3D visualisation, and networking, with the modelling layer pivotal. Yet widely adopted modelling practices remain limited. We propose a digital twin modelling method that combines simulation and data-driven modelling, selecting among three integration strategies by goal: (i) accuracy enhancement via calibration, assimilation, and hybridisation; (ii) execution efficiency via surrogate or reduced-order models; and (iii) decision optimisation via simulation-in-the-loop using learned response surfaces. We formalise selection criteria and workflows for each strategy and show their composition within a single methodology. A smart farm case study demonstrates improved predictive accuracy, reduced runtime, and support for operational optimisation, illustrating practical value for purpose-built digital twins. 33 refs.
(Received in November 2025, accepted in January 2026. This paper was with the author 1 week for 1 revision.)

Key Words: *Digital Twin, Simulation Modelling, Data-Driven Modelling, Hybrid Modelling, Surrogate Modelling, Smart Farm*

Pages 99-110

MODELLING AND DYNAMIC SIMULATION OF A REAL CRUDE OIL OFFSHORE PLANT USING ASPEN HYSYS®

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Abstract
In the offshore crude oil process, water separation has a significant impact on quality improvement. Moreover, the lower the oil content in the residual stream, the less treatment is needed to fulfil specifications. Herein, the use of simulation has become an important tool to achieve a better understanding of the process. However, considering that the petrochemical plant is subjected to extreme time varying operating conditions, which affects the separation train; this poses a challenge to obtain a realistic simulation model. This work presents our original dynamic simulation of a complete crude oil separation unit using Aspen HYSYS® environment. The inlet feed is characterised as a heavy crude oil and different pieces of equipment are carefully designed according to real process parameters. Furthermore, the impact on variations in water content and irregular flows, known as slug flow occurrence, is analysed. Finally, to validate the accuracy of the simulation, operating temperatures, pressures for the separators, and the main flows of the process are compared with actual data. 34 refs.
(Received in November 2025, accepted in January 2026. This paper was with the authors 2 weeks for 1 revision.)

Key Words: *Oil-Water-Gas Separation, Heavy Oil, Dynamic Simulation, Slug Flow, Aspen HYSYS®*

Pages 111-122

SIMULATION OF EMERGENCY EVACUATION IN AIRPORT TERMINAL DEPARTURE HALLS

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Abstract
To identify bottlenecks and propose optimization strategies for emergency evacuation at airport terminals, this study developed a pedestrian evacuation model using AnyLogic simulation software, with Zhengzhou Xinzheng Airport Terminal T2 as a case study. Pedestrian density distribution and evacuation time dynamics were analysed. Issues such as initial exit crowding and imbalanced passage configuration were revealed. Average evacuation time and median changes before and after optimization were calculated. A multilevel evacuation strategy centred on diversion in key areas and passage resource optimization was proposed. Results show that the initial average evacuation times for Scenarios 1, 2, and 3 are 258.47 s, 223.63 s, and 235.33 s, respectively. Through the application of diversion guidance and passage optimization, evacuation efficiency is improved by approximately 9.7 %, 2.3 %, and 14.4 %, respectively, with the integrated scheme combining multi-area diversion and passage management proving most effective. The findings provide a scientific basis and methodological support for emergency evacuation planning and spatial layout optimization in airport terminals. 18 refs.
(Received in December 2025, accepted in February 2026. This paper was with the authors 1 week for 1 revision.)

Key Words: *Airport, Terminal, Emergency Evacuation, Simulation Optimization*

Pages 123-133

HIGH-SPEED MICRO-MACHINING OF T2 COPPER: MODELLING AND VALIDATION

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Abstract
This study systematically investigates the size effect mechanism and its influence on machining quality during micro-milling of T2 copper through an integrated approach combining numerical simulation and experimental validation. A 3D dynamic finite element model with realistic tool geometry was developed in ABAQUS/Explicit, employing the Johnson-Cook constitutive model for thermomechanical behaviour. The results reveal a fundamental transition in material removal mechanism at a critical feed per tooth of 0.22 μm/z, where the dominant process shifts from ploughing-dominated to shear deformation-dominated regime. Experimental validation using a JTGK-600 micro-milling system equipped with piezoelectric dynamometry confirmed the simulation accuracy with errors below 10 % ($p < 0.05$). At the optimal feed rate of 0.44 μm/z, cutting forces decreased by 28 % and surface quality improved by 42 %, with SEM and 3D topography confirming suppressed ploughing effects. These findings provide optimized process parameters for copper-based MEMS fabrication and demonstrate the efficacy of ABAQUS in micro-cutting simulations. 28 refs.
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Key Words: *High-Speed Micro-Milling, Size Effect, T2 Copper, Feed per Tooth*

Pages 134-145

ANALYSIS AND SIMULATION OPTIMIZATION OF CONNECTING ROD CAP FAILURE IN COMPRESSOR

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Abstract
The connecting rod cap is one of the key components for the reciprocating motion of compressors and internal combustion engines, and it works in conjunction with the connecting rod to convert power. Regarding the fracture problem of the connecting rod cap of a certain compressor, the initial cause of the fracture was preliminarily determined through physical and chemical analysis to be the excessively small fillet radius at the bolt installation plane. A finite element model was established to verify the cause of the fracture, and based on this as a comparison benchmark, the model structure was optimized. It was found that increasing the fillet radius could indeed improve the performance of the connecting rod cap, but it is not the case that the larger the fillet radius, the better. In the simulation, it was discovered that the performance of the fillet with a radius of 4.5 mm was significantly worse than that of the fillet with a radius of 3.5 mm. Therefore, in the design of the connecting rod cap, an appropriate fillet radius should be selected to ensure its good performance. Additionally, a design combining the fillet with a chamfer can also be considered. 18 refs.
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Key Words: *Connecting Rod Cap, Failure, Physical and Chemical Analysis, Simulation Optimization*

Pages 146-157

LIGHTWEIGHT DESIGN OF LOADER ROCKER ARM BASED ON STRUCTURAL OPTIMIZATION

Zhao, B.; Liao, J. M.; Zheng, Y. H.; Dai, R. R.; Yin, J. Y. & Pu, J. P.
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Abstract
To enhance the structural efficiency and economy of the loader arm, this study, based on the structural optimization method and aiming at lightweighting, conducts multi-objective topology optimization design of the loader arm using Altair Inspire software. The research verifies the effectiveness of topology optimization technology in the lightweight design of the loader arm, significantly reducing manufacturing costs and fuel consumption, and providing a replicable technical path for the engineering optimization of complex structures. Through static analysis, modal analysis and multi-body dynamics simulation, the load conditions and mechanical characteristics of the bracket are clarified. By comparing different shape control schemes and model reconstruction methods, the optimal design scheme is selected. The results show that the weight of the optimized bracket is reduced by 22.89 %, and the minimum safety factor is 1.9, both meeting the design standards. 17 refs.
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Key Words: *Excavator Boom, Structural Optimization, Inspire Software, Lightweight Design*

Pages 158-169

ROBUST SCHEDULING UNDER DISRUPTIONS USING TRANSFORMERS AND MONTE CARLO SIMULATION

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Abstract
Dynamic job shop scheduling is often affected by uncertainties such as machine failures and process delays. Traditional robust scheduling methods have limitations including high computational complexity, insufficient adaptability, and limited accuracy in risk assessment. To address these problems, this paper proposes an adaptive robust scheduling framework that integrates the sequence modelling capability of Transformers and the risk assessment advantages of Monte Carlo (MC) simulation. The core innovation of this framework is the design of a Transformer-driven disturbance–performance mapping mechanism and an MC-enhanced robustness evaluation module, enabling deep coordination between scheduling decisions and disturbance risk assessment. Comparative experiments based on a Python/SimPy discrete-event simulation platform verify that the proposed method exhibits significant advantages in makespan, tardiness rate, and robustness index, while improving the efficiency of robustness evaluation. This study provides an efficient paradigm for robust scheduling under production uncertainty scenarios. 18 refs.
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Key Words: *Robust Scheduling, Uncertainty Disruptions, Transformer Model, Monte Carlo (MC) Simulation, Production Simulation, Dynamic Job Shop Scheduling*

Pages 170-180

MULTI-OBJECTIVE PRODUCTION PLANNING WITH CYBERSECURITY CONSTRAINTS IN INDUSTRIAL IOT

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Abstract
The integration of the Industrial Internet of Things (IIoT) has increased the interdependence between production systems and cyberspace, making cybersecurity threats a critical factor in manufacturing performance. Traditional production planning methods rarely account for dynamic cyber risks, limiting their ability to ensure resilient and efficient operations. This study proposes a simulation-driven security–production collaborative optimization framework. Cyber threats are modelled through a dynamic coupling mechanism and embedded as operational constraints in a multi-objective production planning model. Based on digital twins and two-stage stochastic programming, the model simultaneously minimizes makespan, energy consumption, and cybersecurity risk. An improved multi-objective evolutionary algorithm with simulation-based evaluation is developed to assess schedule robustness under attack scenarios. The proposed framework enables systematic modelling and evaluation of resilient production planning in IIoT-enabled manufacturing environments. 18 refs.
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Key Words: *IIoT, Cybersecurity, Production Planning Optimization, Multi-Objective Optimization, Digital Twin Simulation*