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SPECTRUM

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Spectrum is an e-magazine with the comprehensive collection of all the papers that have been published in our journal over the last two months — Volume 12, Issue 5 (September-October, 2026). This edition brings together 44 papers by 131 authors from 44 institutions. Each entry links to the abstract and the full paper.

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ABSTRACTS

1 Artificial Intelligence in Higher Education: Opportunities, Challenges and its Impact on Teaching and Learning

Paper ID V12I5-1138 · Pages 1-5 · Education

Dr. D. Rajasekaran, Assistant Professor, NGM College, Pollachi, Tamil Nadu

Artificial Intelligence (AI) has emerged as a transformative technology in higher education, offering new opportunities to enhance teaching, learning, assessment, research, and academic activities. This study examines the awareness and utilisation of AI tools among faculty members and identifies their perceived benefits, challenges, and impact on teaching and learning effectiveness. The study adopts a descriptive and analytical research design and collects primary data from 100 faculty members selected through simple random sampling. Data are collected using a structured questionnaire and analysed through simple percentage analysis, Chi-square test, and regression analysis. The findings indicate that faculty members recognise the potential of AI to improve teaching efficiency, content preparation, personalised learning, assessment, and academic productivity. The Chi-square analysis reveals significant associations between AI utilisation and selected demographic and institutional factors, particularly AI training. Regression analysis demonstrates a positive and significant influence of AI utilisation on perceived teaching and learning effectiveness. However, concerns related to academic integrity, misinformation, privacy, ethical use, and inadequate training remain important challenges. The study concludes that systematic AI training, institutional support, and appropriate ethical guidelines are essential for effective and responsible AI integration in higher education.

Keywords: Artificial Intelligence, Higher Education, Faculty Members, Teaching and Learning

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2 Japanese Expansion in East Asia and Its Historical Legacy

Paper ID V12I5-1144 · Pages 6-10 · Hisotry

Sujeet Shenbagakumar, Student, University of Pecs, Hungary

The paper focuses on how japan emerged as a dominant power in the region following commodore perry arrival and meiji restoration through the world wars and the impact it has in the contemporay world.

Keywords: Meiji restoration, Tokugawa, Daimyo

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3 Digital Health Interventions for Breastfeeding Support: Evidence, Implementation Gaps, and The Next Generation of Equitable Lactation Care

Paper ID V12I5-1148 · Pages 11-19 · Reproductive Health

Dr. Arushi Mishra, Nebulous Business Solutions, Pune, Maharashtra

Breastfeeding is a high-impact maternal and child health intervention, yet global exclusive breastfeeding remains at 48% among infants younger than six months, below the 60% World Health Assembly target for 2030. At the same time, the period after hospital discharge is characterized by fragmented access to skilled lactation support, creating a strong rationale for digital health interventions (DHIs). This narrative evidence review synthesizes recent evidence on mobile health (mHealth), smartphone applications, short-message services, social media and peer-support platforms, telelactation, and hybrid digital-professional models. Particular emphasis is placed on randomized evidence and on the implications for low- and middle-income countries (LMICs). A 2026 systematic review and meta-analysis of 46 randomized or cluster-randomized trials involving 33,785 participants across 18 countries found that DHIs increased the odds of exclusive breastfeeding (OR 2.58, 95% CI 1.91–3.50; 39 trials; n=11,601), although heterogeneity was substantial (I^2=83%) and certainty was very low. Breastfeeding duration showed a moderate standardized benefit (SMD 0.48, 95% CI 0.29–0.67), while any breastfeeding was not significantly improved (OR 1.09, 95% CI 0.90–1.31). Evidence suggests that digitally enabled support is most useful when it is timely, interactive, tailored, and linked to trained personnel rather than functioning as a stand-alone information repository. However, evidence on cost-effectiveness, safety, digital exclusion, implementation fidelity, and long-term scale-up remains sparse. This review argues that the next phase of digital breastfeeding support should shift from asking whether digital tools work to determining which components work, for whom, at what postpartum moment, and under what health-system conditions. Hybrid, equity-sensitive models integrated with routine maternal and newborn care appear the most defensible direction for policy and research.

Keywords: Breastfeeding, Exclusive Breastfeeding, Digital Health, Mhealth, Telelactation, Mobile Applications, SMS, Maternal Health, Lactation Support, LMICS

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4 A Comparative Study on Hemodialysis Versus Peritoneal Dialysis Regarding the Efficacy and Safety in the Management of ESRD

Paper ID V12I5-1147 · Pages 20-24 · Nephrology

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Background: End-stage renal disease (ESRD) is a major clinical condition requiring renal replacement therapy. Hemodialysis (HD) and peritoneal dialysis (PD) are the two commonly used dialysis modalities, but they differ in the way they remove uremic toxins and excess fluid and may therefore have different efficacy and safety profiles. Objective: To compare the efficacy and safety of hemodialysis and peritoneal dialysis in the

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management of patients with ESRD. Methods: A hospital-based prospective observational study was conducted in the Department of Nephrology, King George Hospital, Visakhapatnam, over a period of six months from July to December 2024. Patients with ESRD receiving maintenance HD or PD were included. Demographic characteristics, vital signs, blood urea, blood urea nitrogen (BUN), serum creatinine, and dialysis-related complications were assessed before and after dialysis. Continuous variables were expressed as mean ± standard deviation, while categorical variables were expressed as percentages. Appropriate statistical tests were applied, with p

Keywords: End-Stage Renal Disease, Hemodialysis, Peritoneal Dialysis, Dialysis Efficacy, Serum Creatinine, Peritonitis.

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5 Generative AI in Statistics Education: Predicting Students' Confidence in Evaluating AI-Generated Answers

Paper ID V12I5-1161 · Pages 25-28 · Statistics

Omkar Chandrashekhar Thakur, Assistant Professor, Department of Statistics, St. Xavier's College, Empowered Autonomous Institute, Mumbai

Students are increasingly using Generative Artificial Intelligence (GenAI) for learning, problem solving and understanding statistical concepts. However, the effective use of such tools requires the ability to critically assess and validate AI-generated solutions. In this study we investigate GenAI use among undergraduate Statistics students, focusing on Perceived Learning Benefits (PLB), Verification Behavior Score (VBS) and confidence in judging AI-generated statistical solutions. Data were acquired from 294 undergraduate students (244 GenAI users) through a structured online questionnaire. Perceived learning advantages and verification behavior were assessed using multi-item measures. A Random Forest classification model was constructed to predict students' confidence in judging AI-generated statistical answers from AI-use patterns, learning advantages, verification behavior, Statistics experience and year of study. We tested the model with a stratified 5-fold cross-validation. The results point to the pedagogical value of GenAI and the need for verification and critical evaluation skills in AI-assisted learning of Statistics.

Keywords: Generative AI, Statistics Education, Artificial Intelligence Literacy, Student Confidence

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6 Effect of Rhythmic Auditory Stimulation Versus Non-Rhythmic Auditory Stimulation Training on Lower Extremity Motor Control and Functional Mobility in Sub-Acute and Chronic Stroke Patients: An Experimental Study

Paper ID V12I5-1163 · Pages 29-34 · Physiotherapy

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Stroke frequently damages the brain pathways responsible for planning and carrying out movement, leaving many survivors with weakness, poorly coordinated lower limb movements that make standing, walking and

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turning difficult. Pacing a patient's steps to an external sound, generally called rhythmic auditory stimulation (RAS), is a promising add-on to ordinary physiotherapy, but it remains unclear how much of the benefit comes from the steady beat itself rather than from listening to sound during exercise in general. This experimental study compared a rhythm-based auditory cueing programme with a non-rhythmic (ambient) auditory programme, using identical balance and gait exercises, in patients recovering from stroke. Twenty-two sub-acute and chronic stroke patients aged 40-70 years were selected by purposive sampling and divided into two equal groups. Group A practiced balance and gait exercises paced to metronome beats matched to their own walking cadence; Group B performed the same exercises while listening to ambient music with no fixed beat. Both groups additionally received conventional physiotherapy, three sessions a week for four weeks. Lower-limb motor control, dynamic balance and walking speed were assessed by using Fugl-Meyer Assessment (Lower Extremity), the Dynamic Gait Index and the Ten-Meter Walk Test. Both groups improved significantly on all measures (p

Keywords: Stroke Rehabilitation, Rhythmic Auditory Stimulation, Auditory-Motor Entrainment, Lower Extremity Motor Control, Functional Mobility, Gait Training

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7 Effect of Brain Gym Exercises on Postural Balance and Health-Related Quality of Life in School-Going Hearing Impaired Children: An Experimental Study

Paper ID V12I5-1160 · Pages 35-41 · Physiotherapy

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Dishaba Yogendrasinh Solanki, Student, Pioneer Physiotherapy College, Vadodara, Gujarat

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Children with sensorineural hearing loss often have impaired Balance and postural instability issues occur because of the shared inner ear pathology. Brain Gym exercises combine cross body movements that helps in cross-lateral sensory processing in the brain which may improve postural stability, moreover limited clinical evidence exist regarding its effectiveness in hearing impaired children. Objective: To compare the effect of Brain Gym exercises against standard physical exercises for static, dynamic balance and health-related quality of life (HRQoL) in hearing-impaired school going children. Methods: 30 students (age 10–15 years, hearing loss > 40 dB, Pediatric Balance Scale score < 52) were recruited through purposive sampling from special schools in Vadodara and assigned to Group A (Brain Gym, n=15) or Group B (General Physical Exercises, n=15). Both groups were given exercise protocol for 35–40 minutes per session, 3 days a week for 4 weeks. Outcomes measured were static balance (Flamingo Balance Test), dynamic balance (Y-Balance Test composite score), and quality of life (Pediatric Quality of Life Inventory 4.0). Results: Both groups showed statistically significantwithin-group improvements ($p < 0.001$), Group A achieved greater gains. Fall attempts during Flamingo testdecreased significantly more in Group A compared to Group B (Right: $t = 2.16$, $p = 0.03$; Left: $t = 2.31$, $p = 0.02$). Group A also showed greater improvement in Y-Balance Test composite reach (Right: $t = 6.25$, $p < 0.001$; Left: $t = 4.96$, $p < 0.001$) and overall PedsQL scores ($t = 6.18$, $p < 0.001$). Conclusion: IncorporatingBrain Gym exercises into pediatric rehabilitation of deaf children substantially impacts postural control andquality of life than general physical exercises alone.

Keywords: Hearing Impairment, Brain Gym, Static Balance, Dynamic Balance, Quality Of Life, Pediatric Rehabilitation

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8 A Hybrid Deep Learning Framework Integrating Variational Autoencoder with Self-Attention and MobileNet for Enhanced Malware Detection: An Optimized XGBoost Approach Using EMBER 2018 and 2024 Datasets

Paper ID V12I5-1164 · Pages 42-55 · Cse

Vinita, Research Scholar, JRN Rajasthan Vidhyapeeth (Deemed to bee University), Udaipur, Rajasthan
Manju Mandot, Professor, JRN Rajasthan Vidhyapeeth (Deemed to bee University), Udaipur, Rajasthan

The increase in advanced types of malwares is one of the factors that are very challenging to traditional detection systems. In this paper, a new hybridized deep learning model is proposed, which combines Variational Autoencoder (VAE) and self-attention architecture and MobileNet with strong malware detection and classification. It is proposed that the research methodology will use the EMBER 2018 and EMBER 2024 datasets, with extensive preprocessing and normalization processes to improve the ability of features to be represented. Our dual-branch model learns complementary information the VAE-attention branch learns contextual dependencies of latent representations, whereas the MobileNet branch learns hierarchical visual patterns of malware representation in the form of byte representations. These attributes are combined with the help of interconnecting layers and trained with XGBoost to provide a final classification. As reported by experiment, binary classification and multi-class classification accuracy of 99.47 and 98.23 respectively are significantly better than the current state-of-the-art methods on EMBER 2024. The framework has a 3.2% improvement of detection rate with 42% false positives compared to traditional methods.

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Keywords: Malware Detection, Self-Attention, Variational Autoencoder, XGBoost, EMBER Dataset, MobileNet, Deep Learning, Binary Classification, Feature Fusion, Multi-class Classification

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9 Financial Fundamentals and Stock Market Performance: Evidence from BSE Top 50 Companies

Paper ID V12I5-1167 · Pages 56-61 · Finance

Chetna Tansukhbhai Parmar, Associate Professor, GSFC University, Vadodara, Gujarat

This study examines the relationship between market performance and financial performance of companies listed in the BSE Top 50 index of the Bombay Stock Exchange. The primary objective is to analyze whether strong financial fundamentals translate into superior market returns and to evaluate the risk–return trade-off among leading Indian corporations over medium- and long-term periods. Approach: The study adopts a quantitative and empirical research design using secondary data collected from annual reports, financial statements, and stock market databases. A purposive sample of 50 top-performing companies from the BSE Top 50 was selected. Financial performance was measured using key indicators such as Return on Equity (ROE), Earnings Per Share (EPS), Net Profit Margin, and Return on Assets (ROA), while market performance was evaluated through stock returns, volatility, beta, and risk-adjusted measures including the Sharpe Ratio, Treynor Ratio, and Jensen's Alpha. Data were analyzed over 3-year, 5-year, and 10-year periods using descriptive statistics, correlation analysis, and regression techniques to determine the strength and significance of relationships. Originality: Unlike prior studies that examine either financial performance or stock market performance independently, this research integrates both dimensions to assess whether financial strength consistently leads to superior market valuation and investor returns within India's blue-chip segment. Practical Implementation: The findings provide valuable insights for investors, portfolio managers, and financial analysts by highlighting whether investment decisions should rely primarily on financial fundamentals, market trends, or a combination of both. The study supports evidence-based investment strategies for long-term wealth creation in the Indian equity market.

Keywords: Market Performance, Financial Performance, BSE Top 50, Risk–Return Trade-off, Risk-Adjusted Performance, Sharpe Ratio, Treynor Ratio, Jensen's Alpha, Return on Equity, Indian Stock Market

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10 Can Derivative-Based Hedging Improve the Risk-Adjusted Returns of Portfolios Holding Alternative Investments?

Paper ID V12I5-1151 · Pages 62-67 · Finance

Himanshu Garg, Student, Sri Venkateswara College, University of Delhi, Delhi

The inclusion of alternative investments in modern portfolio allocation can significantly increase diversification because investors want returns that are not fully explained by traditional equity and fixed-income holdings. Alternative investments are here defined as financial assets outside stocks, bonds and cash (e.g., hedge funds, private equity, private credit, real estate, commodities and infrastructure). Although these assets improve

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diversification and have attractive return potential they also come with risks which are often harder to observe or manage than those of traditional securities such as market risk, liquidity risk, credit risk, leverage risk, currency risk and interest rate rise plus non-linear/asymmetric return distributions. Derivatives like futures, options, forwards and swaps allow investors to hedge specific components of this risk without liquidating the underlying positions. This review synthesizes existing literature on derivative-based hedging to test whether it improves risk-adjusted returns of portfolios containing alternative investments. The literature suggests that hedging effectiveness depends on the relationship between the hedging instrument and the exposure being hedged, hedge ratio achieved, investment horizon and market conditions. Hedging costs are incurred, volatility reduction does not translate into improved risk-adjusted return because hedging also requires upside participation so volatility reduction doesn't lead to higher risk adjusted return. From hedge funds, commodities and equity-linked strategies evidence shows that hedging is generally more reliable where underlying risk is systematic and hedging instrument tracks exposure closely but less reliable where risk is idiosyncratic, illiquid or hard to observe which is common in private equity and private credit. In general the literature seems to indicate that derivative-based hedging can enhance risk-adjusted returns of alternative-investment portfolios only if it is applied to identifiable systematic and hedgeable risks, costs are taken into account and so on. Hedging should therefore be viewed as a tool for managing risk exposure and improving efficiency in portfolio management rather than as a guaranteed means of increasing dollar returns.

Keywords: Alternative Investments, Derivatives, Hedging, Portfolio Management, Risk-Adjusted Returns, Futures, Options, Risk Management, Portfolio Diversification, Sharpe Ratio, Sortino Ratio.

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11 Stocks, Bonds, Gold, and Bitcoin: A Comparative Analysis of Risk-Adjusted Returns from 2022 to 2024

Paper ID V12I5-1170 · Pages 68-85 · Economics And Finance

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This paper examines the relationship between U.S equities, gold, Bitcoin and short term government debt over the three years from January 2022 to December 2024, a period defined by the fastest Federal Reserve rate hiking cycle in four decades, the beginnings of a cutting cycle, alongside the January 2024 approval of spot Bitcoin exchange-traded funds. Using a monthly return rate data and a risk-free rate derived from Treasury bill yields, this study calculated Sharpe and Sortino ratios, a six-month rolling beta for Bitcoin and gold against the S&P 500 as well as a pairwise correlation matrix across all three price based assets which is set against the Federal Funds Effective Rate as a contextual overlay. The findings show that gold recorded the highest risk-adjusted return among the three assets. This was the case for both the Sharpe and Sortino ratios. Bitcoin's beta against the S&P 500 also changed significantly during the period studied. It moved from below zero to above four within a few months. This increase occurred during the period following the approval of the Bitcoin ETFs. However, Bitcoin's beta later fell again as the Federal Reserve approached its first rate cut in late 2024. Bitcoin's correlation with the S&P 500 (0.571) was substantially stronger than gold's (0.243). In comparison, Bitcoin and gold themselves had only a weak correlation of 0.299. Overall, these results suggest that Bitcoin behaved more like a volatile and equity-adjacent asset rather than an independent store of value during this period. The study connects this pattern to prospect theory and loss-averse behaviour.

Keywords: Portfolio Diversification, Risk-Adjusted Return, Bitcoin, Monetary Policy, Safe-Haven Assets, Behavioral Finance

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12 A Study to Assess the Effectiveness of Structured Teaching Program on Knowledge Regarding Osteoporosis Among Post-Menopausal Women of Selected Areas of Distt. Mandi (H.P)

Paper ID V12I5-1172 · Pages 86-94 · Msc Nursing In Medical Surgical Nursing

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Abstract: Osteoporosis is a silent, progressive disease characterized by decreased bone mass and structural deterioration, leading to an increased risk of fractures. Postmenopausal women are particularly vulnerable due to hormonal changes, especially the decline in estrogen levels. In India, the prevalence of osteoporosis is high among post-menopausal women, particularly in rural areas where awareness and access to preventive healthcare are limited. Educational interventions like structured teaching programs can help bridge the knowledge gap and promote preventive practices. Aim :To assess the effectiveness of a structured teaching program on knowledge regarding osteoporosis among post-menopausal women in selected areas of District Mandi, Himachal Pradesh. Materials and Methods: A pre-experimental, one-group pretest/post-test designwas adopted. A total of 100 post-menopausal women were selected through non- probability purposive sampling. A structured questionnaire was used to assess their knowledge regarding osteoporosis before and after the intervention. The structured teaching program included lectures, visual aids, and demonstrations related to osteoporosis prevention. Data were analysed using descriptive and inferential statistics; the effectiveness of the intervention was tested using the paired t-test, and associations with demographic variables were analysed using the chi-square test. Findings: Thepretest findings revealed that 5% had good knowledge ,29% ofwomen had poor knowledge, 66% had average knowledge. After the intervention, 62% demonstrated good knowledge,

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38% had average knowledge, and none had poor knowledge. The mean knowledge score increased from 13.56 (SD = 4.76) in the pretest to 22.20 (SD = 3.43) in the post-test.The paired t-test showed a statistically significant improvement (t = 14.28, p = 0.00001*). A significant association was found between knowledge levels and variables such as occupation and type of family. Conclusion: The structured teaching program was effective in significantly enhancing the knowledge of post-menopausal women regarding osteoporosis. Educational interventions can play a critical role in promoting awareness and preventive practices, especially in rural settings where health literacy is low.

Keywords: Knowledge, Structured Teaching Programme, Himanchal Pradesh

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13 Powering Micro-Businesses: A Theoretical Analysis of Electricity Reliability, Productivity and Capital Investment in Maharashtra

Paper ID V12I5-1176 · Pages 95-104 · Energy Economics

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This paper examines how electricity reliability may affect the operating hours and capital investment decisions of micro-businesses in Maharashtra, India. While access to electricity has expanded substantially, having a grid connection does not necessarily guarantee a reliable or predictable supply. For micro-businesses operating with limited financial resources, frequent power interruptions and poor power quality can reduce productive operating time, leave electricity-dependent equipment underutilised, increase operating costs and create uncertainty around future investment. The study adopts a theoretical secondary research approach, drawing on existing literature on electricity reliability, firm productivity, capacity utilisation, infrastructure and investment under uncertainty. Rather than estimating a direct causal relationship using original business-level data, the paper synthesises these strands of literature to develop a conceptual framework for understanding how electricity reliability can influence micro-business decisions. The analysis focuses on two main channels: the effect of electricity reliability on productive operating time and capacity utilisation, and its potential effect on the expected returns and risks associated with capital investment. The paper argues that the economic value of electricity cannot be fully captured by measuring access alone. For micro-businesses, the reliability and predictability of supply may influence how effectively existing productive resources are used and the conditions under which further investment becomes worthwhile. The study concludes by considering the implications for electricity and MSME policy in Maharashtra and identifying areas for future empirical research.

Keywords: Electricity Development, Reliability Capital, Cost of Production, Opportunity Cost

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14 A Simple Dynamic GPS Attendance System for College Classrooms Without Dedicated Hardware

Paper ID V12I5-1177 · Pages 105-107 · Computer Science And Engineering

Prasobh John, Independent Researcher

Taking attendance in college classes usually wastes lecture time or requires costly hardware like fingerprint

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readers, RFID cards, or Bluetooth beacons. Simple web forms are cheaper, but students can easily share access links or class codes with absent friends who punch in from outside the room. This paper presents a practical, low-cost attendance system that needs no extra hardware or paid server hosting. The teacher's mobile phone serves as the location anchor. When an attendance session opens, the app records the teacher's GPS coordinates. Students then open the web portal on their own phones, select their name, type in a temporary 6-digit code shown on the board, and fetch their device location. The system calculates the distance between the student and the teacher using the standard Haversine formula. If the student is within a preset boundary (such as 35 to 50 meters), the punch is recorded as present. We tested the system with a class of 78 engineering students in a multi-story concrete college building in Kerala. The test verified 98.7% of in-class submissions accurately while blocking students outside the boundary. The app also prevents duplicate submissions from the same phone, giving colleges an easy, free way to run quick roll calls.

Keywords: Student Attendance, GPS Geofencing, Mobile Web App, Google Apps Script, Classroom Management.

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15 Wearable ECG Monitoring with Embedded Deep Learning for Real-Time Arrhythmia Detection

Paper ID V12I5-1185 · Pages 108-111 · Biomedical Engineering

Ms. Subha P S, Research Scholar, Marian Engineering College

ardiovascular diseases remain a leading cause of death worldwide, and arrhythmia, an irregularity in heart rhythm, demands timely detection. Conventional ECG monitoring is bulky, hospital-bound and computationally heavy, which limits continuous monitoring in everyday settings. This paper presents an IoT-based arrhythmia detection system that combines a lowcost wearable ECG front end with a lightweight deep learning model running directly on the sensor node. Biopotentials are acquired with ECG electrodes, conditioned by an AD8232 analog front end, digitised and processed by an ESP32 microcontroller, and classified by a one-dimensional convolutional neural network (DL-LAC) into five heartbeat classes: Normal (N), Supraventricular (S), Ventricular (V), Fusion (F) and Paced (P). Because the network learns features directly from raw single-lead ECG, no manual feature engineering is required. The model, trained on the MIT-BIH Arrhythmia Database, reaches approximately 96.2% overall accuracy, with on-device inference latency of about 80 ms per window and a memory footprint below 500 KB. Duty cycling reduces power consumption by about 40%, extending battery life from four to over six hours. The results indicate that on-device deep learning is a practical route to continuous, low-latency and privacy-preserving cardiac monitoring.

Keywords: Arrhythmia Detection, ECG, Internet of Things, Edge Computing, Convolutional Neural Network, ESP32, AD8232

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16 Evaluation of Stress Management Behaviours and Psychological Well-being

Paper ID V12I5-1188 · Pages 112-124 · Psychology

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Stress is a multidimensional psychological and physiological response that occurs when individuals perceive that environmental demands exceed their available coping resources. Although short-term stress may support motivation and adaptive functioning, persistent or poorly managed stress can negatively influence emotional health, concentration, sleep, interpersonal relationships, academic or occupational functioning, and overall quality of life. The present study evaluated stress-management behaviors and psychological well-being using responses obtained through a structured survey. The analysis included 210 consenting participants. Demographic characteristics, perceived stress experiences, coping behaviors, social support, lifestyle practices, and indicators of psychological well-being were examined using descriptive and inferential statistical methods. Mean, median, standard deviation, standard error, frequency, and percentage distributions were calculated. Composite stress-burden and perceived-support indicators were also examined. Pearson and Spearman correlation analyses were used to investigate relationships between continuous or ordinal variables, while chi-square tests examined associations between categorical variables. Exploratory analysis also included one-way analysis of variance and internal-consistency assessment where appropriate. The mean stress-burden score was 6.62, with a median of 7.00, a standard deviation of 2.68, and a standard error of approximately 0.19. Pearson correlation analysis demonstrated a small positive association between the examined variables ($r = .138$, $p = .045$). Chi-square analysis identified statistically significant associations between age group and high-stress classification ($\chi^2 = 11.831$, $p = .008$) and between work/study duration and high-stress classification ($\chi^2 = 9.343$, $p = .025$). These findings suggest that stress experiences are not distributed uniformly across demographic and lifestyle groups. The findings also support the importance of strengthening adaptive stress-management behaviors, social connectedness, healthy routines, physical activity, adequate sleep, and accessible psychological support. Because the study used a cross-sectional survey design, the findings should be interpreted as associations rather than evidence of causation.

Keywords: Stress Management, Psychological Well-Being, Perceived Stress, Coping Behaviour, Social Support, Stress Burden, Mental Health, Lifestyle, Students.

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17 Climate Change and Sustainable Economic Growth: Challenges, Opportunities, and Policy Propositions

Paper ID V12I5-1180 · Pages 125-129 · Humanities

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Climate change has become one of the major challenges facing economic development across the world. Economic growth has improved living standards and reduced poverty, but activities such as industrialization, fossil fuel use, deforestation, and intensive agriculture have also increased pressure on natural resources and the environment. This paper examines the relationship between climate change and sustainable economic

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growth and explores how economies can continue to develop while protecting the environment and improving social well-being. The study is based on secondary data collected from books, academic journals, government publications, and reports of international organizations such as the IPCC, UNDP, World Bank, IEA, and UNEP. A descriptive and analytical approach is used to understand the economic effects of climate change and possible pathways towards sustainability. The study finds that climate change affects several important areas of economic activity, including agriculture, industrial production, infrastructure, public health, labor productivity, and financial stability. Climate-related risks can also slow progress towards several Sustainable Development Goals, particularly those related to poverty, food security, health, water, energy, employment, sustainable cities, and climate action. The paper highlights the importance of combining climate mitigation with adaptation measures to reduce these risks. It further discusses the green economy as a practical pathway towards sustainable growth through renewable energy, efficient use of resources, cleaner technologies, green innovation, and environmental protection. The study argues that economic growth and environmental protection should not be treated as competing objectives. Instead, sustainable policies can help economies achieve growth while building resilience, creating new opportunities, protecting natural resources, and improving the quality of life. A balanced approach that brings together economic progress, environmental responsibility, and social inclusion is therefore essential for achieving sustainable development for present and future generations.

Keywords: Climate Change, Sustainable Economic Growth, Green Economy, Sustainable Development Goals, Climate Resilience

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18 A Simplex based re-evaluation of Goal Programming in Product Mix Optimization Project Report

Paper ID V12I5-1195 · Pages 130-137 · Operations Research

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The most profitable use of a manufacturing company's scarce machine time occurs when the company is operating in the most efficient manner. The product mix problem of XYZ Company, a manufacturer of suits, jackets and trousers is used in this paper to illustrate the real-life application of the Simplex methodology of linear programming. The processing time, weekly station capacity, demand limits, selling prices and raw material costs are from a published case study. The goal is to determine the optimal level of production for each product per week in order to maximize profit. The model contains 3 decision variables, 11 constraints: 8 production stations and 3 demand limits. This was solved by using the Simplex tableau iterations and verified using the Microsoft Excel Solver. The best plan is to sell 476.23 suits, 753.75 jackets, and 600 trousers each week and the maximum weekly profit is ৳612,017.30. The demand limit for trousers is fully utilized and two stations are used: Model Preparation and Slaughterhouse. The shadow prices indicate that an additional minute at Slaughterhouse contributes approximately ৳236.31 to the weekly profit, whereas the other six stations have

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idle time. The results reveal that the Simplex method not only provides a production plan, but also provides a definite direction as to where additional capacity is worth purchasing.

Keywords: Linear Programming, Simplex Method, Product Mix, Shadow Price, Excel Solver, Apparel Industry

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19 Evaluating Machine Learning Signal Validation in Bollinger Band Mean-Reversion Trading: A Strategy-Dependent Experimental Study

Paper ID V12I5-1189 · Pages 138-146 · Computer Science And Engineering

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Abstract Financial markets exhibit changing volatility and regime-dependent behavior, making the interaction between deterministic trading rules and machine-learning validation an important empirical question. This study evaluates a Bollinger Band Mean Reversion (BBMR) strategy and examines whether a generic machine-learning filtering layer improves the characteristics of its candidate signals. The supplied experimental registry contains 30 independent configurations: five unfiltered baseline configurations and 25 ML-assisted configurations formed by crossing five timeframes—1-minute, 3-minute, 5-minute, 15-minute and 1-hour—with five confidence settings of 0.50, 0.53, 0.55, 0.57 and 0.60. Across the registry, 99,807 recorded orders are reported. The five baseline configurations show a descriptive aggregate win percentage of 66.55% and a row-wise Net Realized sum of 316,612.56. The 25 ML-assisted configurations show a descriptive aggregate win percentage of 19.85% and a row-wise Net Realized sum of -135,285.70. Increasing the ML confidence setting reduces recorded activity from 15,278 orders at 0.50 to 2,373 at 0.60, but the reduction in activity is not accompanied by a corresponding improvement in win percentage or aggregate descriptive profitability. The ML-assisted win percentage remains below the baseline at every tested timeframe, and only the 1-hour ML group has a positive row-wise Net Realized sum. An implementation-level inspection further indicates that the validation feature layer is dominated by generic contextual variables such as moving-average slope, momentum, volatility and risk/reward measures rather than direct Bollinger mean-reversion descriptors. The findings therefore suggest a strategy-dependent limitation: the tested ML filter changes the trade population substantially, but does not improve the evaluated BBMR strategy and may be mismatched to the short-horizon mean-reversion mechanism. The result should not be generalized to all ML methods or all BBMR implementations; it is an empirical finding for the supplied configuration. Keywords: Bollinger Bands, Mean Reversion, Machine Learning, Signal Validation, Algorithmic Trading, Feature Engineering, Multi-Timeframe Analysis, Backtesting, Strategy-Dependent Validation.

Keywords: Bollinger Bands, Mean Reversion, Machine Learning, Signal Validation, Algorithmic Trading, Feature Engineering, Multi-Timeframe Analysis, Backtesting, and Strategy-Dependent Validation.

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20 Genetically Modified Crops: Benefits, Risks, and Future Prospects

Paper ID V12I5-1198 · Pages 147-149 · Biotechnology

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Genetically modified (GM) crops are an important application of agricultural biotechnology, developed to introduce selected traits that may improve crop performance, quality, or resilience. This review examines the potential benefits, limitations, and future prospects of GM crops, with attention to their relevance for food security and sustainable agriculture. Desired traits can include resistance to particular insect pests, tolerance to specific herbicides, improved nutritional composition, and selected forms of tolerance to environmental stress. Depending on the crop, trait, and farming system, these technologies may help reduce losses and, in some cases, lower the use of certain insecticides. However, outcomes are not uniform: they depend on local ecology, crop management, resistance-management practices, and access to appropriate seeds and knowledge. Important issues include gene flow, the evolution of resistant pests or weeds, possible effects on non-target organisms, biodiversity, seed affordability, market access, and public confidence. Food and environmental safety therefore require case-by-case assessment based on the specific crop and trait, alongside transparent regulation and monitoring. Newer approaches, including CRISPR-based genome editing, may expand the range of traits available for crop improvement, although their benefits and risks also need careful evaluation. Overall, GM crops should be assessed using scientific evidence and local agricultural conditions rather than treated as universally beneficial or harmful. Their responsible use may contribute to resilient food systems when integrated with sound agronomy, biodiversity protection, and fair access for farmers.

Keywords: Genetically Modified Crops, Agricultural Biotechnology, Genetic Engineering, Biosafety, Crop Improvement, Genome Editing, Food Security, Sustainable Agriculture

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21 Flexibility or Power? A Difference-in-Differences Test of the Remote Work Wage Discount

Paper ID V12I5-1199 · Pages 150-163 · Economics

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Remote work has expanded substantially, giving workers greater flexibility while raising questions about whether differences in remote and on-site wages reflect workers' willingness to trade income for flexibility and how long such wage discounts last. The research question investigates if compensating differentials persist or whether the wage discount for remote work shrinks as remote job options in an occupation expand. A difference-in-differences framework was used to compare occupations experiencing relatively high and low growth in remote job opportunities. The analysis combines occupation-level remote job-posting data from WFH Map with wage data from the American Community Survey analysed by Pabilonia and Vernon. Occupational wage information from the U.S. Bureau of Labor Statistics is also used to provide additional wage context. The high-expansion occupations experienced a 6.62 percentage-point increase in their remote wage differential compared with a 1.05 percentage-point increase in low-expansion occupations, producing a +5.57 percentage-point difference-in-differences estimate, indicating that the relative wage position of remote workers improved more strongly where remote employment opportunities expanded, providing partial support for the monopsony

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mechanism. The relatively limited period and data constraints mean that longer-term changes in the remote labour market may be needed to determine whether the wage discount predicted by the monopsony hypothesis becomes more evident over time.

Keywords: Remote Work, Wage Differentials, Rosen's Compensating Differentials, Monopsony, Labour Market Power, Outside Options, Difference-in-Differences

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22 Testing Subscription Inertia: Evidence from India’s 2021 Recurring-Payment Rules by RBI

Paper ID V12I5-1200 · Pages 164-176 · Economics

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Did the RBI's 2021 recurring-payment rules, which required customers to re-authorise auto-debits, reveal how much subscription retention depended on consumer inertia rather than preference? The study considers the transition period from October 2021 to be a regulatory shock and compares the activity in the months leading up to the shift with the activity in the months following, both in terms of card-based online payments and UPI payments, as well as between credit- and debit-card transactions, by applying an event-study and difference-in-differences framework. RBI card-payment data from public reports and NPCI UPI transaction data for the year 2021 and RBI e-commerce observations of cards made available through May 2022. Online card transactions are a proxy for subscription-level churns, as these aren't publicly known and are interpreted with caution. There was no evidence of a sudden drop in card activity at the moment reported to happen by the inertia hypothesis. Debit-card transactions grew by 1.81% in the first half of the year as compared to the second half, and credit-card transactions grew by 0.79% in the second half when compared to the first half. The difference between the card and UPI was statistically significant, but the pre-existing divergent trends violated the parallel trends assumption. But the evidence does not allow concluding that there is a causal effect of subscription inertia, but merely at the level of the available proxy to payment.

Keywords: Subscription Inertia, Consumer Inertia, Recurring Payments, RBI E-Mandate, Behavioural Economics, Difference-In-Differences, Event Study, Regulatory Shock

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23 Future Directions & Innovation in Hospitality and Tourism Start-ups and Innovation in Sustainable Tourism

Paper ID V12I5-1211 · Pages 177-180 · Hospitality

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The hospitality and tourism industry is experiencing a profound transformation shaped by sustainability concerns, rapid technological advancements, and evolving consumer expectations. This paper explores the future trajectory of the sector with a particular emphasis on the role of start-ups in fostering sustainable tourism innovation. It examines how emerging technologies, novel business models, and environmentally responsible practices are redefining traditional tourism frameworks. The study integrates theoretical

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perspectives with practical insights derived from Indian start-up case studies to illustrate how innovation can drive sustainability. The findings indicate that start-ups are critical enablers of change, promoting resource efficiency, community engagement, and experiential tourism. The paper concludes by outlining strategic recommendations for stakeholders to achieve long-term resilience and sustainability in hospitality and tourism.

Keywords: Sustainable Tourism, Hospitality Innovation, Start-Ups, Green Tourism, Digital Transformation, India

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24 Operations Research in Public Transit and Urban Mobility: A Comparative Review of Eighteen Studies

Paper ID V12I5-1214 · Pages 181-187 · Operations Research

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Public transit is a vast, interconnected systems design problem: coordinating numerous routes, frequencies , vehicles, operators, signals and passengers with uncertain demand and travel times. Operations Research (OR) brings a rich and mature arsenal of tools to tackle these issues. This report brings together 18 published and preprint papers which we have reviewed individually in six student-focussed sections that all bring OR to design of bus routes, timing of signals, quality of service, scheduling of vehicles and crews, demand-responsive transit, gig transportation, bike sharing, and electric vehicle fleet management. We cluster the papers into five categories and compare the OR techniques, which include calculus-based optimisation, mixed-integer, and set-partitioning programming, column-generation, and decomposition, genetic, and large-neighbourhood-search heuristics, robust optimisation, queueing, and stochastic-process models, Markov decision processes, and simulation. Three broad insights stand out. The first is the near-exclusive use of large-scale heuristics for bigger problems versus exact algorithms for smaller problems. The second is the treatment of demand and supply uncertainties as part of the decision making rather than as a post-hoc model refinement. The third is the real improvements, which are measured relative to different baselines on different case studies. We conclude by addressing limitations in the literature as well as in our review.

Keywords: Operations Research, Public Transportation, Bus Scheduling, Demand-Responsive Transportation, Integer Programming Heuristics Robust Optimisation, Queueing Theory

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25 Applications of OR in Portfolio Optimization and Risk Management

Paper ID V12I5-1219 · Pages 188-202 · Finance

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This paper presents a bibliometric analysis of the applications of Operations Research (OR) in portfolio optimization and risk management. The data were retrieved from Elsevier's Scopus database and comprise 1,304 documents published between 2016 and 2026 in 619 sources, together with a corpus of 48 review papers. Science mapping was carried out with Bibliometrix and its Biblioshiny interface to examine the growth, authorship and sources of the field and to build a thematic map of its keywords. The number of publications rose from 51 in 2016 to 244 in 2026, an average annual growth rate of 16.95%. Machine learning and risk analysis emerge as the motor themes, risk management and project portfolios form the basic themes, reinforcement learning is a niche theme, and classical optimization and uncertainty modelling are emerging or declining. The review identifies gaps in validation, integration across methods, and consistent terminology, and uses them to propose a research agenda.

Keywords: Operations Research, Portfolio Optimization, Risk Management, Bibliometric Analysis, Machine Learning

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26 A Bibliometric Review of Portfolio Optimization Models: An Operations Research Perspective

Paper ID V12I5-1213 · Pages 203-216 · Finance

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This study presents a bibliometric review of portfolio optimization research from an Operations Research perspective, covering literature published between 2015 and 2026. A final corpus of 708 documents was identified through a PRISMA-based selection process using Scopus. Biblioshiny and Microsoft Excel were used for data extraction, analysis, and visualization. The study examines publication and citation trends, source performance, author productivity, institutional and country-level output, international collaboration, keyword patterns, conceptual clusters, and thematic evolution. Four research questions address publication and citation activity; prominent journals, authors, institutions, and countries; the field's main conceptual and methodological approaches; and changes in themes between earlier and later periods. The results show that portfolio optimization and portfolio selection remain central to the literature. Robust optimization, robust portfolio optimization, genetic algorithms, asset allocation, machine learning, portfolio management, multi-

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objective optimization, and Conditional Value-at-Risk also appear among frequently observed concepts. Publication output is concentrated in a relatively small group of sources, while researchers and countries contribute across a broad international base. China, the United States, and India are major contributors, and the collaboration analysis shows links among leading research-producing regions. The thematic analysis indicates continuity in the field's core portfolio optimization theme alongside increasing specialization in uncertainty modelling, advanced risk measures, metaheuristics, machine-learning applications, and dynamic stochastic models. The review identifies research opportunities at the intersection of robust or distributionally robust optimization and machine-learning-integrated decision models. It highlights the need to compare these techniques with classical mean-variance models using consistent datasets, realistic constraints, and common evaluation standards. Future research directions include out-of-sample testing, method benchmarking, transparent data definitions, ESG integration, emerging computational approaches, and broader geographic collaboration. Findings remain bounded by the Scopus-based search strategy and the 2015–2026 observation window; citation-age effects and the partial nature

Keywords: Portfolio Optimization, Portfolio Selection, Operations Research, Bibliometric Analysis, Robust Optimization, Metaheuristics, Machine Learning, Portfolio Management

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27 Design and Development of an AI-Driven Framework to Secure IoT Networks

Paper ID V12I5-1221 · Pages 217-222 · Artificial Intelligence

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The rapid proliferation of Internet of Things (IoT) devices across industrial, domestic, and critical-infrastructure environments has created a correspondingly rapid expansion of cyber-attack surfaces, while the heterogeneity, resource constraints, and high-volume dynamic traffic of IoT networks render conventional signature- and rule-based security mechanisms increasingly inadequate. This article presents a comprehensive review of twelve recent studies (2020–2026) on artificial intelligence (AI)-driven approaches to securing IoT networks, spanning machine learning and deep learning intrusion detection systems (IDS), federated and blockchain-assisted learning frameworks, 5G software-defined network (SDN) security architectures, service-oriented edge-layer architectures, and large-scale systematic and taxonomic reviews. Reported detection accuracies across the empirical studies range from approximately 82% to 98.25%, with federated and hybrid blockchain–AI approaches offering the strongest privacy–accuracy trade-offs and 5G-SDN frameworks achieving the lowest detection latencies (as low as 15 milliseconds). Despite these advances, the literature consistently reports unresolved research gaps, including limited adaptability to evolving traffic patterns, elevated false-positive rates, insufficient attention to the computational and energy constraints of IoT endpoints, dependence on single machine learning or deep learning algorithms rather than integrated pipelines, and an absence of unified, lightweight, and quantum-resistant frameworks validated on real hardware. Building on this synthesis, the review articulates a research problem, four research objectives, and a proposed seven-stage AI-driven security framework — spanning data collection, preprocessing, feature extraction and selection, AI-based threat detection, attack classification, adaptive security response, and continuous monitoring — intended for validation on benchmark datasets (CICIoT2023, TON_IoT, BoT-IoT/N-BaIoT) and on constrained hardware

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platforms (Raspberry Pi, ESP32). The proposed research direction aims to deliver a lightweight, adaptive, and empirically validated AI-driven security solution suited to resource-constrained IoT deployments.

Keywords: Internet of Things (IoT), IoT Security, Intrusion Detection System (IDS), Artificial Intelligence, Machine Learning, Deep Learning, Federated Learning, Blockchain-AI Integration, Edge Computing, Anomaly Detection, 5G Software-Defined Networking (SDN), Lightweight Security Framework, and Adaptive Threat Responses.

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28 From Marital Infidelity to Homicide: A Criticism Analysis of Motive, Criminal Lability and Spousal Killing under Indian Criminal Law

Paper ID V12I5-1216 · Pages 223-232 · Art And Social Life

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Spousal homicide is a complex crime involving a criminal and victim that are connected not only by crime but also emotional threads. The problem of intimate killings is linked with the power dynamics between genders. Such killings are different from those crimes of passion that are committed by strangers because in the spouse killing, the relationship between the victim and killer is built on a long and close family relations. The central focus in spousal homicide is the element of motive which can arise from allegations of partner's straying or which can arise from allegations of a partner's straying. Under Indian criminal law, which has been traditionally guided by the Indian Penal Code 1860 (IPC) and now transitioning to Bharatiya Nyaya Sanhita 2023 (BNS), courts are tasked with the precarious responsibility of distinguishing between pre-panned murder and acts of passion stemming from an overwhelming loss of self-control. This paper attempts to critically examine the evidence and substantive role of the element of motive in the context of spousal homicides, and the various ways Indian courts have interpreted the concept of provocation in the wake of accusations of marital unfaithfulness. The paper further attempts to analyse the statutory distinction between Murder (IPC Section 300 / BNS Section 101) and Culpable Homicide not amounting to Murder (IPC Section 299 / BNS 100) through the less of exception 1 (grave and sudden provocation). A gendered analysis of the differing criminal justice responses to male-initiated homicides on the grounds of marital unfaithfulness and female-initiated homicides on the grounds of battered woman syndrome is undertaken. More over the paper aims to critically evaluate the Joseph Shine jurisprudence, as wells as recommend potential statutory amendments under the new criminal law framework for a more equitable adjudication of crimes of passion in light of the newly transitioned BNS.

Keywords: Extramarital affair, Culpable homicide, Murder

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29 A Zero-Infrastructure, Browser-Based Architecture for Automated Video Interview Recording Using Client-Side Media Capture and Serverless Cloud-Storage Integration

Paper ID V12I5-1150 · Pages 233-238 · Computer Science

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Automated asynchronous video interviewing has become a common early-stage recruitment tool, but existing solutions are almost exclusively delivered as paid, proprietary software-as-a-service platforms, creating a cost and integration barrier for individual recruiters, small organizations, and academic institutions. This paper presents the design and implementation of a video interview recording system built entirely from freely available, standards-based browser APIs and a serverless scripting platform, requiring no paid infrastructure, no traditional backend server, and no database. The client captures a continuous audio-video recording across a sequence of timed, operator-defined questions using the W3C MediaStream Recording API, and transmits the result to a serverless integration layer via a custom chunked-upload protocol designed to remove the request-payload ceilings typical of serverless platforms. The integration layer, implemented in Google Apps Script, executes under the operator's own cloud identity, allowing candidates to submit recordings without a Google sign-in of their own while ensuring recordings are persisted directly to the operator's Google Drive. We describe the system architecture, the chunked-transport protocol and its rationale, the access-control model, and a set of controlled technical micro-benchmarks characterizing encoding overhead and payload scaling. We further report on an iterative, real-world debugging process that surfaced two non-obvious browser/platform interoperability failure modes, both resolved and documented here to inform future implementers. We conclude by identifying the system's limitations — principally the absence of a controlled multi-participant usability study — and outline the empirical evaluation required to substantiate broader claims of practical utility.

Keywords: Asynchronous Video Interviewing, Browser-Based Recording, Serverless Architecture, Chunked File Upload, Google Apps Script.

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30 Applications of Operations Research in AI for Optimization: A Bibliometric Review

Paper ID V12I5-1228 · Pages 239-253 · Perations Research

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Artificial intelligence (AI) is increasingly combined with Operations Research (OR) to solve optimisation problems across sectors, yet existing reviews study each sector in isolation. This study presents a cross-sector bibliometric review of 1,550 Scopus-indexed articles and reviews published between 2016 and 2026, analysed using Bibliometrix, Biblioshiny and VOSviewer. Publications have grown rapidly, with 88.3% appearing since

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2024, and the field is highly collaborative and spread across many journals. Thematic mapping identifies predictive analytics and decision-making as the motor theme, machine learning and optimisation as basic themes, and large language models as an emerging theme. The review finds five gaps: prediction dominates prescription, real-world validation is limited, sectors are weakly integrated, adoption barriers are rarely examined, and fairness and AI costs get little attention. A six-priority research agenda is proposed to address them.

Keywords: Operations Research, Artificial Intelligence, Optimization, Predictive Analytics, Machine Learning, Bibliometric Analysis

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31 Applications of Operations Research Consumer Behaviour

Paper ID V12I5-1207 · Pages 254-266 · Consumer Behaviour

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This review is a literature/bibliometric analysis of Consumer Behaviour to understand and scale the field in a holistic manner. Through this review, the authors have tried to find dominant, important themes in the field of Consumer Behaviour and the importance of Operational Research in the Consumer Behaviour sector by making it more reliable. The data for this review is procured from Elseiver's Scopus database by using important keywords. The final database uses 929 articles and reviews. It was found that recent shifts in the ecosystem have begun dominating and shaping this study.

Keywords: Consumer Behaviour, Operations, Research, Bibliometric Analysis

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32 Applications of Operations Research in Retail Management

Paper ID V12I5-1233 · Pages 267-278 · Operations Research

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Retailers face growing pressure to make faster, data-driven decisions on inventory, logistics, pricing and demand, and the shift to e-commerce and omni-channel retailing since the COVID-19 pandemic has made these problems more complex. This study uses a bibliometric approach to map the literature on the application

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of Operations Research (OR) in retail management. Using the Scopus database, 316 peer-reviewed journal articles published between 2010 and 2026 were identified through a PRISMA-guided screening process and analysed with Biblioshiny and Microsoft Excel. The analysis covers publication trends, leading sources, keyword co-occurrence, thematic mapping and multiple correspondence analysis. The results show a sharp rise in output after 2020, peaking at 41 publications in 2025. The literature is built mainly around inventory management, forecasting and distribution, with emerging themes in artificial intelligence, omni-channel retailing and sustainability. However, traditional OR methods and newer computational approaches remain largely disconnected. The study also finds that omni-channel research is mostly descriptive, sustainability is rarely built into optimisation models, food-waste research is still exploratory, and few studies are validated with real retail data. Based on these gaps, the paper proposes a future research agenda covering hybrid AI-OR models, omni-channel optimisation, sustainability as a core constraint, perishable-inventory modelling, customer-centric optimisation and field validation with retailers. The findings help researchers position future work and give practitioners a view of which methods are mature and which still need testing.

Keywords: Operations Research, Retail Management, Bibliometric Analysis, Omni-channel Retailing, Demand Forecasting, Inventory Management, Artificial Intelligence, Sustainability

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33 Optimisation and Policy in Waste Management

Paper ID V12I5-1232 · Pages 279-294 · Operations Research

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Waste management systems must decide where waste is collected, how it is transported, where it is treated and under which rules, and operations research supplies the quantitative tools for these decisions. This study maps the published research at the point where optimization and waste policy meet. A Scopus search for “waste management”, “optimization” and “policy”, screened in four PRISMA 2020 stages, produced a final sample of 967 journal articles and reviews published from 2016 onwards. The records were examined through performance analysis, title-based thematic counts, keyword co-occurrence mapping, a thematic map and a multiple correspondence analysis, together with a reading of the 167 review papers in the sample. Output grew at a compound annual rate of 25.5% between 2016 and 2025, and almost three in five records were published from 2024 onwards. The literature is dispersed across 425 journals and is highly collaborative. Circular economy, sustainability and artificial intelligence form the dominant motor theme, while optimization of solid waste systems and waste-to-energy form two further well-developed themes. Titles on artificial intelligence and machine learning rose from 1.6% to 15.2% of output between 2016–2019 and 2024–2027. Collection and routing, the classic operations research problem in waste management, appear in only 3.7% of titles, and household, residential, citizen or consumer terms in 1.4%. The paper closes with a six-part agenda for future research.

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Keywords: Waste management; optimisation; Operations research; Policy; Circular economy; Bibliometric analysis; PRISMA.

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34 Inventory Management

Paper ID V12I5-1242 · Pages 295-314 · Operations Research

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This study examines the application of Operations Research (OR) techniques to inventory management through a bibliometric analysis of Scopus-indexed literature. The search strategy used the query “inventory management AND operations research” across article titles, abstracts and keywords, producing 1,681 records for the 2000–2026 analytical period. The supplied bibliometric export contains 1,678 article occurrences across 749 source entries, and the distinction between the screened records and exported occurrences is retained transparently. Annual publication output increased from 13 articles in 2000 to 191 in 2025; the 2026 count of 158 is treated as provisional. Source, thematic and conceptual analyses identify inventory control, supply chain management, operations research, optimization and decision-making as central themes. Sustainability is a distinct developed theme, while machine learning and artificial intelligence are increasingly connected with inventory decision support. The paper reviews classical inventory models, mathematical programming, allocation and network methods, supply-chain coordination, and emerging analytics. It concludes with a research agenda focused on integrating prediction and optimization, adaptive control under uncertainty, sustainability, resilient supply chains, real-time data, and empirical model validation.

Keywords: Operations Research, Inventory Management, Inventory Control, Supply Chain Management, Bibliometric Analysis, Optimization, Sustainability, Machine Learning

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35 Supply Chain Management and Industry 4.0

Paper ID V12I5-1243 · Pages 315-330 · Operations Research

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Industry 4.0 has moved from a manufacturing slogan to a central concern of supply chain management (SCM). This review synthesises the literature on the two topics using 1,638 journal articles and reviews indexed in Scopus between 2017 and 2026, and it combines a reading of the most influential studies with the bibliometric

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evidence produced for this project (science mapping in Biblioshiny). Five conclusions emerge. First, research output has grown from 10 documents in 2017 to 301 in 2025, with a cumulative citation count of 88,572. Second, the field is organised around a motor theme of supply chains, decision-making, and artificial intelligence, surrounded by large clusters on sustainability and the circular economy and by smaller clusters on the Internet of Things (IoT), blockchain and resilience. Third, the most cited work is conceptual, review-based or survey-based, and few studies test technology effects with longitudinal or experimental designs. Fourth, scholarship from emerging economies, above all India and China, now dominates by volume, which has shaped the field's attention to adoption barriers and sustainability. Fifth, the field is moving from Industry 4.0 towards Industry 5.0, where resilience, sustainability and human-centricity are treated together. The paper closes with a future research agenda.

Keywords: Supply Chain Management, Industry 4.0, Digital Supply Chain, Sustainability, Circular Economy, Resilience, Blockchain, Internet of Things Artificial Intelligence and Bibliometric Analysis

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36 Application of Operations Research in Customer Satisfaction in E-Commerce

Paper ID V12I5-1253 · Pages 331-345 · Engineering

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This study combines a systematic literature review with a bibliometric analysis to examine research on customer satisfaction and analytics from an Operations Research (OR) perspective in e-commerce. The authors aim to identify publication trends, dominant themes, and the extent to which analytics support OR-based decisions. Data were retrieved from Elsevier's Scopus database and screened using the PRISMA framework, giving a final dataset of 518 articles and 30 review papers. The findings show that the field has grown rapidly since 2018, with machine learning, big data, and sentiment analysis as its dominant themes, while core OR methods remain largely absent.

Keywords: Customer Satisfaction, Operations Research, E-Commerce, Analytics, and Bibliometric Analysis

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37 Application of Operations Research in Financial Risk Management

Paper ID V12I5-1241 · Pages 346-358 · Finance

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Financial risk management has moved from a specialist function to a core part of financial strategy, and operations research (OR) supplies much of its mathematical backbone through optimization, probability modelling, simulation and algorithmic decision support. Existing reviews, however, are organized around a single risk category or industry sector rather than around OR as a methodology, and most stop before the 2024–2026 surge in AI-integrated work. This paper reviews the literature linking OR and financial risk management and complements it with a bibliometric analysis of 260 Scopus documents (227 articles and 33 reviews) published between 2010 and 2026, retrieved with the search string “Risk Management AND Investments AND Analytics” and screened using the PRISMA framework. Performance analysis, keyword co-occurrence and a Callon centrality–density thematic map were produced using Biblioshiny, VOSviewer, Excel and Tableau. The results show a rapidly expanding field, with an annual growth rate of 24.66% and 65.8% of documents published in the last three years. Growth is led by technology rather than by finance-specific themes: machine learning and Industry 4.0 are the motor themes, technology vocabulary accounts for 59.2% of keyword occurrences on the map, and no finance-specific cluster occupies the motor quadrant. The scholarly landscape is also fragmented, with 190 of 218 sources publishing a single document and no author contributing more than three. The paper closes with a future research agenda that calls for structured comparisons of machine-learning models against Value-at-Risk and Conditional Value-at-Risk benchmarks, greater emphasis on explainable AI, sustained interdisciplinary research groups and renewed attention to the OR foundations of risk measurement.

Keywords: Operations Research, Financial Risk Management, Bibliometric Analysis, Value-at-Risk, Machine Learning, Thematic Mapping, Scopus

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38 Applications of Operations Research in Sustainable Supply Chain Optimisation

Paper ID V12I5-1240 · Pages 359-372 · Operations Research

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Operations research (OR) is extensively applied to model cost-emission-resilience compromises in sustainable supply chains, yet the previous literature reviews concentrate mainly on a particular methodological or problematic issue. This article provides a bibliometric analysis of 3,521 Scopus journal articles and reviews published between 2016 and 2027. Bibliometrix tools were used to explore the trends and patterns in the selected literature pieces. The number of papers increased significantly during the timeline, from 77 SCOPUS-indexed documents in 2016 to 803 documents in 2025. A few highly cited documents dominate the distribution, while no single group of authors is more productive than the others. Multi-objective and robust optimisation studies have the largest share of keywords, but the central themes are circular economy, artificial intelligence, and machine learning. According to the identified research frontiers, this article offers a research agenda that consists of six thematic areas and directions of OR applications.

Keywords: Operations Research, Sustainable Supply Chain, Supply Chain Optimisation, Closed-Loop Supply Chain, Bibliometric Analysis

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39 Application of Operations Research in Production Planning

Paper ID V12I5-1251 · Pages 373-385 · Production Planning

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The present review is a systematic literature review-cum-bibliometric analysis of the application of operations research (OR) to production planning and optimisation in manufacturing. The data for the review was procured from Elsevier's Scopus database using the keywords "Production Planning", "Optimization" and "Manufacturing", and was screened using the PRISMA framework. The final database comprises 1,591 articles and review papers published between 2016 and 2026. Using Biblioshiny, the study examines publication trends, leading sources, authorship and the thematic structure of the field. Annual output rose from 75 documents in 2016 to 273 in 2026, an annual growth rate of 13.79%, spread across 568 sources and 5,270 authors. Production control and optimisation, and smart manufacturing and Industry 4.0, were found to be the dominant themes, while sustainability-oriented multi-objective decision making is emerging. The review identifies eight research priorities, including common benchmarks, fair comparison of learning-based and

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classical OR methods, digital twins, human-centric planning and integrated, resilient planning.

Keywords: Operations Research, Production Planning, Optimization, Manufacturing, and Bibliometric Analysis.

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40 AI-Driven Anomaly Detection, Identification and Countermeasures for Unmanned Aerial Vehicles: A Review of Sensor-, Flight-Data- and Counter-UAV-Based Approaches

Paper ID V12I5-1226 · Pages 386-395 · Artificial Intelligence

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Abstract Unmanned aerial vehicles (UAVs) are now used in logistics, agriculture, surveillance and the low-altitude economy, but their growth has created two linked problems: keeping UAVs themselves safe from faults and attacks, and protecting airspace from unauthorized UAVs. This paper reviews 111 studies compiled from seven source papers published between 2019 and 2026 (two comprehensive surveys on counter-UAV sensing and flight-data anomaly detection, one survey on machine learning and large language models (LLMs) for UAV safety and security, and four technical studies). The studies are organized into five areas: (i) multi-sensor detection, identification and localization of hostile UAVs; (ii) physical and cyber countermeasures; (iii) flight-data anomaly detection and recovery; (iv) sensor-malfunction and GNSS-spoofing detection; and (v) vibration-based fault detection and AI-driven safety and security, including LLMs. For each area we summarize the methods, reported accuracy and stated limitations, and compare them in tables. The review shows that deep learning with sensor fusion consistently outperforms single-sensor and classical methods, but that results are hard to compare because datasets differ, anomalies are usually injected artificially, and real-flight validation is rare. We close with a set of research gaps and future directions: public benchmarks, real-flight testing, onboard-efficient models, federated and LLM-based approaches, and joint safety-security frameworks.

Keywords: UAV, Drone, Anomaly Detection, Counter-UAV, Multi-Sensor Fusion, Deep Learning, Reinforcement Learning, GNSS Spoofing, Large Language Models, Flight Data

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41 Uncertainty-Calibrated and Explainable Machine Learning for Early Prediction of Academic Performance and Identification of At-Risk University Students

Paper ID V12I5-1256 · Pages 396-404 · Artificial Intelligence And Machine Learning

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Early identification of students who may experience unsuccessful academic outcomes can support timely academic guidance, provided that predictions are evaluated for both discrimination and reliability. This study

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evaluates a Logistic Regression workflow using the Open University Learning Analytics Dataset (OULAD). Student outcomes were converted to a binary target, with Pass and Distinction treated as successful outcomes and Fail and Withdrawn as unsuccessful outcomes. Models were evaluated at weeks 2, 4, 6, and 8 using student characteristics, enrolment information, and virtual learning environment (VLE) activity. A second configuration added assessment-related features. The best single-split result occurred at week 8 for the activity-plus-assessment configuration (accuracy = 0.7789, F1 = 0.7796, ROC-AUC = 0.8654). Its Brier score and log loss were 0.1463 and 0.4394, respectively. Across confidence thresholds, selective accuracy increased as coverage decreased; at week 8 and a threshold of 0.90, the activity-plus-assessment configuration retained 29.7% of cases with 97.1% accuracy. Across three random seeds, its week-8 mean ROC-AUC was 0.8629 (SD = 0.0029). These findings suggest that later cutoffs and assessment-related information can improve predictive performance in this dataset. However, the availability time of assessment scores must be verified to rule out temporal leakage, and results require external validation before practical deployment.

Keywords: Educational Data Mining, Early Prediction, Student Performance, Logistic Regression, Calibration, Selective Prediction, Explainability, Oulad

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Artificial Intelligence in West Africa: Ethical Governance, Policy, and Institutional Readiness, A Comparative Legal and Institutional Study with Particular Attention to Liberia and Sierra Leone

Paper ID V12I5-1267 · Pages 405-410 · Computer Science

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Ethical governance is central to public trust, development, human rights protection, and the effective delivery of public services. This paper examines the legal and institutional architecture for ethical governance in Sierra Leone, with a comparative focus on Liberia. It considers constitutional accountability, anti-corruption enforcement, public financial management, procurement and concessions, access to information, public-sector ethics, and institutional capacity. The analysis draws on domestic legislation, regional and international instruments, including the United Nations Convention against Corruption (UNCAC), the African Union Convention on Preventing and Combating Corruption, and the African Charter on Human and Peoples' Rights, and selected judicial developments. Sierra Leone's Anti-Corruption Act 2008, as amended in 2019, Public Financial Management Act 2016, Public Procurement Act 2016, and Right of Access to Information Act 2013 provide a broad statutory framework. Liberia's Constitution of 1986, Anti-Corruption Commission legislation, Public Procurement and Concessions Act, and extractive-industry transparency institutions similarly establish formal accountability mechanisms. The paper argues that the main governance challenge is not simply the absence of laws, but the distance between formal rules and consistent implementation. Institutional independence, adequate resources, open contracting, protected whistleblowing, professional civil services, judicial independence, civic participation, and measurable follow-through are therefore essential. It

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recommends a practical implementation agenda for both states, while recognising that their constitutional and institutional contexts are distinct.

Keywords: Ethical Governance, Sierra Leone, Liberia, Anti-Corruption; Rule of Law; Institutional Readiness, Public Procurement, Procurement, Transparency; Accountability, and Public Financial Management.

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43 A Low-Cost Dual-Layer Wastewater Pollution and Toxicity Monitor for MSMEs

Paper ID V12I5-1210 · Pages 411-415 · Enviroinmental Science

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Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) testing is required to monitor pollution load for all medium-scale industrial units that generate process wastewater legally. The incubation period for BOD can be up to five days, which makes it impractical to perform routine testing for micro, small, and medium enterprises (MSMEs), leading to the practice of more frequent pollution monitoring being neglected. In this paper, a cost-field-deployable wastewater screening architecture is proposed, which indirectly estimates BOD and COD by two low-cost proxy measurements. Turbidity, electrical conductivity. The proposed system assumes a 2-sensor input space to enable the full system from acquisition to inference to run on a low-power microcontroller without needing external connectivity. This paper outlines the system architecture, data-collection protocol, candidate regression algorithms, and an evaluation plan using regression metrics compared against statutory discharge limits, placing the system in a position to be a cost-effective early-warning screening device as opposed to a certified laboratory replacement.

Keywords: Wastewater Monitoring, Soft Sensor, Bod Estimation, COD Estimation, Machine Learning, Turbidity, Conductivity, Low-Cost IoT, MSME Pollution Screening, Edge Inference

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Trends in E-Waste Optimization: A Bibliometric Analysis

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Electronic waste (e-waste) optimisation has emerged as an important research area at the intersection of waste management, environmental sustainability, engineering, operations research, materials recovery and digital technology. The present study examines the development of research on e-waste management optimisation through bibliometric analysis and a focused literature review. The research methodology uses Scopus as the sole database and applies the Boolean search string "electronic AND waste AND optimisation" to article titles, abstracts and keywords. The initial search produced 2,562 records. After applying the defined screening criteria for the 2006–2027 period, document type, language and source type, the final dataset contained 1,755 journal articles and reviews. The selection process was designed to maintain a consistent and analysable corpus while preserving the interdisciplinary nature of the field. The data analysis reports 1,755 documents across 624 sources, contributed by 5,889 authors, with an average of 5.08 co-authors per document. Approximately 26.55% of the documents involve authors from more than one country. Publication output accelerated sharply after 2023, increasing from 137 papers in 2023 to 178 in 2024, 300 in 2025 and 450 in 2026. Consequently, the two years 2025 and 2026 alone account for 750 documents, approximately 43% of the dataset. The bibliometric evidence shows rapid growth, expanding interdisciplinarity and increasing attention to battery recovery, sustainability assessment, reverse logistics and digital tools. The central issue for the field is consequently not simply whether an individual technology can recover a material efficiently, but whether the technology can be integrated into a practical system that is environmentally sound, economically viable, socially accessible and scalable.

Keywords: E-Waste Optimisation, Bibliometric Analysis, Materials Recovery, Circular Economy, Reverse Logistics, Digital Technology

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