SHADG 2024

Conference Abstract Proceedings

The International Conference on Safety, Health and Analytics-Driven Governance for Sustainable Development (SHADG 2024)

29th & 30th January 2024

Organized by

Centre of Excellence in Safety Engineering and Analytics (COE-SEA),

IIT Kharagpur

In collaboration with Industry and Academic Partners

SHADG 2024 Academic and Industry Collaborators

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Abstract Proceedings of the International Conference on Safety, Health & Analytics-Driven Governance for Sustainable Development (SHADG 2024)

This book is compiled by COE-SEA team:

Dr. Richa Ahuja ⋆ Dr. Harshad Hemantrao Shrigondekar

Swarnakamal Pradhan ⋆ Gourab Kumar Bagchi ⋆ Sween Josco ⋆ Pritam Ash

Preface

This book contains abstracts of the outstanding research papers accepted for presentation at the international conference on Safety, Health and Analytics-Driven Governance for Sustainable Development (SHADG 2024). Centre of Excellence in Safety Engineering and Analytics (COE-SEA) of IIT Kharagpur successfully organized the conference on 29th & 30th Jan 2024 that brought together many international experts, researchers, and professionals from diverse fields. The conference was organized in collaboration with the industry partners- Tata Steel, Adani Group, and SAIL and the Academic partners which include TRIPC, IIT Delhi, DART lab, IIT Madras, IUINDRR-NIDM, European University Cyprus, Lulia University of Technology, Sweden, and Mary Kay O' Connor Process Safety Center at Texas A&M, US. The IIT Kharagpur Academic partners included Department of Industrial & Systems Engineering, Subir Chowdhury School of Quality and Reliability, Department of Mining Engineering, Department of Chemical Engineering and Department of Humanities and Social Sciences.

The conference was conceived as a platform for disseminating and exchanging ideas, concepts, and results of the researchers from academia and industry to develop a comprehensive understanding of the challenges of the advancements in Safety, Health, and Analytics-Driven Governance for Sustainable Development.

It was planned to bring together stakeholders from various sectors to explore the intersection of safety, health, analytics, and governance in driving sustainable development initiatives. This event was designed to serve as a platform for exchanging ideas, sharing best practices, and fostering collaboration to address contemporary challenges in safety, health, and sustainability.

Total 130 presentations were scheduled in the conference in hybrid mode; however, 102 presentations were made in 2 days. One third of the presentations were by Industry professionals from Tata Steel, Adani, SAIL, NIDM, GAIL, Vedanta, IFFCO, etc. Significant number of industry personnel had attended the conference to listen to various speeches and the research work of others.

This book presents novel contributions to in Safety, Health, and Analytics-Driven Governance for Sustainable Development and serves as reference material for advanced research.

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MS Student, COE-SEA, IIT Kharagpur

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Ph. D. Student, Department of Industrial and Systems Engineering, IIT Kharagpur

Satyajeet Sahoo
Ph. D. Student, Department of Industrial and Systems Engineering, IIT Kharagpur

Suraj Gupta
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Yogesh Kumar Singh
Ph. D. Student, Rekhi Centre of Excellence for the Science of Happiness, IIT Kharagpur

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Sekhar Pal
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Ph. D. Student, Subir Chowdhury School of Quality and Reliability, IIT Kharagpur

Vikram Gupta
Ph. D. Student, Subir Chowdhury School of Quality and Reliability, IIT Kharagpur

Manish Pandit
Ph. D. Student, Subir Chowdhury School of Quality and Reliability, IIT Kharagpur

Event Management

Sween Josco
Project Manager, COE-SEA, IIT Kharagpur

Pritam Ash
Junior Assistant, COE-SEA, IIT Kharagpur

FOREWORD FROM THE ORGANIZING CHAIRMAN & CONVENOR

Prof. Jhareswar Maiti
Organizing Chairman & Convener, SHADG 2024
Chairman, CoE-SEA, IIT Kharagpur

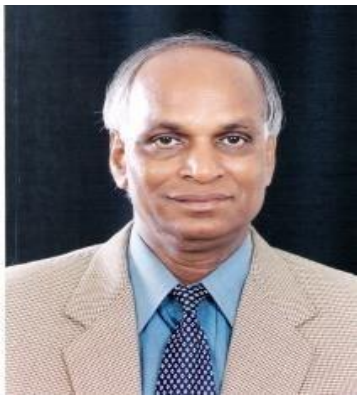
The international conference SHADG 2024, organized by the Centre of Excellence in Safety Engineering and Analytics (CoE-SEA) on January 29 - 30, 2024, was a proud achievement, that provided a platform for exchange of knowledge, ideas, inspiration, and networking among industries, academics, scientists, scholars, etc. SHADG 2024 discussed six unique and inclusive themes in the field of safety, reliability, health, sustainability, human factors, and analytics. This conference provided an enriching experience, as it featured a diverse array of paper presentations, workshops, and panel discussions led by experts from around the world. This conference has helped the attendees, collaborators, and the organisers to understand the state-of-the-art concerns and challenges in achieving sustainable development goals and open doorways to build interventions and strategies to overcome challenges.

This conference proceeding is a collection of abstracts of novel works and best practices that each author has presented to shape a better and safe tomorrow. I dedicate this conference abstract proceedings to all the authors, organisers, collaborators, sponsors, and attendees, to acknowledge their extreme dedication and contributions.

Thank you for your support. Let’s join hands to work together for a safer workplace, society and environment.

Prof. Jhareswar Maiti

FOREWORD FROM THE CONVENOR



Dr. O B Krishna
Convenor, SHADG 2024
Chair Professor,
CoE-SEA, IIT Kharagpur

The mission behind the international conference 'Safety, Health, and Analytics-Driven Governance for Sustainable Development' (SHADG 2024) organized by CoE-SEA, IIT Kharagpur, was to provide an inter and multi-disciplinary forum for knowledge sharing, dissemination, networking, and collaboration in the fields of safety, health, sustainability, human factors, and analytics-driven governance to representatives from various nations, academic institutions, industries, research laboratories, etc. Their contributions made the conference a technically rewarding experience.

The CoE-SEA which was established under the Institute of Eminence (IOE) scheme of Government of India is a unique academic centre in this field, across the world. This addresses all the facets of safety from the engineering to analytics; concept to implementation using advanced techniques, management and analytics. CoE-SEA is successful to help students and practitioners of the industry. This is also visible from the participants and the presentations in the conference.

We present to you this conference abstract proceedings which provides an overview and recap of SHADG 2024. The 99 abstracts presented in this conference proceeding encapsulate the expertise and innovation in the field of safety, health and analytics by various academicians, industry experts, researchers, students, etc. from around the globe. From theoretical frameworks to case studies highlighting best practices in industries, each contribution in this proceeding offers valuable insights to practitioners, academicians, researchers, and safety professionals to advance safety standards in our environment and workplace.

I extend my deepest gratitude to the organizers, partners, presenters, reviewers, and attendees whose collective efforts have made this conference a resounding success.

May this proceeding serve as a catalyst for collaboration, innovation, and initiates.

Dr. O B Krishna

KEYNOTE SPEAKERS

NAME	DESIGNATION & ORGANIZATION	TITLE OF THE SPEECH
Dr. Imitiaz Ali Khan	Director Directorate of Human Space Flight Program Gaganyaan, ISRO	Safety, Reliability and Data analytics: Experiences from Indian Human Spaceflight Programme - Gaganyaan
Dr. Anirudh Gautam	Executive Director Research Designs and Standards Organization	Indian Railways - Transitioning to Predictive Maintenance for higher Safety and Availability
Prof. Kalaga Ramchandra Rao	Professor and MoUD Chair Department of Civil Engineering, IIT Delhi	Pedestrian Safety in the Infrastructure Design
Prof. Geetam Tiwari	Professor, Department of Civil Engineering, IIT Delhi	Traffic Safety Science: Its Current Relevance and Challenges
Prof. Valerio Cozzani	Professor Chemical Engineering, University of Bologna, Italy	Technological Risk deriving from Natural Events: Natech Risk in the Framework of Climate Change
Prof. Santosh Kumar	Senior Advisor National Institute of Disaster Management (NIDM)	Disaster Risk Reduction: Application of Science and Technology Perspective
Dr. Jezdimir Knezevic	Founder and President, MIRCE Academy	MIRCE Science Archive of Safety, Reliability and Maintenance for Analytics-Driven Decisions
Prof. Gopinath Chattopadhyay	Senior Lecturer Maintenance and Reliability Engineering, Federation University, Australia	Asset Risk Management
Prof. Neil Mansfield	Executive Dean, Research and International Reputation, Nottingham Trent University, UK	Predicting and improving the physical environment of future passenger aircraft cabins
Prof. Faisal Khan	Chair Professor and Director, Mary Kay O'Connor Process Safety Center, Texas A&M University	Safety and Security in Energy Transition
Prof. Srinivas Pulugurtha	Research Director, Department of Civil and Environmental Engineering, University of North Carolina, Charlotte	Contemporary Approaches and Trends in Data and Analytics for Enhancing Road Safety

Prof. Gaurav Nanda	Assistant Professor School of Engineering Technology, Purdue University	AI Applications for Improving Injury Surveillance and Safety
Prof. Rajagopalan Srinivasan	Professor, Chemical Engineering Department; Head of the American Express Lab for Data Analytics, Risk & Technology (DART Lab), IIT Madras	Ensuring Worker Safety and Health in Manufacturing through Cognitive Engineering and Analytics
Mr. Sameer Abdul Azeez	Counsellor (Defence Technolgy), Embassy of India, Moscow, Russia	From Coffee Cup Lids to Submarine Command Controls: The Evolving Role & Relevance of Human Factors Engineering
Mr. Rajiv Mangal	Vice President (Safety, Health & Sustainability) Tata Steel Limited	Safety, Emissions, Biodiversity and Circularity- Insights from Tata Steel's Initiatives towards Sustainable Development
Prof. Aurobindo Routray	Professor, Department of Electrical Engineering, IIT Kharagpur	Safety Devices for Operators in critical tasks
Mr. N K Lohia	Managing Director Tara Lohia Pvt. Ltd	The evolution of Fire-Retardant Safety Garments in India
Dr. Birendra Kumar Verma	Joint President and Group Head, Corporate Safety, Adani Enterprises Limited	Analytics Driven Governance Process for Organization Cultural Shift on Health, Safety and Sustainability
Prof. Pradip Kumar Ray	Emeritus Professor, Department of Industrial and Systems Engineering (ISE), IIT Kharagpur	Ergonomic/Human Factors Design of Products in Mechanical Systems Engineering: Few Applications
Prof. Sudip Mishra	Professor Department of Computer Science Engineering, IIT Kharagpur	IoT in Healthcare: Opportunities & Challenges
Mr. Neeraj Kumar Sinha	Chief, Safety Tata Steel Limited	Leveraging Digital & Technology for Influencing Positive Safety Culture
Prof. Siddhartha Mukhopadhyay	Professor, Department of Electrical Engineering; Chairperson, SCSQR and Centre of Excellence for Advanced Transportation, IIT Kharagpur	Looking for the Magic of SURRYA Energy: Into the Pensieve of Data
Mr. Avisek Biswas	Senior Manager, Corporate Safety, Adani Enterprises Limited	Safe Transit- A Journey through Logistics & Road Safety

Prof. Ashis Bhattacharjee	Visiting Professor, IIEST; Former Professor, Department of Mining Engineering, IIT Kharagpur	Whole-body Vibration Exposure and Ergonomic Issues of Heavy Earth Moving Machine Operators in Surface Mines: A Major Health Concern
Dr. Chitta Ranjan	Applied Science Manager, Amazon	Solutions in Complexities- Pushing the Boundaries for Solving Complex Problems in Safety and Health
Prof. A R Mohanty	Professor Mechanical Engineering, IIT Kharagpur	Some perspectives on digital technology for health monitoring of large engineering systems

TABLE OF CONTENTS

PREFACE

ORGANIZING COMMITTEE

FOREWORD FROM ORGANIZING CHAIRMAN AND CONVENOR

FOREWORD FROM CONVENOR

LIST OF KEYNOTES

LIST OF PAPERS

ACOUSTIC-DRIVEN FIRE EXTINCTION PERFORMANCE PREDICTION USING LINEAR REGRESSION AND ENSEMBLE METHODS **20**
AKANSHA AGARWAL[1], BANESWAR SARKER[2], J MAITI[2,3] 20
EVALUATION OF RISK IN ROAD ACCIDENTS: ASSESSING RISK FACTOR AND ROADSIDE FEATURES FOR EFFECTIVE PREVENTION **20**
BANTI SAHU[1], SWARNA KAMAL PRADHAN[2], JHARESWAR MAITI[2,3] 20
BWM INTEGRATED COCOSO METHOD WITH SINGLE VALUED NEUTROSOPHIC FUZZY SETS TO PRIORITIZE THREAT-AGENT TYPES IN CONNECTED AND AUTONOMOUS VEHICLES **21**
BHOSALE AKSHAY TANAJI[1], SAYAK ROYCHOWDHURY[2] 21
ROAD SAFETY ANALYSIS AND RISK ASSESSMENT OF URBAN SCHOOL PROXIMAL ZONES **22**
KSHITIJ JASSAL, RIYA DHIMAN, UMESH SHARMA 22
QUALITATIVE RISK ASSESSMENT OF ROAD CONSTRUCTION ACTIVITIES ON AN INDIAN EXPRESSWAY USING HAZOP **22**
MAHARSHI DUBEY[1], RICHA AHUJA[2] 22
PATTERNS OF FATAL ROAD CRASHES IN DIFFERENT ROAD TYPES: APPLYING ASSOCIATION RULES MINING IN POLICE REPORTED CRASH DATA **23**
SANKHADEEP PRAMANIK[1], JHARESWAR MAITI[1], BHARGAB MAITRA[1] 23
ANALYSING AND PREDICTING ACCIDENT SEVERITY IN ROAD NETWORKS WITH ENSEMBLE MODELS: AN EXPLAINABLE AI BASED APPROACH **23**
ROSHITA BHONSLE[1], SOUVIK DAS[2] 23
NATURAL LANGUAGE PROCESSING-BASED ENSEMBLE TECHNIQUE FOR ENHANCED PROACTIVE POTENTIAL INCIDENT SEVERITY PREDICTION **24**
ARINDAM BARMAN, BANESWAR SARKER, J MAITI 24
RISK ASSESSMENT OF HYDROGEN FOR USE IN HAZARDOUS PROCESS **24**
ABHINEET RAJ, NAVEEN KUMAR, RANADIP DAS, NEERAJ KUMAR SINHA 24
INTELLIGENT RISK ANALYSIS IN PETROCHEMICAL PROCESSES: A TEXT DATA MINING APPROACH FOR HAZOP STUDIES **25**
GOURAB KUMAR BAGCHI, HARSHAD SHRIGONDEKAR, JHARESWAR MAITI 25
TO MITIGATE SAFETY RISK OF AGGLOMERATES DIVISION OF STEEL INDUSTRY THROUGH SYSTEMATIC APPROACH – SAFETY IMPACT CENTRE **26**
MOM MITRA 26

CONSEQUENCE PREDICTION USING MACHINE LEARNING AND DEEP LEARNING: A SYSTEMATIC REVIEW **26**
PREETHA.S, LATHA R NAIR, V.R.RENJITH 26
AN OPTIMIZED PCA-INFUSED KNN BASED APPROACH FOR HORSE INJURY PREDICTION **27**
VARAD INGALE[1], SOUVIK DAS[2], VARUN PATIL[1] 27
PREDICTING THE ELEMENTS OF INCIDENT PATH FROM PROCESS SAFETY REPORTS USING BERT EMBEDDED FEED FORWARD NEURAL NETWORK **27**
SURAJ GUPTA, J MAITI 27
DESIGN AND FABRICATION OF ACOUSTIC ENCLOSURE FOR NOISE CONTROL USING EXPERIMENTAL STUDY OF RECIPROCATING COMPRESSOR **28**
AMIT KUMAR SINGH 28
RELIABILITY CENTRIC SIX SIGMA EVALUATION APPROACH FOR MANUFACTURING PROCESS **28**
ANWESA KAR, RAJIV NANDAN RAI 28
PHYSICS OF FAILURE BASED LIFE CYCLE ASSESSMENT AND PREDICTION OF SRM POWER CONVERTER COMPONENTS: AN APPLICATION, REALISTIC, SUSTAINABLE AND SAFE ELECTRONIC PRODUCT DEVELOPMENT **29**
HITESHREE SURESH SAKHARE, HEERALAL GARGAMA 29
PROPORTIONAL HAZARD MODEL DEVELOPMENT WITH COVARIATES FOR RELIABILITY ANALYSIS OF CUTTING TOOLS. **30**
NEHA PATEL, RAJIV NANDAN RAI 30
APPLICATION OF FUZZY FMEA FOR IMPROVING THE MAINTENANCE PERFORMANCE OF COAL HANDLING SYSTEM **30**
SHUBHAM KUMAR[1], DEEPAK KUMAR KUSHWAHA[2], PRASAD V. KANE[1] 30
RELIABILITY ANALYSIS OF FRICTION STIR WELDED DISSIMILAR JOINTS OF ALUMINUM AND TITANIUM ALLOYS WITH INTERLAYER **31**
SAED ENAM MUSTAFA, RAJIV NANDAN RAI 31
RELIABILITY, AVAILABILITY AND MAINTAINABILITY (RAM) ANALYSIS OF MACHINING LINE AT HEAVY DUTY VEHICLE ENGINE MANUFACTURING **31**
TUSHAR MAHAJAN[1], HEERALAL GARGAMA[1], LOKESH SONAWANE[2] 31
A COMPREHENSIVE REVIEW ON HEAVY METAL CONTAMINATION IN WATER, ITS RISK AND REMOVAL **32**
B SHANKAR NARAYANAN, NITHYA GOPINATH 32
EXPLORING THE CHANGING FACE OF DIABETES IN INDIA: INSIGHTS FROM NATIONAL FAMILY HEALTH SURVEY DATA USING CONCENTRATION INDEX **33**
BHAVANA BARMAN[1] , HARI K. CHOUDHURY[1] , PRATAP C. MOHANTY[2] , HIRANYA K. NATH[3] 33
INTERVENTIONS AND CERVICAL CANCER PREVENTION: EVIDENCE FROM AN EXPERIMENT **33**
HARI K. CHOUDHURY, RUPAK KUMAR BORAH, BHAVANA BARMAN 33
ADDRESSING GLOBAL HEALTH CHALLENGES: A COMPREHENSIVE FRAMEWORK FOR DETERMINANTS OF HEALTH **34**
SAKSHI GUPTA, NEERAJA LUGANI SETHI 34
TRANSFORMATIVE APPROACHES IN HEALTHCARE: LEVERAGING LARGE LANGUAGE MODEL FOR PERSONALIZED DRUG RECOMMENDATIONS **35**
SATYAJEET AZAD[1], LUCKY KUMARI[2], SUMANT AZAD[3], RAJ KUMAR[4] 35
ADVANCING MUSCLE AND JOINT HEALTH DIAGNOSTICS WITH INTELLIGENT sEMG ANALYTICS FOR EARLY DETECTION OF KNEE DISORDERS **35**
VIDYAPATI KUMAR AND DILIP KUMAR PRATIHAR 35
DYNAMIC RISK ANALYSIS OF HYDROGEN STORAGE FACILITIES **36**

ABHINA SAJEESH, E S NAVEEN KRISHNA, NANDANA P K, KARTHIK RAJEEV, ANISH JOB KURIAN 36
CONTROLLED PRODUCTION QUANTITY RELEASE APPLICABILITY DETERMINATION METHOD 37
ZUBAIR MOHAMMED[1], JAMES FREELAND[2], NAGARAJU SOMA[1], DANISHUDDIN S.F. QUADRI[1] 37
A COMPREHENSIVE ANALYSIS OF RISK AND CHALLENGES IN THE SECOND LIFE OF LITHIUM-ION BATTERIES FOR SUSTAINABLE ENERGY STORAGE 37
MADHWIKA AND JHARESWAR MAITI 37
MODELLING, ANALYSIS OF NOVEL LOW-COST AND RELIABLE SINGLE MPPT CONTROL OF HYBRID SOLAR PV AND THERMOELECTRIC GENERATOR SUPPLYING ISOLATED DC MICROGRID 38
PAQUIANADIN V, JAIN VINITH P. R, NAVIN SAM K, SUDHA RANI A AND KOPERUNDEVI G 38
ENVIRONMENTAL REGULATION, PRODUCTIVITY, AND POLLUTION IN INDIAN MANUFACTURING FIRMS 39
PRANTIK BAGCHI[1] AND SANTOSH KUMAR SAHU[2] 39
AN ANALYSIS OF THE FACTORS INFLUENCING BLOCKCHAIN TECHNOLOGY ADOPTION IN GREEN SUPPLY CHAIN 39
VINEETHA P[1], PRC GOPAL[1], KOUSHIK MONDAL[2] 39
PATTERN GENERATION FOR A SUSTAINABLE ONE-DIMENSIONAL STOCK CUTTING WITH LIMITED USAGE OF UNIQUE STANDARD LENGTHS AND UNIQUE PATTERNS FOR MINIMIZING OVERALL TRIM LOSSES AND COST 40
SANTANU BANERJEE[1], ARAVIND ASOKAN[2], ARCHANA BHARATEE[2], SNEGHA A[2] 40
STRATEGIC SUPPLY CHAIN MANAGEMENT FOR CULTURAL EVENTS: A CASE STUDY OF CENTRALISED DISTRIBUTION OF TEMPORARY INFRASTRUCTURE IN WEST MIDNAPORE 40
SOURAV SUR AND SUMANA GUPTA 40
DECISION-SUPPORT SYSTEM FOR INVESTIGATION INTO MUSCULOSKELETAL DISORDERS FOR OILSEED FARMERS 41
AKHILESHWARAN E[1], PRASAD P V[1], DIVYA ZINDANI[1], GURDEEP SINGH[2] 41
EXAMINING THE UTILITY OF THE THEORY OF PLANNED BEHAVIOUR IN PREDICTING THE SPEED LIMIT VIOLATION INTENTIONS OF MOTORBIKE RIDERS DURING RAINY WEATHER IN MOUNTAINOUS TERRAIN 42
ANKIT KUMAR YADAV[1], REGULUS D. SHALLAM[2], JAYATI SINGH[1] 42
HUMAN ERROR REDUCTION STRATEGIES-400 KV TRANSMISSION LINE AND SUBSTATIONS 42
KEVIN CHOTHANI 42
MUSCULOSKELETAL DISORDERS AMONG DENTISTS: AN INDIAN CASE STUDY 43
KRITI KARMAKAR, STUTI PARMAR, PRADIP KUMAR RAY 43
VIRTUAL REALITY TO STUDY HUMAN BEHAVIOUR DURING EMERGENCIES: A REVIEW 43
SHAREEQ KADER 43
AN EMPIRICAL INVESTIGATION ON THE ROLE OF COLOUR PERCEPTION IN ACCIDENT CAUSATION 44
ASUTOSH PUSTI[1], SURENDAR VARADHARAJAN[1,2], ANKIT KUMAR YADAV[1] 44
ESTIMATING WEIGHTAGE AND PRIORITIZING MAJOR DOMAINS OF INCLUSIVE EDUCATION ASSESSMENT FRAMEWORK USING ANALYTICAL HIERARCHY PROCESS 45
UMESH KUMAR AND HAIMANTI BANERJI 45
Z-MARCOS BASED CONSENSUAL FAILURE MODE AND EFFECT ANALYSIS 45
ASHISH GARG[1,3], PRAVIN KUMAR[2], J MAITI[3] 45
ANALYTICS DRIVEN GOVERNANCE PROCESS FOR ORGANIZATION CULTURAL SHIFT ON HEALTH, SAFETY AND SUSTAINABILITY 46
BIRENDRA KUMAR VERMA 46
ANALYSIS OF ACHIEVED SAFETY OF A RAILWAY NETWORK USING HISTORICAL ACCIDENT DATA AND COMPARISON WITH ALARP BOUNDARIES 46

DR. RAJA GOUNDAN[1] AND DR. AJEET KUMAR[2] 46
REVOLUTIONIZING HSE WITH TECHNOLOGY AND INNOVATION - A DIGITAL TRANSFORMATION JOURNEY 47
MRS. ISRAA AL-RASHEED, MR. BALA SIVA SRIKANTH ADIVI, MR. SAMI AL-ENEZI, MR. AJI PANICKER, MRS. SUDHARANI S KSHATRIYA, MS FATEMAH AL-BAROUD 47
INTEGRATING SAFETY INFORMATICS AND FORECAST-DECISION-ACTION (FDA) MODEL INTO PROCESS SAFETY MANAGEMENT (PSM) SYSTEM 47
BISWAJIT DAS, ROHIT JOSHI, KRANTIRADITYA DHALMAHAPATRA 47
INFLUENCE OF DIRECTION VECTORS ON AMPLITUDE FACTOR IN GEARBOX VIBRATION SIGNALS UNDER VARYING LOADING CONDITIONS 48
MANISH PANDIT[1], PROF. SANJAY KUMAR CHATURVEDI[1], PROF. RAJIV NANDAN RAI[1] 48
PROCESS SAFETY MANAGEMENT AUDIT FOR MATURITY LEVEL PSM DEPLOYMENT ACROSS ORGANIZATION 49
ABHINEET RAJ, NAVEEN KUMAR, RANADIP DAS, NEERAJ KUMAR SINHA 49
A LOW-COST, REAL-TIME DEVICE FOR REMOTE HEAD IMPACT DETECTION AND KINEMATICS MEASUREMENTS 49
ALAA ALDIN GHAZAL, S. G. GANPULE 49
APPLICATION OF DIGITAL TOOLS FOR REDUCING INCIDENT POTENTIAL – A CASE STUDY 50
KRISHNA NIRMALYA SEN AND GOLLAPALLI MURALIDHAR 50
HUMAN FACTOR ANALYSIS IN STEEL MELTING SHOPS - A CASE STUDY 50
RANADIP DAS, NAVEEN KUMAR, SHRUTI SINGH, ALISHA KUMARI 50
ROLE OF UAVS IN CONSTRUCTION SAFETY MANAGEMENT: A REVIEW 51
POOJA TRIPATHI AND YASH KUMAR MITTAL 51
MICRO HAZARD MAPPING & MANAGEMENT OF WORK AT HEIGHT JOBS BY USING INDUSTRY 4.0 TECHNOLOGY 51
RAKESH PARMAR, PUSHPENDER SHARMA, RAMA SHANKAR DUBEY 51
STRENGTHENING SAFETY OF INDUSTRIAL IOT: ADDRESSING RELIABILITY AND SECURITY GAPS IN THE INDUSTRY 4.0 LANDSCAPE 52
SHIKHA DWIVEDI AND NEERAJ KUMAR GOYAL 52
CKGRAPH: CHATGPT BASED KNOWLEDGE GRAPH FOR HAZARD IDENTIFICATION IN CONSTRUCTION SAFETY 52
SOUVIK DAS[1], SINJANA CHOUDHURI[2], GAURAV NANDA[1] 52
SAFETY MONITORING AND CONTROL IN POWER GRIDS: INTEGRATING GROUND FAULT DETECTION AND ANOMALY DETECTION IN THE IEEE 14 BUS CONFIGURATION 53
DEEPAK PRASAD[1], SWARNA KAMAL PRADHAN[2], JHARESWAR MAITI[2] 53
SAFETY STANDARD KNOWLEDGE DISSEMINATION TO TATA STEEL LIMITED WORKFORCE BY DIGITIZATION APPROACH 54
ANJALI GHOSH AND NEERAJ KUMAR SINHA 54
CASE STUDY ON HSE STRATEGY ROADMAP FOR BUSINESS EXCELLENCE IN GAS BASE POWER PLANT-ONGC TRIPURA POWER COMPANY (OTPC) 55
ARKO GHOSH 55
EXAMINING THE INTENTION TO USE PUBLIC TRANSPORT DURING DAY AND NIGHT-TIME: THE ROLE OF PERSONAL EXPERIENCES AND SAFETY RISKS 55
JAYATI SINGH AND ANKIT KUMAR YADAV 55
SIX STEPS OF LOCKOUT & TAGOUT IN 24MWP SOLAR PV POWER PLANT 56
KEVIN CHOTHANI 56
DOMINO ACCIDENTS IN CHEMICAL INDUSTRIES-REVIEW ON ITS EVALUATION 57

LEKSHMI S LAL AND NITHYA GOPINATH 57
CLIMATE CHANGE IMPACT ASSESSMENT ON RAILWAY INFRASTRUCTURE IN SWEDEN: A COMPREHENSIVE RELIABILITY ANALYSIS 57
AHMAD KASRAEI, A.H.S GARMABAKI, UDAY KUMAR 57
LEARNING THE MOST COMMON CAUSES OF MAJOR INDUSTRIAL ACCIDENTS AND APPLY BEST PRACTICES TO PREVENT SUCH ACCIDENTS 58
RAJENDER DAHIYA 58
DEVELOPING DEEP LEARNING MODELS FOR MULTIPLE COMPONENT-LEVEL FAULT PREDICTION IN DC-DC POWER CONVERTERS 59
AKANKSHA CHATURVEDI, MONALISA SARMA, SANJAY K. CHATURVEDI 59
ADVANCED KNEE POINT DETECTION AND HEALTH MONITORING TECHNIQUE FOR IMPROVED ELECTRIC VEHICLE BATTERY SAFETY 59
NAMRATA MOHANTY, NEERAJ KUMAR GOYAL, V N ACHUTHA NAIKAN 59
BROKEN TOOTH GEAR FAULT DETECTION USING VIBRATION SIGNALS BASED ON CONVOLUTIONAL NEURAL NETWORK 60
PRIYOM GOSWAMI AND RAJIV NANDAN RAI 60
KNOWLEDGE-EMBEDDED MACHINE LEARNING FOR NON-INTRUSIVE VERIFICATION OF WATER FLOW METERS 60
SAPTARSHI DAS, J MAITI, SAYAK ROYCHOWDHURY 60
INCLUSION OF MENTAL WORKLOAD AND VIGILANCE EFFECTS INTO THE EXISTING HUMAN RELIABILITY ANALYSIS MODELS 61
RAAVI ANITHA, NEHA BOYA, SAHITHI VUSKEBAI, LIKHITHA GADDIPATI, SHABNAM SAMIMA 61
PROGNOSTIC MODELLING OF LI-ION BATTERY USING CONVOLUTIONAL LONG SHORT-TERM MEMORY (CONVO-LSTM) 62
SURAJ GUPTA, SIDDHARTHA DAS, J MAITI 62
FATAL OCCUPATIONAL INJURIES IN MAJOR PORTS: STATUS AND TREND ANALYSIS IN INDIA 62
ARKAPRABHA SAU[1], SANTANU PHADIKAR[1], D. K. SAXENA[2], N. VARADHARAJAN[2], K. SRIVASTAVA[2], D. H. ACHAREKAR[2], M.B. KASULLA[2] 62
MULTI-SCALE MODELLING OF TAU PROTEIN: INTEGRATING HOMOLOGY MODELS WITH ATOMISTIC SIMULATIONS AS TO TREAT ALZHEIMER'S DISEASE 63
NOOPUR KHARE[1 2] AND TANVI JAIN[2] 63
AN ANALYSIS OF OCCUPATIONAL ILLNESS AND INJURIES OF THE INDUSTRIAL WORKERS IN SLUMS 64
SHASHWATI BANERJEE AND KISHOR GOSWAMI 64
V-SVM: A VGG19-BASED SUPPORT VECTOR MACHINE FOR EARLY DETECTION OF PARKINSON'S DISEASE 64
ISHITA LUHARUKA[1], ANSH VARSHNEY[1] AND SOBHAN SARKAR[2] 64
CAPTURE AND UTILIZATION OF CO2 IN STEEL INDUSTRY 65
ABHINEET RAJ, NAVEEN KUMAR, RANADIP DAS, NEERAJ KUMAR SINHA 65
RISK ASSESSMENT OF DATA CENTER COOLING SYSTEM BASED ON HAZOP-LOPA 65
MOHANRAJ NIDUMOLU, ANUDESH KUMAR KATIYAR 65
WORKPLACE SAFETY AND RELIABILITY: A SUSTAINABLE HYBRID WORKPLACE MODEL FOR MEDIUM IT PRODUCT COMPANIES OF SOUTH INDIA 66
PRASANNAKUMAR KALAHASTHI, DR USHA N 66
THE IMPACT OF MOBILE PHONE INTERACTION ON DRIVING PERFORMANCE: DRIVING SIMULATOR EXPERIMENT 67

A NAGESWARA RAO[1,2], R JEYAPAUL[1], B CHAITANYA[2], T SAKTHI NAGARAJ[3], K LAKSHMI PADMAVATHI[4] 67
OPTIMIZING WORKPLACE ERGONOMICS IN SAWMILLS: A COMPREHENSIVE STUDY ON MITIGATING MUSCULOSKELETAL DISORDERS THROUGH ERGONOMIC RISK ASSESSMENT 67
JIBIN JAYAN THRIPPUNATH[1], JISHIN JAYAN THRIPPUNATH[2] 67
INVOLVEMENT OF HUMAN FACTORS IN RAILWAY ACCIDENT- SYSTEMIC REVIEW ON HUMAN ERRORS IN RAILWAYS 68
RIDDHIMAN BISWAS 68
PROCESS SAFETY MANAGEMENT IMPLEMENTATION IN OUTSOURCED OPERATIONS & MAINTENANCE VENDORS 69
ABHINEET RAJ, NAVEEN KUMAR, RANADIP DAS, NEERAJ KUMAR SINHA 69
ERGONOMIC RISKS INVOLVED AMONG THE TAXI BIKE DRIVERS IN URBAN CITIES IN INDIA 69
SANG SANGEETA PANDIT, PUSPENDU ADHIKARI, RAJAT KAMBLE 69
BUILDING A SAFETY CASE ARGUMENT IN COMPLIANCE WITH ISO 26262 70
RAHUL PINGALE 70
HAZOP FOR SAFETY CULTURE: A NOVEL SAFETY CULTURE INDEX 70
SINJANA CHOUDHURI, O BALA KRISHNA, J MAITI 70
FUZZY MODEL REFERENCE LEARNING CONTROL FOR HAZARD IDENTIFICATION IN PORT'S MATERIAL HANDLING OPERATIONS AND MAINTENANCE 71
UDHAYAKUMAR PALANIVEL[1] AND RICHA AHUJA[2] 71
HIERARCHICAL IMPORTANCE OF FACTORS LEADING TO ELECTRICAL SAFETY ISSUES IN THE UTILITY INDUSTRIES 71
BEENA PUTHILLATH, BHASI M, BABU C A 71
ENERGY-EFFICIENT LAST-MILE DELIVERIES THROUGH INTEGRATED AUTOMATION OF FREIGHT AND PASSENGER TRANSPORT 72
ADITYA KUMAR, LOKESH KUMAR KALAHASTHI, ABHISHEK ABHISHEK, LAXMAN SINGH BISHT, IVÁN SÁNCHEZ-DÍAZ 72
NANOMATERIALS FOR FIRE RETARDANCY: A REVIEW 72
ANKITH GEORGE MATHEW 72
USE OF BARRIER MANAGEMENT TECHNIQUE TO REDUCE AND MITIGATE HIGH RISK SCENARIOS 73
ABHINEET RAJ, NAVEEN KUMAR, RANADIP DAS, NEERAJ KUMAR SINHA 73
ROADGUARD: AN OPTIMIZED FRAMEWORK TO PREDICT ROAD ACCIDENT SEVERITY OUTCOMES THROUGH HUMAN-ENVIRONMENTAL INTERACTIONS USING K-NEAREST NEIGHBOUR WITH GNN 74
KALPA PANDIT[1], ABHIRUP BHATTACHARYA[1], SOBHAN SARKAR[2], PARICHAY DAS[2] 74
IDENTIFICATION OF THE PATTERNS AND PREDICTION OF OCCURRENCE OF FOREST FIRES USING ASSOCIATION RULE MINING AND CLASSIFICATION TREES 74
ARNAV PATEL[1], BANESWAR SARKER[2], JHARESWAR MAITI[2] 74
LEVERAGING DIGITAL AND FACTORY AUTOMATION WITH HELP OF A CENTRALLY LOCATED INTEGRATED PLANT OPERATION CENTRE OUTSIDE PLANT PREMISES 75
ABHINEET RAJ, NAVEEN KUMAR, RANADIP DAS, NEERAJ KUMAR SINHA 75
ANALYZING OPERATORS' COGNITIVE BEHAVIORS IN MODERN CONTROL ROOMS USING EYE TRACKING 76
HAIDER ALTAF[1], JHARESWAR MAITI[2], BABJI SRINIVASA[1], RAJAGOPALAN SRINIVASAN[1] 76
HUMAN ERROR FACTORS AFFECTING ROAD TANKER LOADING OPERATION IN PETROLEUM AND CHEMICAL STORAGE TERMINAL & PLANT 77

FIRDAUS QUASIM[1] AND ANAND R MARATHE[2] 77
BLAST FURNACE CAPACITY ENHANCEMENT THROUGH ENGINEERING CONTROL WITH COMPREHENSIVE SAFETY MEASURES **77**
ATANU CHATTERJEE 77
ENSURING SAFETY THROUGH ESG: AN ASSESSMENT OF BUSINESS RESPONSIBILITY AND SUSTAINABILITY REPORT **78**
RICHA AHUJA 78
EVALUATION OF PRE-TIMED AND VEHICLE ACTUATED SIGNAL FOR SAFER COMMUTE ON TRANSPORT CHOWK IN CHANDIGARH **79**
KARAN SHARMA[1], RICHA AHUJA[2], ANUBHAV SHARMA[1] 79
SAFETY INVESTIGATION OF DEDICATED CYCLING INFRASTRUCTURE IN CHANDIGARH – A CASE STUDY **79**
KARAN SHARMA[1], RICHA AHUJA[2], ANUBHAV SHARMA[1] 79
COMPARATIVE ANALYSIS OF MAINTAINABILITY ATTRIBUTES OF AN AERO ENGINE **80**
GIRI K, RAJIV NANDAN RAI, SANJAY KUMAR CHATURVEDI 80

APPENDIX A: CONFERENCE SCHEDULE

APPENDIX B: CONFERENCE BROCHURE

Acoustic-Driven Fire Extinction Performance Prediction Using Linear Regression and Ensemble Methods

Akansha Agarwal[1], Baneswar Sarker[2], J Maiti[2,3]

Affiliating Organization: [1]Department of Mechanical Engineering, Indian Institute of Technology, Kharagpur, India; [2]Department of Industrial and Systems Engineering, Indian Institute of Technology, Kharagpur, India; [3]Centre of Excellence in Safety Engineering and Analytics, Indian Institute of Technology, Kharagpur, India.

Email Id: sarker.baneswar1991@gmail.com

Abstract: Acoustic fire-extinguishing system uses sound waves for the safe handling and control of fire accidents. It is necessary to accurately identify and predict the extinction and non-extinction states of the flames based on certain features. Leveraging machine learning, the study classifies the fuel flame extinguishing status based on sound wave analysis, utilizing a dataset from 17,442 experiments based on features namely, flame sizes, fuel type, airflow, decibel, frequencies, and distance range. A Linear Regression-based model is developed to predict the airflow and decibel based on the other variables. The model also determines the nature of relationships between the variables as well as the variable with the largest influence. Employing the voting ensemble technique with its constituent techniques, namely, Decision Tree, Support Vector Machine, K-Nearest Neighbour, Random Forest, and Naïve Bayes, the research compares their performance metrics. It is observed that frequency and distance are the most important predictors of decibel and airflow, respectively. The voting ensemble technique performs better than the other model with an accuracy of 0.97, a substantial improvement on the performance of its individual constituent technique. These findings hold promise for developing robust flame monitoring and decision-support systems.

Keywords: Acoustic Fire extinction system, Linear Regression, Voting Algorithm

Evaluation of Risk in Road Accidents: Assessing Risk Factor and Roadside Features for Effective Prevention

Banti Sahu[1], Swarna Kamal Pradhan[2], Jhareswar Maiti[2,3]

Affiliating Organization: [1]Department of Geology and Geophysics, Indian Institute of Technology Kharagpur; [2]Centre of Excellence in Safety Engineering and Analytics, Indian Institute of Technology Kharagpur; [3]Department of Industrial and Systems Engineering, Indian Institute of Technology Kharagpur

Email Id: bantisahu1307@kgpian.iitkgp.ac.in

Abstract: Roadside features such as slopes, offsets to objects, barriers, and guardrails are responsible for a substantial number of car accident fatalities. This highlights the crucial role of these elements in influencing the frequency and severity of specific types of accidents, particularly run-off roadway incidents. This research aims to delve into the impact of roadside features on road safety and hazard prediction, specifically in the

context of run-off-roadway accidents, with the goal of improving road safety measures and reducing risks. The project introduces an innovative model that addresses key aspects of road safety, focusing on accurate detection of roadside objects and the prediction of accident probabilities. The model's ability to identify objects with precision and estimate the likelihood of accidents demonstrates its potential to enhance safety measures. It provides valuable insights by considering factors like detected objects and their associated accident probabilities, enabling proactive measures to mitigate hazards. Additionally, a severity index is employed to categorize the level of risks. In summary, this project represents a significant advancement in the field of road safety and sets the stage for ongoing innovation in the pursuit of safer roads.

Keywords: Road Safety, Computer Vison, Risk Assessment

BWM Integrated CoCoSo method with Single Valued Neutrosophic Fuzzy Sets to Prioritize Threat-agent Types in Connected and Autonomous Vehicles

Bhosale Akshay Tanaji[1], Sayak Roychowdhury[2]

Affiliating Organization: [1,2]Department of Industrial and Systems Engineering, IIT Kharagpur

Email Id: bhosaleakshay78@iitkgp.ac.in[1], sroychowdhury@iem.iitkgp.ac.in[2]

Abstract: Connected and autonomous vehicles (CAVs) are one of the vital elements in intelligent transportation systems (ITS). CAVs communicate with each other and the environment using wireless communication technologies that increase the cyber-vulnerabilities in the ITS. Different threat-agents implement the variety of cyber-attacks on CAVs. Each threat-agent consists of different resources, capabilities, motivations, and access that must be considered while defending CAVs against different cyber-attacks. This study aims to prioritize the threat-agent types as part of the cyber risk management techniques using a novel Hybrid Multi-Criteria Decision Making (MCDM) framework. Hence, in this study, five different threat-agent types, which are nation-state, cyber-criminal, hacktivist, terrorist, and insider, with five criteria, namely injury or death to personnel, damage to vehicle or public property, degradation of system availability or performance, loss of critical information, loss of cargo using fuzzy multi-criteria decision making (MCDM) are prioritized. For this purpose, we propose a novel multi-criteria decision-making (MCDM) methodology integrating the Combined Compromise Solution (CoCoSo) methodology and Best-Worst method (BWM) under Single-valued neutrosophic fuzzy sets (SVNFS) have been suggested. The proposed technique will provide helpful insights to the cybersecurity decision-maker for optimizing the mitigation techniques against different categories of threat-agent.

Keywords: Cybersecurity, fuzzy MCDM, Connected and autonomous vehicles, threat-agent prioritization, Combined Compromise Solution (CoCoSo)

Road Safety Analysis and Risk Assessment of Urban School Proximal Zones

Kshitij Jassal, Riya Dhiman, Umesh Sharma

Affiliating Organization: Punjab Engineering College (Deemed to be University), Chandigarh

Email Id: jassalkj13@gmail.com

Abstract: Every year over millions of children and young people are killed in road accidents. It is concerning for youngsters because vulnerable road users bear the brunt of traffic collisions. Children are far more vulnerable to road risks than adults due to their smaller stature, developing sense of judgment in traffic circumstances, lack of transportation experience, and mental deficits such as short-term attention deficit disorder. In this study, a Star Rating System was used to conduct a road safety evaluation of three school zones of Chandigarh. The road sections at these school proximal zones were rated out of five stars using the ViDA program, created by the International Road Assessment Programme (iRAP). A set of thirty of both qualitative and quantitative attributes, along with site photographs are coded in the system and sent for review. A star rating of '1' was generated for two schools, and '3' for one school, suggesting that star rating less than three is a severe case of unsafe road and pedestrian crossing. The countermeasures are suggested based on the low severity level to raise the star rating and make it safer for kids and parents to cross the roads.

Keywords: Star Rating, School Proximal Zone, Child-pedestrian safety, Road Safety Assessment

Qualitative risk assessment of road construction activities on an Indian Expressway using HAZOP

Maharshi Dubey[1], Richa Ahuja[2]

Affiliating Organization: [1]Adani group; [2]COE-SEA, IIT Kharagpur

Email Id: maharshi.dubey@adani.com

Abstract: The lack of identification of hazards and moving further towards its sub system i.e. at micro level is a major challenge in road construction industry. The existing methods are only available with identification of macro hazards on a broader scale. By doing micro hazard mapping we are able to identify the hazards, knowing the initiating mechanism, calculation of risks and provide the intervention. Further we will also use HAZOP for road construction process and use different new guidewords to identify the hazards and provide respective safeguards or interventions to minimize the risk. HAZOP is generally used in process industry but here we are applying HAZOP to road construction industry as well.

Patterns of Fatal Road Crashes in Different Road Types: Applying Association Rules Mining in Police Reported Crash Data

Sankhadeep Pramanik[1], Jhareswar Maiti[1], Bhargab Maitra[1]

Affiliating Organization: Indian Institute of Technology Kharagpur

Email Id: sankhadeepp97@gmail.com

Abstract: Road crashes and resulting fatalities are a major public health concern, especially in developing countries, due to the challenges related to engineering, education, enforcement, etc. Road safety issues vary with respect to different functional categories of roads (i.e., National Highways (NH), State Highways (SH), and in roads other than NH or SH). In this regard, the present study finds the patterns among fatal road crashes and how they differ for different road categories. A total of 20,556 police-reported crash data between 2020 to 2023 from the state of West Bengal, India, has been utilised to find these patterns. The key findings explored through association rules mining suggested a variation among the associated factors behind a fatal crash in different categories of roads. These findings could be useful for making necessary interventions and policy decisions related to road safety based on a particular road category.

Keywords: Road safety, Association Rules Mining, Crash data analysis, Road type

Analysing and Predicting Accident Severity in Road Networks with Ensemble Models: An Explainable AI based approach

Roshita Bhonsle[1], Souvik Das[2]

Affiliating Organization: [1]Vishwakarma Institute of Technology, Pune, India; [2]Purdue University, West Lafayette, USA

Email Id: roshita1608@gmail.com

Abstract: Worldwide, there has been a sharp increase in traffic accidents that cause injuries and often result in fatalities. Initiatives to reduce this figure are therefore becoming more and more necessary. Machine learning models can facilitate the examination of the many factors that influence the incidence of traffic accidents. Using the road traffic dataset of Addis Ababa City, Ethiopia, this study analyses factors responsible for road traffic accidents and predicts the severity of road traffic injuries. Five ensemble models were utilized in the analysis, namely Random Forest, LightGBM, XGBoost, and AdaBoost, and hyperparameter optimization was implemented to enhance the efficiency of the models. The comparison results show that XGBoost is the best classifier with 92.43% accuracy, 92.57% precision, 92.43% recall, and 92.43% of F1-Score. Model explainability techniques such as Permutation Feature Importance, SHapley Additive exPlanations (SHAP) and Local Interpretable Model-agnostic Explanation (LIME) have been employed to interpret the performance of the XGBoost model.

Keywords: Accident Severity Classification, Explainable AI, Tree-based ensemble models, XGBoost

Natural Language Processing-based Ensemble Technique for Enhanced Proactive Potential Incident Severity Prediction

Arindam Barman, Baneswar Sarker, J Maiti

Affiliating Organization: Department of Industrial and Systems Engineering, IIT Kharagpur

Email Id: sarker.baneswar1991@gmail.com

Abstract: In an effort to mitigate occupational hazards and promote proactive safety measures in workplaces, this study explores the application of ensemble learning and natural language processing (NLP) techniques to analyze potential incident severity. Although the utility of machine learning (ML) techniques is established in the occupational accident domain using reactive data, its exploration in predicting incident severity using proactive data, especially combining text reports and categorical features, is comparatively new. Based on the Fatality Risk Control Programme (FRCP) road safety data collected from an integrated steel plant, our study focuses on classifying incidents into different categories of severity. Dealing with unstructured texts and class-imbalanced data poses a significant challenge. To deal with the class imbalance in our dataset, we apply the Synthetic Minority Over-sampling Technique (SMOTE). We extracted insights from text data through NLP techniques and incorporated categorical features, developing a rich feature set. An ensemble model is developed employing six prediction algorithms: Decision tree, Random Forest, Naive Bayes, Support Vector Machine, Extreme Gradient Boosting, and AdaBoost. Utilizing bagging learning and probabilistic fusion approaches, the ensemble model employs the Maximum Voting Ensemble, specifically Soft Voting, yielding a robust classification. By integrating these techniques, the study presents a novel approach to anticipate accident severity beforehand, allowing authorities to take proactive interventions for improved workplace safety, thus offering a comprehensive framework for enhancing safety protocols in industrial settings.

Keywords: Ensemble Learning, NLP, Accident Severity Prediction, Proactive Safety

Risk Assessment of Hydrogen for Use in Hazardous Process

Abhineet Raj, Naveen Kumar, Ranadip Das, Neeraj Kumar Sinha

Affiliating Organization: Tata Steel Limited

Email Id: abhineet.raj@tatasteel.com

Abstract: CO2 emissions in BF-BOF based steel industry is mainly attributed to usage of coal as a fuel & reducing agent for smelting of iron ore. This results in emission of approximately 1.80 tons of CO2 per tonne of hot metal. In line with fuel rate reduction in iron making through blast furnace route, alternate fuel injection, alternate reductants are being practiced in different parts of the world. Most of these also are hydrogen rich. These injectants also lead to reduction of CO2 footprint, thereby participating in carbon direct

avoidance (CDA). Considering the same, effort was made to inject pure hydrogen in one of its blast furnaces.

Project Description: Trial was carried out with hydrogen injection via 4 tuyeres in one of the blast furnaces. Main objectives of this revolves around learning usage of hydrogen and are listed as follows: Hydrogen handling and safety concerns Basic engineering Plant technology requirements Suitability and compatibility of injection hardware. Achievements: Our company became 1 to inject such large volume of hydrogen in any Blast Furnace. During Hazop, 52 number of high-risk scenarios were identified and mitigated at the design phase itself Hydrogen Injection is one of the key strategies of our company in the decarbonisation journey. The endeavour is aligned with the Company's vision of becoming Net Zero by 2045 kick started with this project The trial has the potential to reduce the coke rate by 10%, translating into around 7-10% reduction in CO2 emissions per ton of crude steel produced saving millions of money. Very encouraging process results were observed during the trial and team learnt Safe handling/managing hydrogen injection in Blast Furnace. The process sees hydrogen substituted in for carbon as the reducing agent in the extraction process at 40% of the furnace's injection systems.

Intelligent Risk Analysis in Petrochemical Processes: A Text Data Mining Approach for HAZOP Studies

Gourab Kumar Bagchi, Harshad Shrigondekar, Jhareswar Maiti

Affiliating Organization: Centre of Excellence in Safety Engineering and Analytics, IIT Kharagpur

Email Id: bagchigourab@gmail.com

Abstract: This research presents a comprehensive methodology leveraging text data mining techniques on Hazard and Operability (HAZOP) data to intelligently analyze emerging petrochemical processes. The approach involves extracting topic information related to deviations, causes, and consequences, enabling the intelligent forecasting of overall risk levels for potential abnormal events. Utilizing Natural Language Processing (NLP) with the TF-IDF approach, features determining outcomes are transformed into feature vectors from sentences in the HAZOP study worksheet. Various machine learning models, including KNN, Random Forest, Decision Tree, Support Vector Machine, Gradient Boosting, Neural Networks, and an Ensemble model, are applied to predict overall risk for each node. The results showcase the efficacy of the proposed methodology, demonstrating improved accuracy through KNN classifiers compared to other models. Hyperparameter tuning further enhances the performance of the KNN-classifier. This research contributes to prioritizing nodes, examining accident patterns, and supporting HAZOP analysis for enhanced safety in petrochemical processes.

Keywords: Petrochemical Processes, Text Data Mining, HAZOP Analysis, Intelligent Risk Forecasting

To Mitigate Safety Risk of Agglomerates Division of Steel Industry Through Systematic Approach – Safety Impact Centre

Mom Mitra

Affiliating Organization: Tata Steel Limited, Jamshedpur

Email Id: mom.mitra1@tatasteel.com

Abstract: Protecting the safety and health of everyone who works in the steel industries is of vital importance. Steel industries have been categorized as one of the most hazardous industries and fatalities and lost time injuries are of concern to leadership. In steel industries who have imbibed in safety excellence journey, Lost time injuries have decreased over a period, while fatalities remain a concern. The major causes of LTI in past three years has been slip/trip/fall, manual tasks and tools, falling objects and material handling. For achieving zero harm the organization has imbibed on six strategies namely: (1) Building leadership strategy; (2) Enhancing competency and capability (3) Improvements in process safety management; (4) Contractor safety management; (5) Rail and Road Safety (6) Occupational Health Safety. A cause-effect diagram was also used to logically organize possible causes for injuries.

Keywords: impact centre, risks

Consequence prediction using machine learning and deep learning: A systematic review

Preetha.S, Latha R Nair, V.R.Renjith

Affiliating Organization: Cochin University of Science and Technology (CUSAT), Kochi

Email Id: preethas@cusat.ac.in

Abstract: Machine learning plays a significant role in enhancing process safety across various industries, especially in sectors such as manufacturing, oil and gas, chemical processing, pharmaceuticals, and more. The accurate prediction of consequences is vital in emergency response and risk assessment, especially in scenarios involving fire, explosions, and the potential impact on nearby facilities, infrastructure, and communities. This paper offers a comprehensive guide to Machine Learning (ML) applications in predicting the consequence especially in industries. The paper navigates the extensive ML landscape, categorizing tasks, models, and algorithms. It reviews past ML applications in these fields, emphasizing the rise of Deep Learning. It highlights ML's potential for better insights from accident data, aiding decision-making and accident prevention. Looking ahead, it outlines opportunities for ML in enhancing reliability and safety measures. Overall, it asserts ML's capacity to innovate and improve the consequence prediction domain significantly.

Keywords: Consequence prediction, Machine learning, Deep learning, Fire and Explosion, Toxic gas dispersion

An Optimized PCA-Infused KNN based Approach for Horse Injury Prediction

Varad Ingale[1], Souvik Das[2], Varun Patil[1]

Affiliating Organization: [1]Vishwakarma Institute of Technology, Pune, India; [2]Purdue University, USA.

Email Id: varad.ingale20@vit.edu

Abstract: In today's athletics, injury prevention is essential. Horse racing and other animal-related sports are comparable to those played by humans. Movement efficiency is often related to enhancements in performance and injury avoidance. Data on the horse's heart rate, EKG, longitudinal movement, dorsal/ventral movement, medial/lateral deviation, total power, and overall landing vibration are among the many measurements that are currently being taken. The aim of this study is to better understand the relationship between equine performance and well-being for racing horse owners, trainers, and veterinarians. This paper focuses into data preprocessing techniques, including One Hot Encoding for categorical values, K-Means Clustering for horse injury prediction, and Principal Component Analysis (PCA) for dimensionality reduction. we have determined that KNN is the best performing model for our derby data. Results indicate high accuracy and reliability, offering valuable insights for horse owners and jockeys in optimizing race selections. This research contributes to the broader field of data-driven decision-making in the domain of horse racing and lays the foundation for future studies in equine sports analytics.

Keywords: Classification, Clustering, KNN, Injury, Machine Learning, Principal Component Analysis

Predicting the Elements of Incident Path from Process Safety Reports Using BERT Embedded Feed Forward Neural Network

Suraj Gupta, J Maiti

Affiliating Organization: Department of Industrial and Systems Engineering, Indian Institute of Technology Kharagpur

Email Id: suraj.gupta20@kgpian.iitkgp.ac.in

Abstract: Despite the established efficacy of machine learning (ML) in predicting future outcomes across various domains such as maintenance, healthcare, and automobiles, its utilization in the safety domain remains largely unexplored. A significant challenge encountered by industries involves identifying latent hazardous elements, initiating mechanisms, and their associated accident paths. Nonetheless, the full integration of analytics and machine learning to automatically categorize accident path elements using ML approaches is yet to be firmly established. Effective implication of machine learning techniques in the safety domain aids management in automatically identifying and labeling accident path elements, leading to significant time savings, eliminates manual

labeling errors and facilitates the deployment of precise risk control systems to avert potential accidents in future. Considering the aforementioned issues, this study transformer-based feed forward neural network to automatically classify the different topics from text data pertaining to process safety reports. The results of the study have also been compared to the state-of-the-art machine learning algorithms such Kernel Support Vector Machine (Kernel SVM), Multinomial Naive Bayes (MNB), XGBoost Algorithm, as well as Feed Forward Neural Networks (FFNN), to identify the efficacy of the proposed model. Finally, the results of the study shows that the proposed model other models significantly producing much better results in terms of various performance measures. The case study was conducted using a dataset from a steel plant.

Keywords: Bert-Embedded feed forward neural network, Accident path prediction, Process safety, Machine learning.

Design and Fabrication of acoustic enclosure for noise control using experimental study of reciprocating compressor

Amit Kumar Singh

Affiliating Organization: Indian Institute of Technology, Kharagpur

Email Id: amit2021@kgpian.iitkgp.ac.in

Abstract: The objective of this experimental investigation is to assess the effects of an acoustic enclosure for a high-pressure centrifugal pump, which is utilised to lower its noise emissions situated in a research laboratory. The compressor was producing a noise level of about 90dB which was causing difficulties to the personnel working in the lab. The

noise level limit for laboratories recommended by central pollution control board (CPCB) standards is 65dB. An acoustic enclosure needed to be designed and fabricated to reduce the noise level. The existing noise level and temperature emitted were experimentally measured. Based on this data, dimensions were worked out. An enclosure was designed and fabricated to meet the requirements. The enclosure consists of hardwood as panel absorbers, nitrile rubber as porous absorbers and a lid working on the principle of Helmholtz resonators. The sound pressure level dropped by around 22%-25% dB throughout almost the whole test frequency range, confirming the high-pressure reciprocating pump enclosure's amazing noise reduction ability.

Keywords: Acoustic enclosure, noise reduction, temperature distribution, sound pressure level

Reliability Centric Six Sigma Evaluation Approach for Manufacturing Process

Anwesa Kar, Rajiv Nandan Rai

Affiliating Organization: Subir Chowdhury School of Quality and Reliability, Indian Institute of Technology Kharagpur

Email Id: anwesakar@iitkgp.ac.in

Abstract: The failure to achieve the product's design reliability, stemming from manufacturing quality variations, results in an elevated defect count and subsequent customer dissatisfaction, highlighting the necessity for a reliability-centric quality evaluation approach. This paper presents an integrated Six-Sigma evaluation framework quantifying the potential increase in failures within a fleet of one million units over time t for not meeting the design reliability requirement. Firstly, the system design reliability is determined through reliability modelling of components. Secondly, the achieved reliability is computed using a mathematical model that incorporates variations in quality due to component non-conformance and assembly errors. Next, the discrepancy between the design and achieved reliability is used to calculate the quality of the manufacturing process in terms of Six-Sigma metric. Further to this, a modified bath-tub curve is proposed that illustrates the relationship between quality and reliability and computing the additional number of failures the organization can expect specifically during the burn-in phase of the product due to the manufacturing variation. A sensitivity analysis is conducted to demonstrate the fluctuation of defects per million opportunities (DPMO) with the hazard rate considering manufacturing variation.

Keywords: Product reliability, Six Sigma, Quality variation, bath-tub curve, DPMO

Physics of Failure based Life Cycle Assessment and Prediction of SRM Power Converter components: An Application, Realistic, Sustainable and Safe Electronic Product Development

Hiteshree Suresh Sakhare, Heeralal Gargama

Affiliating Organization: Subir Choudhury School of Quality and Reliability, IIT Kharagpur

Email Id: hiteshreesakhare@kgpian.iitkgp.ac.in

Abstract: Electronics, including those utilized in the energy, aerospace, and communication sectors, frequently have demanding reliability standards. Power electronic converters play a crucial role in the functioning of Switched Reluctance Machines (SRMs). Over recent years, various configurations and designs have been created to cater to specific applications of SRMs, enhancing control strategies, expanding performance capabilities, enabling fault-tolerant operations, and addressing other relevant aspects. This paper throws a light on the Simulation Assisted Reliability Assessment (SARA) approach to enhance electronic product development. Traditional physical testing for reliability is noted for its drawbacks, including time consumption and potential design delays. The SARA approach leverages simulation techniques to replicate physical tests virtually, aiming to reduce time to market and development costs while improving reliability. The scope of simulation includes replicating anticipated use and test conditions, identifying failure mechanisms, and estimating time to failure. The paper discusses failure mechanisms, provides methods for time to failure estimation, and presents a analysis on a components used in power converter including drive circuit of 4 phase Switched reluctance motor (SRM). Overall, SARA offers a more efficient and cost-effective solution for virtual qualification in electronic product development.

Keywords: Life cycle assessment, SRM power converter, SARA, physics of failure

Proportional Hazard Model Development with Covariates for Reliability Analysis of Cutting Tools.

Neha Patel, Rajiv Nandan Rai

Affiliating Organization: Subir Chowdhury School of Quality and Reliability, Indian Institute of Technology Kharagpur, India

Email Id: neha845888@gmail.com

Abstract: In machining operations, the reliability of cutting tools is critical for minimizing downtime, preventing sudden breakages, and enhancing overall productivity. This research examines four key factors that influence the lifespan and reliability of the cutting tools by employing the proportional hazard model (PHM). Initially main and interaction effect graphs are plotted to analyze the variability of the key factors on tool life with the help of time to failures (TTF) data of the cutting tools followed by data fitment through probability distribution plots. However, this analysis did not provide sufficient information on variability of factors that significantly influence the cutting tools' lifespan. To address this problem, the paper performs a PHM analysis using the key factors as covariates forming a maximum likelihood equation. The equation is then solved using "fsolve" to determine likelihood parameters. Reliability and hazard rate plots are generated to evaluate these factors' impact on tool life. The reliability and hazard curves reveal drastic changes in wear-out conditions of the cutting tools at the highest levels of the key factors. This research aims to establish the variability effect of key factors on cutting tools lifespan, developing a PHM based reliability model to provide valuable insights for the machining sector.

Keywords: Cutting Tools, Lifespan, Reliability, Proportional Hazard Model, Maximum Likelihood estimation

Application of Fuzzy FMEA for improving the maintenance performance of coal handling system

Shubham Kumar[1], Deepak Kumar Kushwaha[2], Prasad V. Kane[1]

Affiliating Organization: [1]Visvesvaraya National Institute of Technology (VNIT) Nagpur; [2]Industrial and Systems Engineering Department, Indian Institute of Technology Kharagpur

Email Id: prasadkane20@gmail.com

Abstract: The maintenance and reliability improvement of various subsystems and their equipment is the most important for uninterrupted operations and optimal efficiency in a power generation plant. This study give emphasis to the comprehensive framework that integrates qualitative and quantitative analysis which pinpoints the critical components and comprehend the causes of failure which impacts the overall effectiveness and longevity of the coal handling system. In this work Fuzzy Failure Mode and Effect Analysis

(FFMEA) model is proposed for the thorough examination of the coal handling system process, data collection, and risk assessment. To overcome the limitations of conventional FMEA, the proposed method suggests employing Fuzzy Risk Priority Number (FRPN) for prioritizing and evaluating potential failures within the coal handling system of a thermal power plant. A comparative analysis between traditional FMEA and FFMEA is presented which helps in the decisions regarding corrective actions, enhancing confidence in maintenance interventions prior to system failures, thereby minimizing system downtime and maximizing operational efficiency. Furthermore, the application of Fuzzy FMEA contributes to selecting corrective actions judiciously, elevating the safety level within the work system.

Keyword:Failure mode and effects analysis (FMEA),Fuzzy FMEA,Fault Tree Analysis (FTA), Coal Handling System (CHS)

Reliability Analysis of Friction Stir Welded Dissimilar Joints of Aluminum and Titanium Alloys with Interlayer

Saed Enam Mustafa, Rajiv Nandan Rai

Affiliating Organization: Subir Chowdhury School of Quality and Reliability, Indian Institute of Technology Kharagpur

Email Id: semustafa@iitkgp.ac.in

Abstract: In this experimental work, friction stir welding (FSW) is carried out to weld the alloys of titanium (Ti6Al4V) and aluminum (6061-T6) with Nickel interlayer, to enhance the mechanical properties of the joint, by reducing the formation of hard and brittle intermetallic of the joints. Two different types of tool pin diameters are considered for experimentation at varying tool rotation and traverse speeds. Tensile strength of the different samples welded is obtained through mechanical testing. By estimating the Weibull parameters using the maximum likelihood method, the reliability of tensile strength of the FSW welded joints is determined. Two-parameter Weibull distribution is found to be well suited for predicting the life of friction welded joints. From the analysis, it is determined that the fracture strength of friction stir welded joint below 149 MPa is found to be most reliable. It is also found 37.55 % of the tested specimen has the fracture strength of 175 MPa.

Keywords: Friction stir welding, nickel interlayer, Weibull, reliability

Reliability, Availability and Maintainability (RAM) Analysis of Machining Line at Heavy Duty Vehicle Engine Manufacturing

Tushar Mahajan[1], Heeralal Gargama[1], Lokesh Sonawane[2]

Affiliating Organization: [1]Subir Chowdhury School of Quality and Reliability, IIT Kharagpur; [2]Cummins Technologies Pvt Ltd, Pune

Email Id: tusharmahajan@kgpian.iitkgp.ac.in

Abstract: In today's dynamic and competitive manufacturing landscape, the pursuit and maintenance of operational excellence stand as imperatives for organizational success. Continuous production is the lifeblood of industries, where the optimal functioning of machines is crucial to meet high demand punctually. Unplanned downtime poses a significant threat to revenue streams. This paper presents reliability, availability and maintainability (RAM) analysis of machining line which consists of 14 machines at heavy duty engine manufacturing plant. Out of 14 machines, 11 machines are sequentially connected for various operations and three machines have parallel redundancy to optimize cycle times. The objective of the present analysis is to address recurring issue of frequent machine failures, and therefore to improve the reliability and availability of machines, as a consequence it will improve overall plant efficiency. To execute the RAM analysis, comprehensive failure and maintenance time data of 14 machines over the period of last one year has been collected from the machining line. Thereafter, data cleaning and analysis approaches has been implemented to evaluate various statistical parameters of reliability and maintainability model. The analysis reveals a comparative analysis of machine breakdown frequency, Reliability, Availability, and Maintainability characteristics across various machines within the manufacturing plant. Additionally, this analysis also includes a reliability versus time plot for individual machines and the overall machining line. Furthermore, the study proposes maintenance intervals based on availability maximization, offering a strategic approach to enhance operational efficiency. The results serve as a valuable guide for finding critical machines, optimizing maintenance practices, minimizing downtime, and ultimately improving the overall reliability of the machinery and processes within the manufacturing facility.

Keywords: Availability, Maintainability, Maintenance Strategy, RAM Analysis, Reliability, Unplanned Downtime

A Comprehensive Review on Heavy Metal Contamination in Water, its Risk and Removal

B Shankar Narayanan, Nithya Gopinath

Affiliating Organization: Cochin University of Science and Technology (CUSAT), Kochi

Email Id: bshankarnarayanan@pg.cusat.ac.in, nithyakrishnang@gmail.com

Abstract: Water is a vital resource that sustains all life on Earth. However, with the increasing population and industrialization, our water sources are becoming more polluted. One of the most concerning pollutants is hazardous chemicals, these can have detrimental effects on both human health and the environment. One of the significant and most common components of hazardous contaminants in water is the heavy metals, which originate from a variety of sources and play a major role in water contamination and posing risk to both environment and life. This review aims to explore the hazardous chemicals present in water, its risk and removal along with a comprehensive study on heavy metal contamination and strategies for its effective removal.

Keywords: Heavy metals, Environmental impacts, Human health, removal methodology

Exploring the changing face of Diabetes in India: Insights from National Family Health Survey Data using Concentration Index

Bhavana Barman[1] , Hari K. Choudhury[1] , Pratap C. Mohanty[2] , Hiranya K. Nath[3]

Affiliating Organization: [1]Indian Institute of Information Technology Guwahati; [2]Indian Institute of Technology Roorkee; [3]Sam Houston State University, Huntsville

Email Id: bhavana.barman@iiitg.ac.in

Abstract: Diabetes is a chronic lifestyle disease associated with serious complications, including blindness, kidney failure, and heart disease. In India, the prevalence of diabetes has been on the rise, leading to a significant burden on public health. By analysing data from the National Family Health Survey (NFHS) rounds 4 and 5, the study seeks to understand the changing landscape of diabetes prevalence regarding the concentration of diabetes among the various sections of the society and its implications for healthcare in India. The incidence of diabetes among various socioeconomic groups was investigated using Concentration Indices and Concentration Curves. In NFHS 4, diabetes prevalence was around 8% in males and 6% in females. In NFHS 5, these rates increased to 9.8% in males and 8.1% in females. Diabetes was more prevalent among individuals over 35 years of age. The concentration indices for diabetes incidence in males and females indicated a trend towards the line of equality, suggesting a shift towards a more equitable distribution of the disease across socioeconomic groups. The calculation of separate concentration indices for all states of India among men, women, urban men & women and rural men & women also shows rapid negative concentration indices for various states. The increasing prevalence of diabetes among economically disadvantaged segments emphasizes the need for targeted interventions and improved awareness, particularly in rural areas. By addressing the changing trends in diabetes prevalence, policymakers can work towards reducing the burden of this chronic disease on individuals and the healthcare system.

Keywords: Diabetes Prevalence, Socioeconomic Inequality, Concentration Index, Concentration Curve, National Family Health Survey

Interventions and cervical cancer prevention: Evidence from an experiment

Hari K. Choudhury, Rupak Kumar Borah, Bhavana Barman

Affiliating Organization: Indian Institute of Information Technology Guwahati (IIITG)

Email Id: hari@iiitg.ac.in

Abstract: Background: Prevention programs have made significant progress in developed countries. However, in low and middle-income countries (LMICs) the risk of cervical cancer is still high due to poor awareness levels among the common masses. Research shows low rates of acceptance of cervical cancer screening programs among women in these regions is one of the contributing factors to the high incidence rate in these countries. This study is an attempt to assess the efficacy of monetary incentives on women's participation in a cervical cancer screening program. Methods: To evaluate the

effectiveness of financial incentives as an intervention in improving women's participation in a cancer screening program, a randomized controlled trial (RCT) was conducted in the Kamrup district of Assam, India. A total of 196 women participated in the awareness campaign, and the participants were randomly categorized using STATA 15 software into three random groups namely a high-incentivized group, a low-incentivized group, and the controlled group. Result: The likelihood of women's participation in a cancer screening program is 76.76 times more for the high incentivized group compared to the control group. The results also indicate the odds in favor of women's participation in a cervical cancer screening program is 4.33 times more for the high-incentivized group compared to the low-incentivized group. Conclusion: The results of the experiment reveal a positive impact of financial incentives as a way of encouraging women to participate in a cervical cancer screening program. Intervention in the form of financial incentives can go a long way to mitigate the major problem of low participation of women in cervical cancer screening programs in developing countries like India.

Keywords: Intervention, Cervical cancer, Randomized Controlled Trial (RCT)

Addressing Global Health Challenges: A Comprehensive Framework for Determinants of Health

Sakshi Gupta, Neeraja Lugani Sethi

Affiliating Organization: University School of Architecture and Planning, Guru Gobind Singh Indraprastha University, Delhi

Email Id: ar.sakshijain@gmail.com

Abstract: In 2021, Niti Aayog recommended a central sector scheme for developing 500 Health Cities by 2030 under the Healthy Cities Programme. This aligns with the WHO's Healthy Cities Programme which was initiated in 1984 to address the global health challenges arising from rapid urbanization and globalization within its six regions. The programme emphasizes the importance of addressing the physical, social and economic determinants of health—the factors that directly or indirectly influence health—for effective policy interventions leading to health promotion. There exists several models and frameworks to comprehend the multifaceted nature of health determinants. While these models have helped shape public health strategies, they exhibit limitations and gaps that hinder a comprehensive understanding of the determinants of health in and evolving globalized world. In this context, this research aims to study the proceedings of ten global conferences on health promotion and the existing models of determinants of health to identify the gaps that necessitate development of an updated comprehensive framework for the determinants of urban health for effective decision making in the face of dynamic global health landscapes.

Keywords: Determinants of health, global health challenges, healthy cities, health inequalities, sustainability, urban health, well-being

Transformative Approaches in Healthcare: Leveraging Large Language Model for Personalized Drug Recommendations

Satyajeet Azad[1], Lucky Kumari[2], Sumant Azad[3], Raj Kumar[4]

Affiliating Organization: [1]Excelinnova Consultancy Services Pvt Ltd, New Delhi; [2]Dr. Yadubir Sinha Homoeopathic Medical College & Hospital, Darbhanga, Bihar; [3]Azad Campus Technology Solutions Pvt Ltd, Bihar; [4]Indian Institute of Technology, Jodhpur Rajasthan

Email Id: satyajeet.dmsiitd@gmail.com

Abstract: In recent years, there has been a surge in research application focused on artificial intelligence (AI) technologies in the medical domain. One area of key interest is the development of AI-based systems to improve the process of drug prescription, particularly in the field of homeopathy. Homeopathy is a holistic approach to medicine that relies on the principle of "like cures like" and symptoms of individuals. This study explores the utilization of large language models(LLMs), specifically generative AI systems, to recommend patient homeopathy drugs based on symptoms and medical history. To achieve this, we develop a comprehensive dataset containing symptom-drug pairs in the domain of homeopathy. The generated response recommendations will be evaluated by medical experts to ensure their correctness and clinical relevance to mitigate the bias generated out of this recommendation systems. The proposed AI system has the potential to greatly enhance and supplement practitioner the efficiency and accuracy of homeopathy drug prescription. By leveraging the large knowledge base encoded within these language models, this AI system can offer personalized drug recommendations tailored to an individual's symptoms. This will not only save time for medical practitioner and professionals, but also facilitate access to accurate and appropriate homeopathy treatments for patients. The potential benefits of such AI system include improved efficiency, accuracy, and accessibility in the field of homeopathy, ultimately leading to better individual patient care and outcomes.

Keywords: Drug Recommendation, Generative AI, Large Language Model, Llama, Artificial Intelligence, GPT-4

Advancing Muscle and Joint Health Diagnostics with Intelligent sEMG Analytics for Early Detection of Knee Disorders

Vidyapati Kumar and Dilip Kumar Pratihar

Affiliating Organization: Department of Mechanical Engineering, Indian Institute of Technology, Kharagpur

Email Id: vidyapatikumar.me@gmail.com

Abstract: Knee abnormalities are a pressing health concern warranting accessible and accurate screening methods. This study proposes an AI-based framework combining electromyography (EMG) and goniometry data with machine learning for enhanced knee

disorder diagnostics. The key novelty lies in harnessing multi-modal physiological signals and advanced ML models for automated, precision screening. Data was collected from 22 subjects performing motions using EMG-goniometry equipment. Preprocessing and feature engineering extracted relevant signal attributes. Numerous ML algorithms including Random Forest, Decision Tree, SVM, ID3, Gradient Boosting, Extra Trees, MLP, XG Boost, and AdaBoost were trained. Extra Trees achieved remarkable training accuracy of 91.70\% and testing accuracy of 92.19\%. It also attained highest testing precision of 0.979 and recall of 0.990. Random Forest achieved training accuracy of 90.12\% and testing accuracy of 92\%. Feature importance analysis revealed Willison Amplitude as most important features of this analysis. This demonstrates the framework's capacity to leverage EMG-goniometry data and ML for robust knee abnormality detection. It offers an accessible and consistent screening methodology to aid early diagnosis. Further refinements and clinical validation will enhance effectiveness as a deployable diagnostic aid.

Keywords: Knee Abnormality Detection, Electromyography, Goniometry, Machine Learning, Artificial Intelligence

Dynamic Risk Analysis of Hydrogen Storage Facilities

Abhina Sajeesh, E S Naveen Krishna, Nandana P K, Karthik Rajeev, Anish Job Kurian

Affiliating Organization: Division of Safety and Fire Engineering, School of Engineering, Cochin University of Science and Technology

Email Id: karthik.rajeev@cusat.ac.in

Abstract: Hydrogen storage facilities are likely to pose critical risk in terms of safety and risk. Since hazards are involved the design for the storage are mostly expensive and lack safety features. This paper aims to conduct dynamic risk analysis of the hydrogen facility to study the effect of hydrogen storage facilities based on the storage pressure, temperature and amount of substance stored. A conventional event tree analysis is done to analyse the frequency of the hazards that are generated from hydrogen storage based on the initial event frequency and individual probabilities and to the end dynamic event tree analysis method is used to analyse the risk associated with dynamic accident sequences as the method helps to provide a support framework for stochastic variations during operations. The result shows that the pressure and amount of substance stored have influence on the storage facility and this method can be used to scenarios not identified by conventional models and can be used as tool to assess the vulnerability of the area surrounding the site.

Keywords: Hydrogen Storage, Conventional Event Tree Analysis, Dynamic Event Tree Analysis

Controlled Production Quantity Release Applicability Determination Method

Zubair Mohammed[1], James Freeland[2], Nagaraju Soma[1], Danishuddin S.F. Quadri[1]

Affiliating Organization: [1]Eaton India Innovation Center; [2]Eaton Corporation

Email Id: MohammedZubair@eaton.com

Abstract: During product development or design change, the aim is to fully validate all potential issues. On programs with significant complexity, it is impossible to fully retire all combinations of risk factors even with comprehensive analysis and testing approaches. These complex projects have the highest risk of launching with hidden defects, resulting in high warranty costs and erosion of customer satisfaction. This paper discusses a conservative approach called Controlled Production Quantity Release (CPQR) to manage the risks of these complex releases or changes by presenting a decision framework executed by a cross-functional team to identify those complex releases that deserve the methodical and monitored approach necessary to manage risk at the beginning of the project. The purpose of this method is to gain early concurrence with the program team with documented decision criteria rather than relying on individual opinions. This proposed method will enhance a team's ability to decide the CPQR applicability. Three scenarios are discussed in this paper to show how this method has helped the team making sound judgement by incorporating the CPQR schedule in project timelines upfront with stakeholders' alignment avoiding program delays and enabling on time quality product launch. This is not intended as a checklist but is intended as a guideline for CPQR evaluation. This method may not be all inclusive dependent upon the specifics of the product application. These CPQR units are not intended to demonstrate reliability for product but for uncovering the system interaction related failure modes.

Keywords: Controlled Production Quantity Release (CPQR), Cost per unit (CPU), Parts per million (PPM), Production Part Approval Process (PPAP), Permanent Corrective Action (PCA), Start of Production (SOP), Months in service (MIS), Program Manager (PM), Supplier Quality Engineer (SQE), Supply Chain Management (SCM), Failure Reporting Analysis and Corrective Action System (FRACAS)

A Comprehensive Analysis of Risk and Challenges in the Second Life of Lithium-ion Batteries for Sustainable Energy Storage

Madhwika and Jhareswar Maiti

Affiliating Organization: Department of Industrial and Systems Engineering, Indian Institute of Technology Kharagpur

Email Id: madhwika.ark@kgpian.iitkgp.ac.in

Abstract: The second useful life of lithium-ion batteries presents a promising avenue for sustainable energy storage solutions, allowing for the repurposing of spent batteries from electric vehicles, using lithium-ion batteries is imported rather than throwing them in the garbage will risk the environment as well as society, the demand of lithium-ion batteries increasing, and renewable energy systems. However, this transition from primary to

secondary use has inherent risks. This abstract explores the multifaceted risks associated with the second life of lithium-ion batteries, focusing on from collection, and dismantling of the retired lithium-ion batteries to ready for a second useful life, degradation, safety concerns, and environmental impact. As batteries undergo a complex interplay of chemical and electrochemical processes during their initial use, their suitability for a second life becomes contingent on various challenges, including capacity fade, thermal runaway, and the potential release of hazardous materials. The work delves into the technological, operational, and regulatory aspects that contribute to these risks, emphasizing the need for robust testing, monitoring, and management strategies to ensure battery safe and efficient utilization in their second life. Balancing the environmental benefits of battery reuse with the challenges and risks involved is crucial for establishing a sustainable and responsible framework for the second useful life of lithium-ion batteries.

Modelling, analysis of novel low-cost and reliable single MPPT control of hybrid solar PV and thermoelectric generator supplying isolated DC microgrid

Paquianadin V, Jain Vinith P. R, Navin Sam K, Sudha Rani A and Koperundevi G

Affiliating Organization: Department of Electrical and Electronics Engineering, National Institute of Technology, Puducherry

Email Id: paquianadin@gmail.com

Abstract: The purpose of this paper is to develop a novel simple, low-cost, and reliable single Maximum Power Point Tracking (MPPT) controller for a hybrid solar Photovoltaic (PV) generator and Thermoelectric Generator (TEG) supplying an isolated DC microgrid for Social and environmental sustainability. This controller requires single Sensing and Signal Conditioning Circuit (SSCC) and digital controller. The isolated DC microgrid with the single MPPT controller can provide electricity to the remote community with less investment cost and improved Mean Time to Failure (MTTF). This isolated DC microgrid with the single MPPT controller is realized by a solar PV generator, TEG, DC-DC converters, SSCC, MPPT controller, and second-life battery packs. The second-life battery packs are employed to form a 48V isolated DC microgrid feeding domestic loads for Sustainable development. The requirement of a single SSCC and digital controller are the major advantages of the proposed MPPT controller for extracting the Maximum Power (MP) from both the solar PV generator and TEG. Thus, the proposed controller requires less cost, consumes less power, simplifies the control complexity, and improves reliability. The modelling, simulation, and control are verified in MATLAB / Simulink environment. Simulation results show that the proposed controller tracks the MP available in both solar PV generator and TEG for various possible operating conditions.

Keywords: Hybrid solar PV generator and TEG, Single MPPT controller, Single sensor, Social and Environmental Sustainability

Environmental Regulation, Productivity, and Pollution in Indian Manufacturing Firms

Prantik Bagchi[1] and Santosh Kumar Sahu[2]

Affiliating Organization: [1]Department of Humanities and Social Sciences, Indian Institute of Technology Kharagpur, Kharagpur; [2]Department of Humanities and Social Sciences, Indian Institute of Technology Madras

Email Id: prantikbagchi95@gmail.com

Abstract: India has become one of the largest emitters in the twenty-first century. To counter the situation lots of environmental policies have been implemented in the last two decades to meet the obligations of the committed targets in the global negotiations. The impact of environmental regulations has shown different impacts on firm performances across various sectors. Since the Indian manufacturing sector is one of the largest contributors to pollution, we check the impact of environmental regulations on productivity at the firm level. Using the CMIE Prowess IQ data and MoEF&CC data, we carry out an empirical analysis to address the issue by validating the Porter Hypothesis. Our findings suggest that environmental regulation adversely affects firm's productivity. We also find that pollutive firms do not perform well in terms of technological advancement and the variation among the firms based on pollution loads becomes more prominent with stringent environmental measures. This leads us to verify the Pollution Haven Hypothesis and Pollution Halo Hypothesis to check the impact of productivity in controlling pollution. Applying, a panel threshold regression model, we find evidence of pollution haven. Thus, India should allow less polluting foreign firms.

Keywords: Productivity, Porter Hypothesis, Pollution Haven Hypothesis

An Analysis of the Factors Influencing Blockchain Technology Adoption in Green Supply Chain

Vineetha P[1], PRC Gopal[1], Koushik Mondal[2]

Affiliating Organization: [1]NIT Warangal and [2]IIT Kharagpur

Email Id: prcgopal@nitw.ac.in

Abstract: In order to reduce the environmental risks, Green Supply Chain has been

emerging as an important organizational philosophy. On the other hand, the ability of Blockchain technology to transform sectors by boosting traceability, transparency, and trust among transaction parties has garnered academic and corporate interest. Blockchain is used in supply chain, particularly in environmentally friendly or green supply chains, which are trending due to environmental concerns, awareness, and regulations. Limited research has been conducted on the potential of blockchain technology in the context of green supply chain management. The present research examines the drivers of blockchain and the challenges in green supply chain that the

technology may be able to assist in resolving, thereby combining these two trending topics using ISM methodology.

Keywords: Blockchain technology, Green Supply Chain, drivers, Interpretive Structural Modelling (ISM)

Pattern Generation for a sustainable One-Dimensional Stock Cutting with limited usage of unique Standard Lengths and unique Patterns for minimizing overall Trim Losses and Cost

Santanu Banerjee[1], Aravind Asokan[2], Archana Bharatee[2], Snegha A[2]

Affiliating Organization: [1]Department of Industrial and Systems Engineering, IIT Kharagpur, [2]B2BOptimize

Email Id: santanu@kgpian.iitkgp.ac.in

Abstract: As we progress into an era plagued by the climate crisis, where the survival of distributed-but-interconnected planetary ecosystems comes closer to risky tipping points forcing eternal oblivion, intelligent approaches to identify and mitigate drivers of such catastrophic change must be set forth and implemented swiftly. A major chunk of the industrial wastes are produced from manufacturing processes and the first step towards reducing this is scrap optimization, the next phases being analysis of the unavoidable scraps to utilize them for further designing. Addressing a part of this problem, we focus on methods to reduce trim-losses implementing sustainability in manufacturing. A deterministic-heuristic approach is suggested to develop good cutting patterns to the classical one-dimensional cutting-stock problem with multiple standard lengths, focusing on minimizing wastage. We assume any extra final cuts may be stored in inventory for satisfying future requirements and develop a stepwise minimization approach of waste (W), cost (C), unique standard (S) length usages, and unique pattern (P) usages for a WCSP optimization idea; each minimization step being connected to the next problem as a constraint.

Keywords: Cutting Stock Problem, Pattern Generation, Sustainability through Waste Nullification, Industrial Manufacturing-Waste Management, Limited usage of Multiple Unique Standard Lengths

Strategic Supply Chain Management for Cultural Events: A Case Study of Centralised Distribution of Temporary Infrastructure in West Midnapore

Sourav Sur and Sumana Gupta

Affiliating Organization: Department of Architecture and Regional Planning, Indian Institute of Technology Kharagpur

Email Id: sur_sourav@iitkgp.ac.in

Abstract: This study focuses on the intricate logistics of managing cultural fairs and festivals in India, focusing on the dynamic sub-urban landscape of West Midnapore, West

Bengal. Although India's rich and diverse cultural events present economic opportunities, the logistical challenges in setting up and dismantling temporary infrastructure for these events are substantial. The prevalent practice incurs significant logistical costs, particularly on the transportation side. This paper proposes a paradigm shift—a centralised system, operating from a single node for the timely supply of temporary infrastructure, aimed at cutting down transportation costs through a sustainable distribution model. The research question addresses the feasibility of developing such a system, fostering a comprehensive examination of its potential benefits. By applying a Vehicle Routing Problem (VRP) framework, the paper offers a strategic solution to enhance efficiency, reduce costs, and promote the reuse of infrastructure thus enabling the creation of a sustainable supply chain. This research contributes to the broader discourse on sustainable event management, offering valuable insights for policymakers, event organisers, and scholars in logistics and cultural studies.

Keywords: Sustainable Supply Chain, Vehicle Routing Problem, GIS Analysis, Transportation Cost, Temporary Infrastructure

Decision-support System for Investigation into Musculoskeletal Disorders for Oilseed Farmers

Akhileshwaran E[1], Prasad P V[1], Divya Zindani[1], Gurdeep Singh[2]

Affiliating Organization: [1]Sri Sivasubramaniya Nadar (SSN) College of Engineering, Kalavakkam, Tamil Nadu, India; [2] IIT Guwahati, Guwahhati, Assam, India

Email Id: zindandivya@gmail.com

Abstract: Agriculture lacks organizational frameworks which are needed for musculoskeletal disorders (MSD) management techniques to operate effectively. Thus, it becomes essential to analyse the magnitude and the severity levels of the MSD problems within the agricultural sector. Hence, an attempt has been made in this study to explore the prevalence of MSD disorders and discomforts amongst the female oilseed farmers of Tamil Nadu in India. At first, MSD issues of the female farmers were analysed based on the literature review and the data was collected by personal interaction and questionnaires. Next, the RULA tool was used to assess the ergonomics involved in various postures taken by the farmers in different oilseed farming processes. Based on the obtained RULA scores and a novel decision-making framework the severity level of the various oilseed farming practices while carrying out oilseed farming has been appraised. The decision-support system has been referred to as q-rung orthopair fuzzy Lance TODIM approach. The findings reveals that the harvesting process (HP) is where the female farmers are adversely affected regarding the MSDs. The findings in this study may have positive implications for extension programs and policy formulation in agricultural sectors.

Keywords: Agriculture, Oilseed farmers, MSDs, RULA, TODIM

Examining the utility of the theory of planned behaviour in predicting the speed limit violation intentions of motorbike riders during rainy weather in mountainous terrain

Ankit Kumar Yadav[1], Regulus D. Shallam[2], Jayati Singh[1]

Affiliating Organization: [1]School of Advanced Engineering, UPES Dehradun, [2]Department of Civil Engineering, Indian Institute of Technology (IIT), Guwahati

Email Id: Jayati.125372@stu.upes.ac.in

Abstract: Speeding behavior is often linked with risk-taking, and significantly increases the likelihood of a crash. Speeding becomes more critical during extreme weather conditions like rainfall and difficult terrains such as hilly regions. This study conducts a survey of motorbike riders to investigate the significant psychological predictors of intentions to violate speed limits during rainy weather in mountainous regions using an extended version of the Theory of Planned Behavior (TPB). A total of 300 responses were captured, out of which 245 responses were considered after removing the erroneous responses. Hierarchical regression analysis was conducted to model the influence of TPB and extension variables on the intention to violate speed limits. Riders' attitudes were found to have the highest impact on their speed limit violation intentions ($\beta = 0.408$, $p < 0.001$). Subjective norms showed a significant negative association with speed limit violation intentions ($\beta = -0.331$, $p = 0.001$), indicating that the more family members and closed relatives do not appreciate riders' speeding intentions, the less likely the rider intends to speed. Overall, the model implied that the extended TPB model successfully predicted 77.2% of the variance in riders' intention to violate speed limits.

Keywords: Speed, Motorbike, Psychology, Intention, Safety

Human Error Reduction Strategies-400 KV Transmission Line and Substations

Kevin Chothani

Affiliating Organization: Sekura India Management

Email Id: kevin_nachiketa@yahoo.com

Abstract: EHV (Extra High Voltage) electrical power transmission substation operation & maintenance activities have significant electrocution and arc flash risks as well as possible environmental impacts e.g. Oil spillage, SF6 leakage etc. Intentional or unintentional deviation/s in substation O&M (Operation & Maintenance) activities, can cause significant injuries to technicians, engineers, or other supporting staff. Also, it can indirectly impact public who are dependent on this power grid in case of grid failure due to fire/explosion. This paper contains four important techniques used to reduce intentional or unintentional deviations in EHV substations operations and maintenance activities: (1) Flagging and blocking, (2) Verification Practices, (3) Recognition based procedure and (4) Competence Assurance. These error reduction strategies helped us to sustain zero harm

culture through proactive tap errors. Focusing on these strategies will also help to sustain existing results and keep incident rate lower than any other similar types of organizations.

Keywords: Human Factors, Error Reduction Techniques, EHV substations

Musculoskeletal Disorders among Dentists: An Indian case study

Kriti Karmakar, Stuti Parmar, Pradip Kumar Ray

Affiliating Organization: Department of Industrial and Systems Engineering, Indian Institute of Technology Kharagpur

Email Id: kritikarmakar@yahoo.in

Abstract: Introduction: Application of ergonomics for dental practitioners is of extreme importance as dentists require high level of physical and mental concentration while providing dental care to the patients. Dental professionals are susceptible to develop variety of occupational diseases and disorders, musculoskeletal disorders (MSDs) being most frequently reported. Long working hours in awkward body postures lead to development of pain in neck, back, shoulders affecting the nerves, muscles, tendons, bones, joints, cartilage, and intervertebral discs. The objective of this study is to calculate the compressive force at L4-L5 discs and stress in the head-neck area in different postures of the dental professionals for recommending preventive measures. Methodology: Data regarding various MSDs and their impact among dental professionals is collected from literature and surgical standards handbooks. Dentists of an Indian hospital were observed while working in a clinical set up and their postures were recorded. A bio mechanical model is developed using CATIA human postural analysis module. Results: The analysis of various postures of the dentists reveals that compression force at L4-L5 in sitting dentistry is much higher compared to standing dentistry while the stress in head and neck area is more in standing dentistry. Conclusion: Good ergonomic work environment is essential so that efficiency and high clinical level of treatment can be maintained throughout the working life of dental professionals. It is found that use of stools and mirrors while operating on a patient will significantly reduce the load on the back as well as the stress in neck area. Exercise disciplines and alternative therapies are also advised and promoted to the dental practitioners in order to prevent occupational MSDs.

Virtual Reality to Study Human Behaviour During Emergencies: A Review

Shareeq Kader

Affiliating Organization: Cochin University of Science and Technology (CUSAT), Kochi

Email Id: shareeqkader@gmail.com

Abstract: The study of human behaviour during emergencies, particularly in the context of fire evacuation, is an important area of research. It allows for the development of effective
strategies and interventions to ensure the safety and well-being of individuals in

emergencies. One innovative approach to studying human behaviour in emergencies is through the use of virtual reality technology. Majority of the fire related fatalities occurred in residential fires and in most of the cases people were aware of the fire early enough to evacuate safely, although, for some reason, they did not. To improve fire safety designs, a deeper understanding of this behaviour is therefore needed. In this review paper the application of virtual reality in studying human behaviour during emergency scenarios is explored. Various studies considered include studying human behaviour during virtual reality residential fire, during a virtual reality tunnel fire scenario, virtual reality crowd evacuation in a shopping mall, during movement through smoke in virtual reality and other studies considering the influence of way finding systems. The outcomes of these studies validate that virtual reality could be used as a method to study human behaviour during emergency scenarios.

Keywords: Human behaviour, virtual reality, crowd evacuation, emergency evacuation

An empirical investigation on the role of colour perception in accident causation

Asutosh Pusti[1], Surendar Varadharajan[1,2], Ankit Kumar Yadav[1]

Affiliating Organization: [1]School of Advanced Engineering, UPES, Dehradun and [2]Dr. B R Ambedkar National Institute of Technology, Jalandhar, Punjab

Email Id: vsurendar1990@gmail.com

Abstract: The present study aims to examine the complex associations between color perception, emotions, behavior, and unsafe acts. The following three hypotheses were tested: (1) if emotions are linked with color; (2) if behavior is correlated with emotions; and (3) if unsafe acts are affiliated with behavior. A questionnaire survey was conducted, and a range of colors were presented to industry officials. To encapsulate diverse emotional responses, the color categories included primary, secondary, and tertiary colors, along with their shades and hues. Participants were prompted to express their emotional reactions after being presented with color stimuli via a standardized questionnaire intended to capture a wide range of emotions, both negative (e.g., sadness and anger) and positive (e.g., excitement and happiness). The chi-square tests were conducted to statistically analyse the data and test the hypotheses. By finding a significant relationship between colour, mood, and behaviour, the study supports the claim that colour can be used as a tool to influence human behaviour, thereby reducing the occurrence of unsafe acts. This has far-reaching implications for several fields, including safety management, where colour can be used strategically in the design of workspaces, equipment, and signage to evoke emotions that encourage safer acts.

Keywords: Color, Reaction, Unsafe act, Industry, Accident

Estimating Weightage and Prioritizing Major Domains of Inclusive Education Assessment Framework using Analytical Hierarchy Process

Umesh Kumar and Haimanti Banerji

Affiliating Organization: Department of Architecture and Regional Planning, Indian Institute of Technology Kharagpur

Email Id: umesh.kumar@iitkgp.ac.in

Abstract: Inclusive education, imperative globally, addresses the challenges faced by a substantial population with disabilities. The principles of human factor engineering, centered on creating a holistic, safe, and sustainable environment, directly align with mainstreaming persons with disabilities. Quality education, a vital aspect of Sustainable

Development Goals, enhances societal resilience. In India, the absence of facilities, inclusive infrastructure, and a barrier-free environment hampers inclusive school achievement. This study contributes to an ongoing investigation, creating an assessment framework for successful inclusive education in Delhi's elementary schools. After consensus analysis with 25 experts through two rounds of fuzzy Delphi, 33 assessment indicators were derived across 7 domains. Indicators are previously prioritized by MCDM methods (TOPSIS, GRA, RIDIT), this research now aims to prioritize and assign weights to the seven major domains using the Analytical Hierarchy Process (AHP). A paper-based survey gathered 71 responses from educational professionals. Results highlight the highest weightage for "Availability of appropriate resources (21.4%)" and the lowest for "Teacher's Attitude (7.9%)". Future work involves developing an assessment framework for effective inclusive education, utilizing the research's priorities and weights to enhance budgeting, strategic planning, and policymaking for inclusive schools in India.

Keywords: Inclusive Education, Children with Disabilities, Priority Ranking, Weightage, Analytical Hierarchy Process (AHP)

Z-MARCOS based consensual failure mode and effect analysis

Ashish Garg[1,3], Pravin Kumar[2], J Maiti[3]

Affiliating Organization: [1]HCL Technologies Ltd., Bengaluru, India, [2]URBAN Company Pvt. Ltd., Bengaluru, India, [3]Centre of Excellence in Safety Engineering and Analytics, Indian Institute of Technology, Kharagpur

Email Id: ashish.gargnitt@gmail.com

Abstract: In this article, we have investigated the failure mode and effect analysis model with the concept of consensus and Z-numbers. Z-numbers are employed to effectively model the uncertainty and reliability of the risk assessment information. To compute the similarity between Z-numbers, a Z-cosine similarity measure is proposed. A Z-number-based consensus model (Z-CM) is defined to check the consensus level among the experts. Finally, a risk prioritization scheme is proposed by extending the MARCOS (Measurement

of alternatives and ranking according to COmpromise solution) method in the Z-environment. The feasibility and applicability of the proposed model are checked through a real-world case study. The results have also been compared with the existing state-of-the-art models. The results confirm that the proposed model can effectively model the uncertainties and improve the credibility and acceptability of the results and the final decisions.

Keywords: Z-numbers, Risk Assessment, Consensus, Similarity Measure, MARCOS

Analytics Driven Governance Process for Organization Cultural Shift on Health, Safety and Sustainability

Birendra Kumar Verma

Affiliating Organization: Adani Enterprises Limited, Ahmedabad

Email Id: BirendraKumar.Verma@adani.com

Abstract: One of the biggest pillars in implementing a successful safety management system is leadership mindset transformation and commitment. In view of generating new practices through synergic approach to create values to build resilience and sustainability and to propagate a culture of care towards all stakeholders, analytics driven governance process plays a vital role in safety improvement strategy. Various Safety Performance Indicators, Management Information System (MIS) which defines system effectiveness and weaknesses along with technology interventions, decision support systems, planning, policies, and processes which facilitate mass involvement and ownership on safety improvement which helps in generating a robust safety excellence model for any organization to keep pace with business expansion and embedding resilience at every level. This colossal amount of data generated at grassroots holds potential to revolutionize strong governance processes by building a foundation for data backed decision making. Therefore, such structured data must be combined with detailed analysis through various statistical techniques to become a world class leader in nation building and sustainable value creation.

Keywords: Technology Interventions, Safety Management System, Safety Performance Indicators, Statistical Techniques, Analytics Driven Governance, Management Information System

Analysis of Achieved Safety of a Railway Network using Historical Accident Data and Comparison with ALARP Boundaries

Dr. Raja Goundan[1] and Dr. Ajeet Kumar[2]

Affiliating Organization: [1]RAMS Consultant, Hyderabad and [2]Mott MacDonald India, Bangalore

Email Id: prgoundan@gmail.com

Abstract: Safety is freedom from unacceptable Risk. In safety analysis therefore we need to benchmark what is acceptable risk. Individual risk has been taken as parameter for safety analysis by European Railways. The acceptable individual risk based on As Low As Reasonably Practicable (ALARP) principle is used to compare Indian railways safety performance with the benchmark values. Past accident data is used in this work. As a starting point we examine the appropriate dimensional unit for individual risk so that comparison with existing international practice can be carried out. We derive the individual risk from accident data of Indian Railways. The effect of impact of Technological intervention such as large-scale Train detection system, Electronic Interlocking, introduction of improved coaches, large scale track renewal, introduction of concrete sleepers is examined and seen to decrease the individual risk of travelling passengers. This methodology can be used for any railway network.

Keywords: Individual risk, ALARP, Railway Safety Works, Risk Metric

Revolutionizing HSE with Technology and Innovation - A Digital Transformation Journey

Mrs. Israa Al-Rasheed, Mr. Bala Siva Srikanth Adivi, Mr. Sami Al-Enezi, Mr. Aji Panicker, Mrs. Sudharani S Kshatriya, Ms Fatemah Al-Baroud

Affiliating Organization: Kuwait Oil Company, Kuwait

Email Id: abssrikanth@gmail.com

Abstract: Organizations have a responsibility to ensure that a safe working environment is always provided for all its employees and to the community. Raising awareness for occupational health and safety and instilling a zero-harm culture is key to achieving that goal. This can be a challenge for large organizations having multinational workforce and having location spread geographically at different sites across Kuwait. Utilizing the Technology through various HSE applications that are accessible in our organization, i.e. Kuwait Oil Company, Kuwait through its intranet can help address this issue by enabling various stakeholders with quick and easy access to relevant information that will help the organization to embark on enhanced performance.

Keywords: HSE, Safety, Technology, Innovation, Analytics

Integrating Safety Informatics and Forecast-Decision-Action (FDA) Model into Process Safety Management (PSM) System

Biswajit Das, Rohit Joshi, Krantiraditya Dhalmahapatra

Affiliating Organization: Indian Institute of Management, Shillong

Email Id: bdas.phdwp22@iimshillong.ac.in

Abstract: After Bhopal gas tragedy (1984), different organisations engaged in oil and gas industries, major hazard industries, chemical process industries, and regulatory bodies of different countries developed and adopted their own PSM framework to deal with various process related hazards and incidents. Process Safety Management (PSM) regulation (29

CFR 1910.119) enacted by Occupational Safety and Health Agency (OSHA) in 1992 is significant one among them. Modern research shows safety informatics and safety intelligence can bring positive improvements in the safety management. To explore the position of safety informatics in PSM system, the current study reviewed different PSM frameworks. Every PSM framework consists of certain elements. Integrating these PSM elements into a framework and supporting them with effective management practices, an organisation manages and enhance its safety performance. An examination of 21 different PSM systems finds 26 distinct elements in them. Notably, none of these elements addresses use of safety informatics and safety intelligence in PSM system. Over time, organisations have introduced new elements to augment effectiveness of their PSM systems. With similar goal in mind, this paper proposes inclusion of a new element, "Safety Informatics" in PSM, along with practicing 'Forecast – Decision – Action' model of accident prevention.

Keywords: Process Safety Management, Safety informatics, Safety intelligence, Forecast–Decision–Action model

Influence of Direction Vectors on Amplitude Factor in Gearbox Vibration Signals under Varying Loading Conditions

Manish Pandit[1], Prof. Sanjay Kumar Chaturvedi[1], Prof. Rajiv Nandan Rai[1]

Affiliating Organization: Subir Chowdhury School of Quality and Reliability, IIT Kharagpur

Email Id: manishpandit614@kgpian.iitkgp.ac.in

Abstract: The condition monitoring of gearboxes is crucial due to their extensive use in various mechanical transmission systems, facing challenges of fluctuating loads and speeds, which can lead to system failure. Vibration analysis is a preferred technique for condition monitoring of the gearbox. This research employs Multivariate Empirical Mode Decomposition (MEMD) to decompose the raw 3D vibration signal into 3D Intrinsic Mode Functions (IMFs) and investigates the influence of direction vectors under varying loading conditions on Amplitude Factor (AF). The methodology involves collecting vibration data at varying loading conditions and using a defined set of direction vectors to decompose the IMFs from the vibration signal through MEMD. The Amplitude Factor (AF) is then calculated using the normalized FFT of IMFs for both faulty and healthy signals at defined operating conditions for each direction vector. The results of this study provide insights into the impact of direction vectors on AF and emphasize the significance of exploring multiple values of direction vectors for gearbox condition monitoring. The findings of this work can be used for further feature extraction and selection, enhancing the understanding of gearbox behavior and improving the effectiveness of condition monitoring techniques.

Keywords: Multivariate-EMD, Direction vector, Amplitude Factor, IMF selection

Process Safety Management Audit for Maturity Level PSM Deployment across Organization

Abhineet Raj, Naveen Kumar, Ranadip Das, Neeraj Kumar Sinha

Affiliating Organization: Tata Steel Limited

Email Id: abhineet.raj@tatasteel.com

Abstract: We conduct half yearly Process Safety Management audit to check the PSM deployment maturity across organization. The audit is conducted in 50 depts across Tata Steel. Audit scope covers management of change, Interlock bypass, Bow Tie, Barrier Management, Tabletop Exercise, Mock drill, PSI, PHA, Training, PSM linewalk etc. The audit criteria are set with each questions carrying weightage on each of the elements. Based upon the audit conducted by PSM Exemplars, scoring of each depts is provided. Based upon this score, we divide maturity level of departments. The categories are Advance, Established, Evolving and basic maturity stages. Based upon this, each year performance is compared and benchmarked depts which fall under Advance category are awarded on annually. Also, action plan is prepared by each depts to move in next level of maturity.

A Low-Cost, Real-Time Device for Remote Head Impact Detection and Kinematics Measurements

Alaa Aldin Ghazal, S. G. Ganpule

Affiliating Organization: Department of Mechanical and Industrial Engineering, Indian Institute of Technology, Roorkee

Email Id: alaa_ag@me.iitr.ac.in

Abstract: Concussion is a serious public health concern with significant consequences. Most concussions do not involve loss of consciousness and take weeks to diagnose, which extends the recovery time from injuries and reduces the person's life quality. Head kinematics measurements are crucial for rapid on-field diagnosis and decision-making. Current commercial systems are often expensive and lack open-source availability, limiting their accessibility and hindering research. This research presents the design of a wearable, low-cost device for head impact detection and kinematics measurement. This device uses open-source tools and inexpensive off-the-shelf sensors to monitor real-time linear acceleration and angular velocity. It can be attached to a helmet, and data is transmitted over Wi-Fi to a user-friendly web interface for observation and analysis. Its portability and affordability make it accessible for various applications, including sports, military, and industrial settings. This research contributes to the development of accessible and practical tools to aid in diagnosing and managing concussions.

Keywords: Concussion, Health Remote Monitoring, Sensors, Safety

Application of digital tools for reducing incident potential – A case study

Krishna Nirmalya Sen and Gollapalli Muralidhar

Affiliating Organization: L&T Construction, Minerals &Metals SBG

Email Id: knsen@lntecc.com

Abstract: Introduction: Advent of digital technology is influencing human lives and industrial sector is no exception. Usage of various digital application are enabling capturing of deficiencies and facilitating systematic monitoring and enhancement of safety compliances. Leading indicators such as safety observations pivotal in preventing workplace incidents, injuries, & illness. Safety observations, a combination of safe and unsafe acts or conditions at the workplace, helps the management in establishing preventive strategies. Safety observations commensurate with level of risk involved, facilitates prioritisation of efforts for risk mitigation and ensure safer work environment. From the concept of accident pyramid, focusing on at risk-behaviours can have a significant impact on reduction of incident potential. Majority of organisations approach this leading indicator with focus on high-risk observations, analysis of past incidents at a large construction company highlighted the need for paying attention to low and medium severity observations as they contributed to majority of recent incidents. Materials & Methods: To achieve this objective of systematic change and the desired outcomes, various initiatives are taken across the company such as enhanced capturing of safety observations using digital tools with clear focus on low and medium observations, frequent reviews by leadership team, and reward/reprimanding employees to influence the behavioural aspects. Results & Conclusion: With the improved capabilities to capture, analyse and disseminate the safety data on real-time basis has enabled prompt implementation of appropriate safety measures, involvement of leadership and execution staff and increased awareness level has helped in curtailing the high potential observations and the reduction in incident frequency rate across the organization.

Human Factor Analysis in Steel Melting Shops - A Case Study

Ranadip Das, Naveen Kumar, Shruti Singh, Alisha Kumari

Affiliating Organization: Tata Steel Limited

Email Id: shruti.singh1@tatasteel.com

Abstract: This study employs the Human Error Assessment and Reduction Technique (H.E.A.R.T.) to scrutinize the human factors influencing liquid steel crane operations in steel melting shops. Focusing on the intricate relation between operators, design elements, and standard procedures, we uncover critical gaps. Through the H.E.A.R.T. methodology, we not only pinpoint these issues but propose targeted solutions. Our

findings reveal deficiencies in design and operational procedures, impacting operator morale. Recommendations include design intervention, enhanced operating procedures, and strategies for boosting operator morale. This research also brings to focus how contribution of human factors changes with the change in the circle of organization, be it within departments, inter-departments, or inter-organization. As the structure gets complex, human factors become an even more significant contributor in bolstering safety, efficiency, and overall operational resilience.

Keywords: Human Factors, Crane operations, H.E.A.R.T, Safety

Role of UAVs in construction safety management: A Review

Pooja Tripathi and Yash Kumar Mittal

Affiliating Organization: Malaviya National Institute of Technology, Jaipur

Email Id: 2021rar9008@mnit.ac.in

Abstract: Purpose -Construction industry is known as the most dangerous industry because of its complicated design, increasing accident cases, project time and cost limitations. The safety of construction workers on the job site, accident causation factors and preventive measures are mostly emphasized in recent research. Integrating safety management aspects with digital technologies like UAVs, BIM, IOT, VR and AR has the potential to minimize on-site accidents and injuries during construction. Methodology: A systematic literature review with PRISMA methodology has been conducted to understand the role of UAVs in construction safety. The WoS database is used to retrieved the relevant literature. This study also offers a comprehensive analysis of the most recent trends and advancements of using UAVs in the construction sector. Findings: The study has identified the growth of publications, country contributions and different research themes in the subject domain. It also reviews the present status of UAV technology and examines the various drone applications and challenges in adopting UAV on construction site. This research also examines UAV integration with various image and remote sensing technologies with emphasis on data analysis using AI and machine learning techniques. Practical Implications: The results offer a useful resource to help researchers and industry practitioners to understand the advantages and barriers to the adoption of UAVs for construction safety management.

Keywords: Construction industry, Inspection and monitoring, Review, Safety management, Unmanned aerial vehicle

Micro hazard mapping & management of work at height jobs by using industry 4.0 technology

Rakesh Parmar, Pushpender Sharma, Rama Shankar Dubey

Affiliating Organization: Adani Enterprises Limited

Email Id: Rakesh.Parmar@adani.com

Abstract: Work At Height is very essential in almost all the structural buildings of different plants. Despite workers being made aware of the dangers associated with work at height jobs when not using right PPEs with right practices; multiple violations are being observed during supervision. To address this problem, this paper develops an automated computer vision-based method. Hence, the computer vision-based methodology supported by Industry 4.0 technology developed can be used by construction and safety managers as a instrument to proactively identify unsafe behaviour and therefore take immediate action to mitigate the likelihood of a FFH occurring.

Strengthening Safety of Industrial IoT: Addressing Reliability and Security Gaps in the Industry 4.0 Landscape

Shikha Dwivedi and Neeraj Kumar Goyal

Affiliating Organization: SCSQR, IIT Kharagpur

Email Id: shikhadwivedi1969@iitkgp.ac.in

Abstract: In the Industry 4.0 era, the incorporation of Industrial Internet of Things (IIoT) systems introduces challenges in reliability and security, profoundly impacting industrial safety. Inadequacies in reliability lead to device failures and inaccurate data, while security vulnerabilities expose systems to cyber threats, heightening safety risks. The proposed work highlights the critical interplay between security breaches, unreliable data, and device failures, emphasizing their direct impact on IIoT safety. It emphasizes how reliability issues lead to incorrect decision-making, triggering hazardous scenarios, and how security breaches compromise data integrity and amplify safety risks. Proposing a layered evaluation approach across perception, network, and application layers, the research aims to uncover vulnerabilities and strengthen IIoT systems comprehensively. Additionally, we presented a case study on IoT camera safety in remote patient monitoring by outlining the direct impact of reliability and security deficits on safety, it seeks to propose adaptive strategies and frameworks to establish a robust safety infrastructure for secure and reliable IIoT operation in Industry 4.0 ecosystem.

Keywords: Industrial IoT, Safety, Security, Reliability.

CKGraph: ChatGPT based knowledge graph for hazard identification in construction safety

Souvik Das[1], Sinjana Choudhuri[2], Gaurav Nanda[1]

Affiliating Organization: [1]Purdue University, USA, [2]Indian Institute of Technology Kharagpur

Email Id: rndas9@gmail.com

Abstract: At construction sites, various safety hazards exist including falls from heights (FFH), trench and scaffold collapse, electric shock and arc flash/arc blast, and failure to use proper personal protective equipment, which are significant contributors to accidents and fatalities. Construction accident narratives reports which are published regularly by the Occupational Safety and Health Administration (OSHA) contain detailed information about the main causes and leading circumstances of these accidents. However, due to the unstructured nature of the accident narratives, it is hard to extract specific information about the factors causing the hazard. The key knowledge about the factors is often hidden in large blocks of text narratives which are typically collected manually. In this paper, a new knowledge graph construction approach to explore the construction accidents is proposed, aiming to extract a structured information about the hazard triangle factors from the large block of text narratives. ChatGPT, as a recently launched large language model (LLM), has shown promising performance in various natural language processing (NLP) tasks involving analysis of noisy text data. However, their use for extracting linguistic concepts from unstructured text is underexplored. In this study, we propose a novel framework that leverages the power of ChatGPT for extracting knowledge graph of hazardous factors from accident narratives. The proposed framework can extract refined and structural knowledge from the raw accident narratives which can provide an in-depth understanding of the accidents and will help to identify the existing safety risks associated with similar accidents and take preventive actions accordingly to save lives and minimize the risk of injuries.

Keywords: Construction Industry, Accident Narratives, Large Language Model, ChatGPT, Knowledge Graph, Hazard Identification

Safety Monitoring and Control in Power Grids: Integrating Ground Fault Detection and Anomaly Detection in the IEEE 14 BUS Configuration

Deepak Prasad[1], Swarna kamal Pradhan[2], Jhareswar Maiti[2]

Affiliating Organization: [1]Department Of Geology and Geophysics, IIT Kharagpur, [2]Centre of Excellence in Safety Engineering and Analytics, IIT Kharagpur

Email Id: dp9mercy@kgpian.iitkgp.ac.in

Abstract: Anomaly detection plays a crucial role in ensuring the safety and reliability of

power systems. Any abnormal behavior or unforeseen events in these systems can lead to disruptions, outages, or even safety hazards. Current study introduces a comprehensive approach to fortify power system safety by integrating ground fault detection and anomaly detection within the IEEE 14 BUS configuration. With a focus on advancing grid resilience, our research employs fault current analysis and machine learning algorithms for enhanced ground fault detection. This integration aims to minimize the risk of electrical accidents and system-wide failures, aligning with the conference theme of innovative safety solutions. Complementing ground fault detection, anomaly detection using advanced data analytics and real-time monitoring. This dual-

detection strategy creates a robust safety net capable of promptly identifying abnormal behaviors and potential threats within the power system, contributing to proactive risk mitigation.

Keywords: Ground Fault Detection, Anomaly Detection, Electrical Safety

Safety Standard Knowledge Dissemination to Tata Steel Limited Workforce by Digitization approach

Anjali Ghosh and Neeraj Kumar Sinha

Affiliating Organization: Tata steel LImited

Email Id: anjalighosh0@gmail.com

Abstract: Introduction: Safety standards are amalgamation of different national & international OHS legislations and best practices. So, they are generally voluminous, with high technical content and complex to be followed by various employees who are having different literacy and safety maturity level. Tata Steel Limited (TSL) has taken Apex level Safety initiative to make these complex safety standards easily interpretable by these diversified group of working people so that they can apply the safety standard requirements into day-to-day work for achieving zero harm. Design/Methodology/Approach: A Cross Functional Team was formed with TSL domain experts from different functional areas like Operation, Maintenance, Mining, Safety, TQM, Capability Development, IT etc who along with external consultant worked on this project under regular mentorship from Senior Leadership Team to develop easy to refer simplified documents with impactful visual corroborating to real life scenario & multilingual E-Learning modules adopting storytelling and gamification approach. Results and Discussion: All 86 Nos safety standards of TSL which are developed over the years for driving Safety Management System are converted into the learner centric E Learning modules for Steel Industries. Articulate Storyline 360 with industry best features e.g. customized challenges, Quiz Maker, animations, transitions, integrated language packages, with language selection option etc. is used to create a comprehensive SCORM-compliant package. Seamless multidevice learning facility (PC, Laptop, Mobile, Tab etc.) was provided to all TSL employees through Sum Total Talent Pro portal which can be accessed anytime, anywhere by TSL workforce 24x7. For assignment of these E learning modules to the workforce based on their specific job requirements, an organization wide extensive mapping exercise was carried out by developing and rolling out an IT system for Safety Standard E Learning module assignment, validation, approval & MIS dashboard for TSL. The completion of required 2 safety standard E Learning modules has been integrated with transfer & promotion policy linked with specific position code of employees. TSL has received Intellectual Property Rights (IPR) for phase#1 of these project and for next phase application is submitted to copyright offices. Conclusions: The compliance to safety standard positively impacts employee's behavior and reinforce positive safety culture in the organization resulting into reduction in accidents and indirect saving of accident costs.

Keywords: Safety Standards, Safety Training, Safety E-Learning

Case study on HSE Strategy Roadmap for Business Excellence in Gas Base Power Plant-ONGC Tripura Power Company (OTPC)

Arko Ghosh

Affiliating Organization: ONGC Tripura Power Company

Email Id: arkoghosh03@gmail.com

Abstract: The case study delves into OTPC's proactive Health, Safety, and Environment (HSE) strategies aligned with their business plan. It highlights the crucial objectives across various domains: worker safety, environmental impact mitigation, public health considerations, regulatory compliance, operational efficiency, and risk management. OTPC emphasizes rigorous safety protocols, environmental assessments, community engagement, and strict adherence to regulations to ensure operational continuity and excellence. The HSE Strategy Roadmap outlines clear objectives, regulatory compliance measures, technological integrations like IoT and AI, comprehensive employee training, and transparent reporting mechanisms for continuous enhancement. The study underscores technological advancements in IoT, AI, and data analytics for real-time monitoring, risk prediction, and continuous improvement. Additionally, it focuses on fostering a culture of HSE excellence by emphasizing leadership commitment, employee empowerment, communication, and regular training. The integration of technology enhances efficiency and provides insights for continuous improvement while acknowledging the centrality of leadership commitment and employee involvement in HSE success. The way forward suggests continuous review and adaptation of the HSE strategy, collaboration with peers and regulatory bodies, assessment of technological effectiveness, and regular audits to ensure ongoing compliance with HSE standards. Overall, OTPC's proactive approach aims to create a safer, sustainable working environment while meeting regulatory requirements and achieving business excellence.

Examining the intention to use public transport during day and night-time: The role of personal experiences and safety risks

Jayati Singh and Ankit Kumar Yadav

Affiliating Organization: School of Advanced Engineering, University of Petroleum and Energy Studies, Dehradun

Email Id: Jayati.125372@stu.upes.ac.in

Abstract: The present study examines how the personal experiences and safety perceptions of commuters are linked with their intentions to use public transport during day and night-time. A questionnaire survey was conducted where 320 responses were

captured from all over the country. The survey enquired about the sociodemographic information, safety perceptions while using public transport during day and night, personal experiences related to public transport use (e.g., cleanliness, comfort, satisfaction with respect to frequency and schedule, accessibility, cost-effectiveness, security, safety perceptions of family members, and the duration of public transport use), and intentions to use public transport during day and night-time in future. ANOVA tests were conducted to examine whether there was a significant difference between safety perceptions and intentions during day versus night. Further, separate multiple regression models were developed to identify the significant factors influencing intentions to use public transport during day and night. The safety perceptions for using public transport at night were significantly lower than in the day. The intention to use public transport during the day was significantly higher than at night. The study provides insights to the policymakers and to create more effective plans to enhance the travel experience of commuters while using public transportation.

Keywords: Public transport, Safety; Risk, Perceptions

Six steps of Lockout & Tagout in 24MWp Solar PV power plant

Kevin Chothani

Affiliating Organization: Sekura India Management

Email Id: kevin_nachiketa@yahoo.com

Abstract: Solar Photovoltaic power plant operation & maintenance activities have following possible risks: (1) Electrical shock and arc flash risks while carrying out scheduled and unscheduled repair and maintenance of the electrical panel, and equipment (2) Electrical shock, crush and entanglement risks while carrying out fan and pumps. Intentional or unintentional deviation/s in substation O&M (Operation & Maintenance) activities, can cause significant injuries to technicians, engineers, or other supporting staff. Proper lockout/tagout (LOTO) steps safeguard persons from hazardous energy releases while carrying out operation and maintenance of equipment. This paper

contains six important LOTO steps which are used to reduce electrical shock, fire, explosion, cut, entanglement risks, burns, splash, spill, and other risks which may be due to electrical, chemical, potential, kinetic energy while carrying out equipment maintenance. It is comprehensive step-by-step processes that involve communication, coordination, and training. This method helped us to achieve and sustain zero injuries while hazardous energies exposure. Focusing on these strategies will also help to sustain existing results and keep incident rate lower than any other similar types of organizations.

Keywords: Electrical Safety, Lockout &amp, Tagout, Solar PV Plant

Domino Accidents in Chemical Industries-Review on its evaluation

Lekshmi S Lal and Nithya Gopinath

Affiliating Organization: Division of Safety and Fire Engineering, CUSAT, Kochi

Email Id: lekshmislal2001@gmail.com

Abstract: Domino accidents are common low-frequency, high impact incidents in the chemical process industries. The expansion of the chemical industry has also resulted in the usage of more dangerous compounds, typically at high pressures and temperatures. This increases the risk factors of a certain surgery. The ramifications Successful deliberate assaults on chemical plants can be devastating and can escalate, possibly hurting people and the environment. The risk assessment model is a prime topic to be considered. The risk of chemical industries is estimated using a quantitative risk assessment (QRA) model in this article. This research addresses domino effect accidents (DEAs) and presents the Hierarchical Analyst Domino Evaluation System (HADES) for decommissioning. HADES is distinct from standard DEA risk assessment approaches, which rely heavily on empirical calculations to evaluate the likelihood of risk or harm. The paper's findings show that Natech events and multi-level domino effects can elevate the risk to an unacceptable level, and that suitable mitigation measures can reduce the risk to an acceptable level. Thus, number of evaluation models are discussed and the future scope and technical gaps such as improvement in Natech based domino effects, experimental and simulation methods are required are being highlighted in this paper.

Keywords: Domino effect accidents, QRA, Natech, HADES, hazardous chemicals, Bayesian network

Climate Change Impact Assessment on Railway Infrastructure in Sweden: A Comprehensive Reliability Analysis

Ahmad Kasraei, A.H.S Garmabaki, Uday Kumar

Affiliating Organization: Luleå University of Technology, Sweden

Email Id: uday.kumar@ltu.se, Ahmad.kasraei@associated.ltu.se, Amir.garmabaki@ltu.se

Abstract: The impact of climate change on infrastructures can accelerate their deterioration, affecting functionality, safety, and operation and maintenance (O&M). This study specifically investigates the influence of climate change on railway infrastructure in Sweden. To account for the country's diverse geography, the railway network is categorized into different climate zones using the K-means algorithm. The research proposes a reliability analysis employing the Cox Proportional Hazard Model, which integrates meteorological parameters and operational factors to predict the impact of various climatic conditions on railway infrastructure assets. The methodology's validity is demonstrated by selecting critical components, namely switches and crossings (S&Cs), in different railway stations across varied climate zones in Sweden. The study

examines multiple databases and suggests a climatic feature to identify climate-related risks associated with S&C assets. Additionally, various meteorological covariates are analyzed to better understand the relationship between asset health and meteorological parameters. By identifying vulnerable assets and determining significant covariates, infrastructure asset managers can tailor climate adaptation measures based on geographical location, asset age, and other life cycle parameters. A sensitivity analysis of significant covariates at the railway station reveals a notable variation in asset reliability with an increase in precipitation.

Keywords: climate change, proportional hazard model, reliability analysis

Learning the Most Common Causes of Major Industrial Accidents and Apply Best Practices to Prevent Such Accidents

Rajender Dahiya

Affiliating Organization: SARP Risk Consulting, LLC, Houston

Email Id: sarp.hse@gmail.com

Abstract: Introduction: Investigation outcomes of major process incidents have been consistent for decades and validate that the causes and consequences are often identical. The debate remains – why do we continue to experience similar process incidents even with enormous development of new tools, technologies, industry standards, codes, regulations, and learning processes? The objective of this paper is to investigate the most common causes of major industrial incidents and reveal industry challenges and best practices to prevent such incidents. This section should cover the scope and objective of the extended abstract. A research gap should be concisely described based on a short literature survey. The authors should provide problem statements and key contributions and outcomes of the work. Design/Methodology/Approach: The author in his current role performs audits and inspections of a variety of high hazard industries in North America including petroleum refineries, chemicals, petrochemicals, manufacturing, etc. In this presentation, he will share real life scenarios, examples, and case studies from variety of high hazards operating facilities including key challenges and best practices. Results and Discussion: Failure to identify the hazards and manage the risks of highly hazardous materials and processes is one of the primary root-causes of an incident, and failure to learn from the past incidents is the leading cause of recurrences of incidents. Commonalities in past incidents clearly indicate that there are continuing gaps in the learning process. Several investigations of major incidents discovered that each showed several warning signs before occurring, and most importantly all were preventable. Author will discuss why preventable incidents were not prevented and review the mutual causes of learning failures from past major incidents. Conclusions: This paper will be concluded by sharing how a well implemented operating management system, good process safety culture, and competent leaders and staff in process safety contributed to identifying the hazards and managing the risks to prevent major incidents.

Keywords: process safety, incident investigation, risk management, loss prevention

Developing Deep Learning Models for Multiple Component-Level Fault Prediction in DC-DC Power Converters

Akanksha Chaturvedi, Monalisa Sarma, Sanjay K. Chaturvedi

Affiliating Organization: Subir Chowdhury School of Quality and Reliability, IIT Kharagpur

Email Id: akanksha.chtrvd@iitkgp.ac.in

Abstract: Prognostic and Health Management (PHM) of power converters is imperative for mission and safety-critical applications, enabling early fault detection in power converter components. This study places a primary emphasis on developing fault prediction methodologies, specifically targeting the component level. Addressing the prevalent focus on evaluating individual component degradation through output variables, the research endeavors to uncover intricate component-level prognosis, especially in the context of concurrent degradation in multiple components. Employing deep learning models to monitor the degradation of multiple power converter components, the approach aims at optimizing monitoring costs. Through simulation experiments, the proposed fault prediction methodology is validated, with a closed-loop Single-Ended Primary Inductor Converter (SEPIC) serving as a case study. The study systematically compares the performance of various deep learning models, assessing key metrics such as RMSE, MAPE, and MAE. In essence, this research contributes valuable insights toward enhancing the efficiency and reliability of power converter systems.

Keywords: Power Converter, Component-level Prognosis, Multiple Component degradation, Deep Learning

Advanced Knee Point Detection and Health Monitoring Technique for Improved Electric Vehicle Battery Safety

Namrata Mohanty, Neeraj Kumar Goyal, V N Achutha Naikan

Affiliating Organization: Subir Chowdhury School of Quality and Reliability, IIT Kharagpur

Email Id: namratamohanty@kgpian.iitkgp.ac.in

Abstract: Detecting accurate knee points in electric vehicle (EV) batteries is crucial for ensuring battery safety by identifying critical conditions and potential hazards. Leveraging machine learning (ML) algorithms, including support vector machine (SVM), AdaBoost, neural networks (NN), and proposed novel XGBoost-random forest (XG-RF), the research aims to enhance the reliability of knee point detection using slope change method. Assessment involves absolute error metrics like mean absolute error (MAE) to measure the accuracy of knee point model predictions and mean absolute deviations (MAD) for slope change deviations on dynamic state of health (SOH) curve for different battery chemistries (LFP and NMC) at various temperatures (0°C, 25°C, and 35°C). The proposed XG-RF model consistently outperforms with improved accuracy in identifying critical states. The study's anticipated outcomes extend insights into ML model

comparison, novel metric validation, and a comprehensive understanding of algorithms impacting knee point predictions, ultimately contributing to improved EV battery safety.

Keywords: Knee-point detection, Battery safety, Electric vehicles, Machine learning, State of health

Broken Tooth Gear Fault Detection Using Vibration Signals Based on Convolutional Neural Network

Priyom Goswami and Rajiv Nandan Rai

Affiliating Organization: Indian Institute of Technology, Kharagpur

Email Id: priyom.mechengg@gmail.com

Abstract: Gear systems are integral to diverse industrial applications, demanding reliable performance for operational efficiency and safety. This paper explores Convolutional Neural Networks (CNNs) as potent tools for gear fault detection, addressing the limitations of traditional methods like vibration signal processing and Support Vector Machine (SVM) classification. The experiment for the complete work was conducted at the Indian Institute of Technology, Kharagpur. Vibration signals, generated under various conditions, are subjected to Time-Frequency Resolution (TFR) maps using the Short Time Fourier Transform (STFT). A CNN model is trained on 1800 TFR images representing different operating conditions and gear configurations. The CNN's performance is compared with traditional signal processing techniques and feature-based machine learning models Support Vector Machines (SVM), demonstrating superior fault

classification accuracy without requiring manual feature engineering. The results underscore the efficacy of CNNs in gear fault detection with an accuracy of 98.6% compared to SVM with 90.7% accuracy with SVM using Root Mean Square (RMS) as an input feature. The study identifies hyperparameter tuning and window length optimization for TFR image generation as future research directions. To infer, CNN-based fault detection emerges as a promising and efficient alternative to traditional methods for identifying broken teeth in gears.

Keywords: Gear Fault, Convolutional Neural Networks (CNN), Support Vector Machine (SVM), Wavelet Denoising, Broken Teeth Gear Fault Detection

Knowledge-Embedded Machine Learning for Non-Intrusive Verification of Water Flow Meters

Saptarshi Das, J Maiti, Sayak Roychowdhury

Affiliating Organization: Dept. of I&SE, IIT Kharagpur

Email Id: saptarshi.das@iitkgp.ac.in

Abstract: In the Industry 4.0 era, the critical role of monitoring manufacturing processes is evident, fostering the creation of digital twins through AI and edge computing. This

approach not only enhances process understanding and but also facilitates effective predictive maintenance. The beverage industries face heightened demand for costly flowmeters to monitor the liquid exchange and adhere to regulatory mandates, which are capital intensive. But it is difficult for them to plan a shutdown and thus calibration and periodic maintenance are subjected to time constraints. This study introduces an innovative solution utilizing knowledge-embedded machine learning (KML) for verification of the flow meters using data from other sensors. The integration with the Internet of Things (IoT) incorporates pressure and temperature sensors, and consideration of pipe characteristics, fortifying the system's robustness with historical flow data and physics-based models. The proposed approach reduces dependence on periodic external calibration. Instead, the performance of the flowmeters can be verified at any time instant. Real-time insights facilitate immediate adjustments, marking a transformative shift in flow rate monitoring. This is exemplified through a case study in the clean in place (CIP) plant of a beverage industry, where these advancements bring about tangible improvements in cost-effectiveness, operational adaptability and reduced shut down for maintenance. As industries continue to evolve in the digital age, embracing such methodologies becomes imperative for sustained growth, operational excellence, and adherence to Industry 4.0 principles

Keywords: Industry 4.0, Flow measurement, Artificial intelligence, Condition monitoring

Inclusion of Mental Workload and Vigilance Effects into the existing Human Reliability Analysis Models

Raavi Anitha, Neha Boya, Sahithi Vuskebai, Likhitha Gaddipati, Shabnam Samima

Affiliating Organization: Mahindra University

Email Id: shabnam.samima@mahindrauniversity.edu.in

Abstract: The complexity of today's human machine systems has prompted researchers and practitioners to advocate new approaches to safety. To address the issue, many human reliability estimation methods have been established. However, these methods for addressing technical, human and organizational factors do not fully reflect the cognitive aspects of human behaviour. The human factors examined in this article are vigilance deficits and mental work-load imbalance. To investigate the impact of vigilance and workload, we conducted an innovative exploratory study in the current human reliability analysis (HRA) approaches. We also performed a literature survey for the possibility of including these factors for improving existing HRA approaches. The results revealed that these factors are not explicitly included or taken subjectively which dilutes the overall impact of these important parameters. To overcome the stated limitation, the current work proposes an approach through which these factors can be directly taken from the human and incorporated. Currently, the work limits to discuss the two mentioned factors only, but can be extended for other human factors in similar manner.

Keywords: Human reliability analysis, Performance shaping factors, Mental workload, Vigilance, Human performance

Prognostic Modelling of Li-ion Battery Using Convolutional Long Short-Term Memory (Convo-LSTM)

Suraj Gupta, Siddhartha Das, J Maiti

Affiliating Organization: Department of Industrial and Systems Engineering, Indian Institute of Technology Kharagpur

Email Id: suraj.gupta20@kgpian.iitkgp.ac.in

Abstract: In present times where the entire world is taking a paradigm shift from using conventional fuels to Li-ion batteries, there are certain associated challenges to it. The major challenge being approximating the degradation trends of the battery life. Due to several factors the degradation is subjected to high non-linearity making it difficult for the decision makers to take appropriate measure for battery life cycle management. Thus, based on the aforementioned lacunas this study proposes an innovative methodology that combines two well-established models from distinct domains to form a hybrid model namely one dimensional Convolutional Long Short-Term Memory (1DConvo-LSTM). This hybrid approach aims to provide a robust prognostic solution for predicting the

remaining useful life of Li-ion batteries, offering a novel prescription on the intricate dynamics of the battery degradation. To start with, the proposed study shows cases three different case studies on the battery dataset made available by NASA prognostics center. The first case shows the best suited optimizer having lowest RMSE value at the optimal number of epochs. Following it the second case study shows the application of a feature selection technique with the best optimizer and number of epoch resulted from case 1. Finally in the third case study, we applied dimensional reduction using PCA and compared the results with the two cases. To conclude, the study proposes that 1DConvo-LSTM model with ADAM optimizer at 21 epochs and 4 features selected using mutual information produces the best results. The root mean square error achieved at this combination is 0.0025.

Keywords: Lithium-ion battery, Convolutional-LSTM, Mutual Information, Principal Component Analysis, Prognostics modeling

Fatal Occupational Injuries in Major Ports: Status and Trend Analysis in India

Arkaprabha Sau[1], Santanu Phadikar[1], D. K. Saxena[2], N. Varadharajan[2], K. Srivastava[2], D. H. Acharekar[2], M.B. Kasulla[2]

Affiliating Organization: [1]Maulana Abul Kalam Azad University of Technology, West Bengal and [2]Regional Labour Institute, Kanpur, Directorate General Factory Advice Service and Labour Institutes, Ministry of Labour and Employment, Government of India

Email Id: arka.doctor@gmail.com

Abstract: Occupational safety & health in major ports is a critical aspect of port operations, impacting the well-being of workers and the overall efficiency of port activities. Time series forecasting plays a crucial role in predicting fatal injuries in major ports in India by

providing a systematic approach to anticipate future trends and patterns. By analyzing the results, it enables the identification of future trends, allowing for proactive safety measures and interventions, ultimately enhancing the overall occupational safety environment, and preventing fatal accidents in port operations. In this research article, the numbers of five-year fatal occupational injuries were forecasted and compared by Seasonal Autoregressive Integrated Moving Average Exogenous (SARIMAX), Facebook Prophet and Long Short-Term Memory (LSTM) modelling approach. Data on fatal occupational injuries was collated from 1996 to 2021 as available in the open-source repository of DGFASLI, Ministry of Labour and Employment, Govt. of India. It appears that state of the art machine learning based LSTM model is the best among the three as evidenced by the lowest root mean squared error (RMSE), mean absolute error (MAE), and Mean Absolute Percentage Error (MAPE) on the test dataset. Based on the trained models number of fatal occupational injuries in the upcoming five years (2022-2026) has also been projected.

Keywords: Fatal, Occupational Injury, Major Port, SARIMAX, Prophet, LSTM

Multi-Scale Modelling of Tau protein: Integrating Homology Models with Atomistic Simulations as to Treat Alzheimer's Disease

Noopur Khare[1 2] and Tanvi Jain[2]

Affiliating Organization: [1]Bhai Gurdas Institute of Engineering and Technology, Sangrur, Punjab and [2]Shri Ramswaroop Memorial University, Barabanki, Uttar Pradesh, India

Email Id: tanvi.bt@srmu.ac.in

Abstract: Alzheimer's disease, marked by aberrant Tau protein accumulation leading to brain tangles and neuronal dysfunction, is a focus of therapeutic research targeting tau abnormalities. Homology modeling generated multiple tau protein models validated through Rampage. Molecular docking and dynamics simulations explored flavonoids and alkaloids from Bauhinia variegata as potential inhibitors. UniProt provided the tau protein sequence, and secondary structure estimation employed CFSSP, GOR4, and SOPMA. Validation through Rampage followed structure identification by LOMETS, MUSTER, and MODELLER. Molecular dynamics validated the tau protein-ligand complex. The MODELLER-generated model excelled in the Ramachandran plot. Beta carotene exhibited optimal binding energy (-14.69 kcal/mol) in docking analyses. Molsoft and Molinspiration assessed beta carotene's ADME properties. Stability was observed over 2500 ps in molecular dynamics simulations. In silico findings propose beta carotene as a potential Alzheimer's inhibitor, emphasizing the need for further in vitro and in vivo verification. This study lays groundwork for future Alzheimer's treatments, highlighting beta carotene as a promising subject for further investigation and experimental validation.

Keywords: Multi-Scale Modeling, Tau Protein, Homology Models, Atomistic Simulations, Alzheimer's Disease Treatment

An Analysis of Occupational Illness and Injuries of the Industrial Workers in Slums

Shashwati Banerjee and Kishor Goswami

Affiliating Organization: IIT Kharagpur

Email Id: shashwatieco@gmail.com

Abstract: This study investigates occupational health challenges among slum dwellers in West Bengal, focusing on 17 industries categorized into civil/mechanical, textile, consumable items, and chemical sectors. The research examines the nature and extent of occupational illnesses and injuries, highlighting industry-specific differences. Workers in textile and consumable items industries are prone to chronic illnesses, while those in civil, mechanical, and chemical sectors face a higher risk of acute illnesses, particularly injuries. Factors such as income, religion, job experience, and exposure to high-risk intensities

influence health outcomes. The study also delves into occupational injuries, revealing industry-specific differences and emphasizing the need for tailored safety interventions. Workers in construction, textile, and chemical industries face elevated risks, impacting healthcare expenses. The absence of medical leave and insurance coverage for slum workers demands urgent attention. Injured workers spend 59 percent of their monthly income on out-of-pocket medical expenses. The study recommends a health scheme tailored to industry-specific health risks for better health and sustainable income, emphasizing efficient implementation, management commitment, and safe working conditions. Overall, the research contributes valuable insights for policymakers and practitioners aiming to enhance the well-being of industrial workers in slums.

V-SVM: A VGG19-based Support Vector Machine for Early Detection of Parkinson's Disease

Ishita Luharuka[1], Ansh Varshney[1] and Sobhan Sarkar[2]

Affiliating Organization: [1]Dept. of Chemical Engineering, Indian Institute of Technology Kharagpur, [2]Information Systems & Business Analytics, Indian Institute of Management Ranchi

Email Id: ishitaluharuka@gmail.com

Abstract: Parkinson's disease (PD) is a neurodegenerative disorder characterized by tremors, bradykinesia, and rigidity. Early and accurate diagnosis is crucial for timely intervention and improved patient outcomes. We explore the effectiveness of VGG19, a convolutional neural network architecture consisting of 19 layers, which include 16 convolutional layers and 3 fully connected layers for feature extraction coupled with Support Vector Machines (SVMs) for image classification. Our proposed model leverages the strengths of both techniques: CNNs excel at extracting spatial features from handwritten characters, while SVMs provide

robust classification. We compare our approach to other established ML models which include SVM and CNN individually. Our results demonstrate that the VGG19-SVM combination achieves superior performance in identifying PD cases compared to other models, highlighting the potential of this approach for early and reliable PD detection using readily available handwriting data. This hybrid methodology holds promise for enhancing patient outcomes through timely intervention.

Keywords: Parkinson's disease, Speech, Convolutional neural networks, Reinforcement learning

Capture and Utilization of CO2 in Steel Industry

Abhineet Raj, Naveen Kumar, Ranadip Das, Neeraj Kumar Sinha

Affiliating Organization: Tata Steel Limited

Email Id: abhineet.raj@tatasteel.com

Abstract: Current Scenario: CO is required for GCP water treatment in steel making shops for reduction of TDS (total dissolved solid) from GCP (Gas cleaning plant) water. In this process metallic oxide is converted in to carbonate with help of CO and precipitated out. Methodology: Our company produces slag and part of it is converted to products used in building roads, fly ash bricks etc. and the balance is disposed as waste. Our company intends to utilize this slag waste by carbonization of slag to reduce the disposal costs and to produce value products. For slag carbonation, our company intends to use the CO2 in the stack emissions or any other gas source available within the plant. Fuel gas for CO2 recovery plant is tapped from the gas network. In this process, all impurities like SOX, NOX, and particulate matters are removed from blast furnace gas in pre-treatment section and after that gas is fed to absorber. In pre-treatment section, sodium bicarbonate is used as scrubbing solution. CO2 is adsorbed in amine (CDRMax solvent) in atmospheric and temperature condition from BF gas and CO2 free BF gas is again sent back to system. The solvent selectively absorbs CO2 from the gas mixture. Then CO2 is separated from rich amine solution in stripper at 80- 1000C using steam in reboiler and solvent is regenerated as lean solvent. The generated CO2 is 96% pure on wet basis and more than 99% pure on dry basis. Benefits: Favourable to environment due to reduction of GHG emission, mitigation of climate change through CO capture 1 of its kind to be used in any steel company worldwide Saving of annual costs of 20 million INR. It produces 5 tonnes per day (TPD) industrial plant for carbon capture and utilisation from blast furnace off-gas which helped in reducing freshwater consumption, developing sustainable supply chains, and imbibing circular economy.

Risk Assessment of Data Center Cooling System based on HAZOP-LOPA

Mohanraj Nidumolu, Anudesh Kumar Katiyar

Affiliating Organization: Adani Enterprises Limited

Email Id: mohanraj.nidumolu@gmail.com

Abstract: The data centers are the digital infrastructure that involves high capital and operational costs. A small failure may turn into a catastrophic effect leading to large financial losses. The cooling system maintains optimal operating conditions for servers and information technology (IT) equipment in the data center. It is indispensable for maintaining the reliability, efficiency, and safety of IT operations. In the present work, hazards and operability (HAZOP)-layer of protection analysis (LOPA) techniques are applied to assess the risk associated with the operation stage of the data center cooling

system. The chiller plant manager (CPM) is considered the node with the failure to condition the environment as a deviation. A risk matrix is developed considering severity levels associated with people, assets, environment, and reputation. Based on the outcome of the HAZOPS, three prominent initiating events resulting in the highest risk levels are selected for further assessment using LOPA. Six different independent protection layers (IPLs) considered are temperature sensors, training of operators and procedures, automated control systems, remote monitoring and management, periodic maintenance and inspection, and critical spares available at the site. A detailed risk assessment is presented for the data center cooling system by considering initiating event frequencies, probability of failure on demand (PFD) for each IPL, enabling condition, conditional modifiers, and mitigated frequencies.

Workplace Safety and Reliability: A Sustainable Hybrid Workplace Model for Medium IT Product Companies of South India

Prasannakumar Kalahasthi, Dr Usha N

Affiliating Organization: MS Ramaiah University of Applied Sciences

Email Id: prsnkmr@gmail.com

Abstract: Organizations face myriad challenges to implement a reliable and safe workplace model with flexibility as a future work policy in the post-pandemic period. Employers should identify the influencing factors to enhance workplace safety and health of employees by implementing a hybrid workplace. This study aims to investigate a mediation model of a hybrid workplace for medium-based IT product companies. This research considers Moonlighting, Work Engagement and Work-Life Balance as parallel mediation factors and Employee Satisfaction as serial mediation factor to understand the impact on Employee Performance with independent factors as Hybrid Workplace and Work Ethics. A questionnaire-based survey was conducted through expert opinion, and the mediation factors were analysed using bootstrapping technique. One of the key findings is that Work Engagement, Work-Life Balance, and Employee Satisfaction have significantly impacted Employee Performance at Hybrid Workplace. The proposed mediation model postulates and evinces that a hybrid workplace has to be implemented to enhance the Work-Life Balance, Employee Satisfaction, and Employee Performance. The identified factors have contributed to Social Exchange Theory (SET) using organizational citizenship behaviour and psychological employment contract as the pertinent theories of this study with future recommendations. The proposed hybrid workplace model would assist Human resources redefine the sustainable and safe work policy for an exquisite work ergonomics.

Keywords: Hybrid Workplace, Moonlighting, Work Engagement, Work-Life Balance, Employee Satisfaction

The Impact of Mobile Phone Interaction on Driving Performance: Driving Simulator Experiment

A Nageswara Rao[1,2], R Jeyapaul[1], B Chaitanya[2], T Sakthi Nagaraj[3], K Lakshmi Padmavathi[4]

Affiliating Organization: [1]Ergonomics Laboratory, Department of Production Engineering, National Institute of Technology- Tiruchirappalli, Tiruchirappalli - 620015, Tamil Nadu, India. [2]Cognitive Science Research Centre, Department of Mechanical Engineering, Lakireddy Bali Reddy College of Engineering, Krishna District, Andhra Pradesh, India-521230. [3]Amrita School of Business, Amrita Vishwa Vidyapeetham, Coimbatore 641 112, Tamil Nadu, India. [4]Department of Computer Science and Engineering, Amrita Sai Institute of Science and Technology Paritala, Andhra Pradesh, India

Email Id: nageswarnitt@gmail.com

Abstract: The objective of this study was to investigate the impact of visual and cognitive distractions on driving performance. Forty-four young drivers participated in three simulated driving trials, each consisting of a distraction-free drive (baseline) and drives with distractions. Two types of distractions were introduced as secondary tasks: mobile phone texting, considered a visual distraction, and mobile phone conversation, categorized as a cognitive distraction. The simulator recorded critical driving parameters, including lane position, speed control, steering, signs adherence, and lane changes. The findings unveiled that drivers were more prone to making errors in distracted conditions. Mobile phone texting while driving displayed a notable increase in errors related to lane position deviation, speed control deviations, steering irregularities, and lane change errors. Moreover, the study detected elevated mental and physical demands, heightened temporal demands, increased frustration, and an overall increased effort in the workload rating when driving with mobile phone use. These results suggest that mobile phone usage during driving significantly alters driving performance. It impairs the perception of vehicle speed while elevating the subjective mental workload experienced by the driver.

Keywords: Young Driver, Mobile phone interaction, Driving simulator, safety, driving errors, subjective workload.

Optimizing Workplace Ergonomics in Sawmills: A Comprehensive Study on Mitigating Musculoskeletal Disorders through Ergonomic Risk Assessment

Jibin Jayan Thrippunath[1], Jishin Jayan Thrippunath[2]

Affiliating Organization: [1]Government Engineering College Thrissur, Kerala, [2]St Theresa International College, Nakhon Nayokh, Thailand

Email Id: jibinjayan2014@gmail.com, jishin.t@stic.ac.th

Abstract: Sawmills, characterized by labor-intensive operations, present distinct challenges related to manual tasks, heavy lifting, and repetitive motions. Despite

advancements, a significant portion of employees in Indian sawmills still engages in manual work, resulting in frequent musculoskeletal problems and accidents. Awkward postures during lifting, carrying, and pushing contribute to the development of Work-Related Musculoskeletal Disorders (WRMSDs) and Lower Back Pain (LBP), impacting workforce efficiency and industry productivity. This study aims to enhance ergonomic conditions at identified workstations, focusing on postural correction and preventing WRMSDs, utilizing Rapid Entire Body Assessment (REBA), Quick Exposure Check (QEC), and NIOSH lifting equation. Workers engaged in awkward postures and heavy manual lifting were selected based on high-risk indications, necessitating immediate posture changes. Ergonomic interventions were suggested, and improved postures were evaluated using REBA and QEC to reduce posture scores to low risk. The NIOSH lifting equation assessed manual lifting tasks at the origin and destination, aiming to minimize ergonomic interventions by reducing the lifting index to a safe limit. This research is crucial for sawmill industries, providing insights into effective ergonomic measures, contributing to the prevention of musculoskeletal issues, and promoting a safer work environment.

Keywords: Sawmill Operations, Ergonomics, Work-Related Musculoskeletal Disorders (WRMSDs), Occupational Health and Safety

Involvement of human factors in railway accident- Systemic review on human errors in railways

Riddhiman Biswas

Affiliating Organization: Department of Design, Indian Institute of Technology Guwahati

Email Id: b.riddhiman@iitg.ac.in

Abstract: The railway system is a complex sociotechnical system, which requires a high degree of interconnections between human and technical functions to achieve the system goals. Disruption by railway accidents and incidents with different factors can widely cause the disturbance of railway network. This article developed a comparative study to understand the status of research works about the involvement of human factors within the railway system, special emphasizing on human errors in railway accidents. Using the standard methodology of systemic review, Scopus database was used to identify the literatures and total 36 literatures were analysed. The study revealed that human error is one the major causal factors to railway accidents in globally. According to Human Factors Analysis and Classification System (HFACS), it was reviewed that the level 1 unsafe act of operators has a major role in human errors to railway accidents. However, the state of art analysis has some analytical gaps which are needed to be discussed in future work.

Keywords: Human error, human reliability, railway accident, HFACS

Process Safety Management Implementation in Outsourced Operations & Maintenance Vendors

Abhineet Raj, Naveen Kumar, Ranadip Das, Neeraj Kumar Sinha

Affiliating Organization: Tata Steel Limited

Email Id: abhineet.raj@tatasteel.com

Abstract: In view of recent incidents related to high-risk processes involving O&M (Operations and Maintenance) vendors, we undertook an important initiative to ensure the safety, efficiency, and reliability of our operations. As part of this effort, we conducted PSM audit of O&M vendors involved in all high hazard processes. For this, the scope and objectives of the audit, we made the audit checklist and schedule. Our aim is to assess each vendor's adherence to industry best practices and regulatory requirements, ultimately strengthening our partnership with them. Findings of the audit was presented in top management meetings which helped in taking policy level decisions and improved the vendor performance in field of Process Safety.

Ergonomic risks involved among the taxi bike drivers in urban cities in India

Sang Sangeeta Pandit, Puspendu Adhikari, Rajat Kamble

Affiliating Organization: PDPM Indian Institute of Information Technology Design and Manufacturing Jabalpur, Madhya Pradesh 482005, India

Email Id: s.pandit@iiitdmj.ac.in

Abstract: Currently, taxi-motorbikes have become a more convenient mode of transportation in urban cities compared to traditional taxi or cabs. The taxi-motorbike service industry is projected to grow significantly, with business opportunities estimated to reach $1,478.0 million by 2030. However, the drivers of these taxi-motorbikes often face challenges associated with long working hours and unfavourable traffic conditions. This study is aimed to determine occupational hazards related to Work-related Musculoskeletal Disorders (WMSDs) among motorbike drivers. The research was conducted on a sample of 45 motorbike drivers from various taxi service providers in metropolitan areas. Interviews and modified Nordic questionnaire were used to evaluate the severity of WMSDs and other occupational hazards due to extensive motorbike riding. The study revealed that 82.37% motorbike drivers who were working more than 8 hours per day and overall, 60 % of drivers were facing WMSDs at lower back, they also reported significant pain at their upper back (p=0.04), neck & shoulder (p=0.041) and felt pain with numbness and tingling sensation in wrists (p= 0.032). The study concludes that an ergonomic design intervention is needed to reduce WMSDs among the motorbike drivers.

Keywords: WMSDs, Taxi-motorbike, Mobility service, Long exposure motorbike riding, Occupational hazards of drivers

Building a Safety Case Argument in Compliance with ISO 26262

Rahul Pingale

Affiliating Organization: Eaton India Innovation Center

Email Id: RahulSPingale@eaton.com

Abstract: Automotive embedded systems have become more complex, strongly integrated and safety-criticality of these systems raises new challenges Therefore, there is an increased threat in terms of hardware and/or software failures that could potentially lead to intolerable hazards. The compliance to the functional safety is very important to avoid or mitigate these potential unacceptable risks. Safety case is now regularly used to communicate the argument about the achievement of acceptable levels of safety for safety critical systems and shows compliance with the automotive standard ISO 26262. To rationalize freedom from unreasonable risk, a safety case argument should be developed in which the technical safety requirements are addressed and satisfied by the substantiation generated from the ISO 26262 work products. However, the standard does not provide practical guidelines for how it should be developed and reviewed. Especially, the standard doesn't narrate how the safety case argument should be assessed in the functional safety assessment process. In this paper, the main argument structures required of a safety case is categorized, analyzed and specified the relationships that exist between these structures. Finally, the paper concludes with a discussion of the potential benefits and challenges of the structured safety case arguments for evaluating the rationale, assumptions and evidence put forward when claiming compliance with ISO 26262.

Keywords: Automotive safety, safety case arguments, Safety case, ISO 26262

HAZOP for Safety Culture: A Novel Safety Culture Index

Sinjana Choudhuri, O Bala Krishna, J Maiti

Affiliating Organization: IIT Kharagpur

Email Id: chdhdsinjana@gmail.com

Abstract: Safety culture, defined as the shared values, attitudes, and behaviors of individuals within an organization towards workplace safety, plays a crucial role in preventing accidents, injuries, and incidents. Cultivating a positive safety culture is essential for organizations to improve their safety performance and ensure the well-being of their workforce. This paper proposes a novel approach for assessing safety culture using Hazard and Operability Study (HAZOP), a systematic technique for identifying and mitigating potential hazards in processes or systems. We argue that HAZOP, with its focus on proactive risk management, can be effectively utilized to analyze an organization's Integrated Vibrant Safety Management System (IVSMS) and develop a Safety Culture Index (SCI). The IVSMS, encompassing 21 elements such as Industry 4.0 and

Digitalization, Process Safety Management, and Occupational Safety and Health, to name a few provides a comprehensive framework for evaluating safety management practices of an organization. By analyzing each element through the lens of HAZOP, we can gain insights into the organization's strengths and weaknesses regarding risk identification, communication, and mitigation strategies. The resulting SCI serves as a quantifiable measure of an organization's safety culture, allowing for benchmarking against industry standards and identification of areas for improvement. Ultimately, a robust safety culture, fostered through the application of HAZOP and continuous improvement efforts, contributes not only to enhanced safety performance but also to the overall success and stability of an organization.

Keywords: Safety Culture, HAZOP, Safety Management, IVSMS, Continuous Improvement

Fuzzy Model Reference Learning Control for Hazard Identification in Port's Material Handling Operations and Maintenance

Udhayakumar palanivel[1] and Richa Ahuja[2]

Affiliating Organization: [1]Adani Ports and Special Economic Zone, [2]COE-SEA, IIT Kharagpur

Email Id: uthayas.kumar@gmail.com, richa.ahuja76@gmail.com

Abstract: Fuzzy Model Reference Learning Control (FMRLC) is an approach that combines fuzzy logic with learning control techniques to address systems with uncertainties and non-linearity's. When applied to hazard identification, FMRLC can enhance the accuracy of hazard assessments and responses. The integration of automation and digitization has resulted in tremendous efficiency gains across multiple sectors as industries rapidly progress towards industry 4.0 and the industrial Internet of things (IIoT). The port operation and maintenance sectors entail crucial handling procedures that require a variety of material handling equipment. Numerous significant dangers and hazards are still present in the procedure. The aim of this study is to detect and assess any potential risks and hazards connected to a specific activity, procedure, or environment by using Fuzzy Model Reference Learning Control Mechanism. This study brings out the application of of a comprehensive risk assessment method potentially useful to individuals and organizations for effective recognition of possible risks. It would empower them for taking suitable measures, to eliminate or minimize them, thereby decreasing the probability of accidents, injuries, and fatalities.

Keywords: FMRLC, Hazards Control, IIoT, Accident detection

Hierarchical importance of factors leading to Electrical Safety Issues in the Utility Industries

Beena Puthillath, Bhasi M, Babu C A

Affiliating Organization: CUSAT, Ernakulam

Email Id: beena.ajit1998@gmail.com

Abstract: Safety issues in energy industries often lead to fatal and non-fatal accidents. Main cause of electrical accidents is unauthorized work, contact with live conductor, improper reporting and documentation, lack of supervision, perception, peer pressure, work stress, attitude, safety belief etc. Human factors play a vital role in accidents. Safety climate and Safety culture are the important factors leading to safety issues in every industry. Safety culture and safety climate varies from industry to industry. Since the utility industry is a high-risk industry, the associated will be high and there is a need to study all the influencing factors affecting electrical accidents.

Energy-Efficient Last-Mile Deliveries Through Integrated Automation of Freight and Passenger Transport

Aditya Kumar, Lokesh Kumar Kalahasthi, Abhishek Abhishek, Laxman Singh Bisht, Iván Sánchez-Díaz

Affiliating Organization: Indian Institute of Technology Delhi

Email Id: klokesh@iitd.ac.in

Abstract: The paper "Energy-Efficient Last-Mile Deliveries Through Integrated Automation of Freight and Passenger Transport" explores the integration of autonomous last-mile deliveries with self-driving minibuses at Chalmers University in Sweden. This study examines the feasibility and potential energy savings associated with this integration, with a particular focus on safety aspects. To collect data on travel times, energy consumption, and speeds, robots and minibuses are being used in pilot tests on the university campus. Compared to using robots alone, integrating robots with minibuses could reduce energy consumption by 16-70%, leading to significant energy savings and potential benefits for safety. Integration reduces the number of vehicles on the road, thus ensuring pedestrian and user safety. Additionally, the study emphasizes the need for further research to evaluate practical challenges related to user safety, energy efficiency, and feasibility on a regional or urban scale. Autonomous passenger and freight transport systems have the potential to enhance safety, reduce traffic congestion, and create efficient urban logistics hubs.

Nanomaterials for Fire Retardancy: A Review

Ankith George Mathew

Affiliating Organization: Cochin University of Science and Technology

Email Id: ankithhse@pg.cusat.ac.in

Abstract: Fire can cause a lot of destruction and casualties, and the resulting costs are just beyond expectations. It is a necessity to reduce the impact of fires to prevent losses that occur as its aftermath. The most frequent commercial and large-scale procedure to impart fire retardant properties is the addition of flame retardant (FR) additives in the material matrix. But these conventional and commercially available flame retardant additives pose

a serious threat to both humans and the environment. It also affects the mechanical, thermal and electric properties of the material. Hence, with the advancements in nanotechnology, the trend has moved to the use of nanomaterials and nanocomposites for flame retardancy. Nanoparticles (NPs) have larger surface-to-volume ratios and surface energies, which promote stronger connections and contribute to improved attributes. Along with excellent fire resisting properties, they also show an improved mechanical performance. The paper reviews the various nanomaterials being used, its various applications and the advances.

Keywords: fire, flame retardant, nanotechnology, nanomaterials

Use of Barrier Management Technique to Reduce and Mitigate High Risk Scenarios

Abhineet Raj, Naveen Kumar, Ranadip Das, Neeraj Kumar Sinha

Affiliating Organization: Tata Steel Limited

Email Id: abhineet.raj@tatasteel.com

Abstract: The philosophy of barrier audit is to ensure that the barriers are effective. Preferably barrier audit should be carried out after stimulating the demand condition on the barrier. 3 critical questions which we ask: 1. Do we know what can go wrong? 2. Do we know what barriers we have to ensure that it doesn't go wrong? 3. Do we know that our barriers are effective and working properly? All department develop an implementation plan for Barrier Audit. Prior to conducting Barrier audits department must prepare Bow Tie diagram for all the C4 and C5 consequence scenarios as derived from the PHA (Process Hazard Analysis) process or scenarios identified through HIRA (Hazard Identification & Risk Assessment) technique The departments where PHA or HIRA (Hazard Identification & Risk Assessment) process is not being followed can select the top events as per their emergency preparedness & response document. Every department need to identify a cross functional team in their department who will be responsible for carrying out the Barrier Audit. Cross functional team must consist of employees from operation and maintenance both. Department should prepare Barrier Audit Plan based upon the C4 & C5 scenarios identified through either PHA or HIRA technique. All C4 & C5 scenario barrier audit must be done at least once in a year.For all the barriers audited, findings to be noted down and all the applicable fields like current condition, OFI, action, responsibility & target date to be filled up by the team. Also, mention the barrier owner for each barrier components in case of active & administrative barrier. For passive barrier, barrier owner to be mentioned for whole barrier. All the actionable points against the barrier to be reviewed by the department chief (as per the frequency defined by the department). A confirmation check/audit to be done once all the OFIs have been complied.

RoadGuard: An optimized framework to predict Road Accident Severity Outcomes through Human-environmental Interactions using K-nearest Neighbour with GNN

Kalpa Pandit[1], Abhirup Bhattacharya[1], Sobhan Sarkar[2], Parichay Das[2]

Affiliating Organization: [1]Computer Science Engineering, Techno International New Town, Kolkata, [2]Information Systems & Business Analytics, Indian Institute of Management Ranchi, Jharkhand

Email Id: abhirupbhattacharya97@gmail.com

Abstract: Traffic accidents severely hamper traffic control and public safety. Studies that have been conducted on accident severity have majorly taken into consideration human factors, such as gender and age of the driver, vehicular factors, such as vehicle type, and the number of vehicles involved, and light factors, such as streetlights and daylights. Analysis of weather, pressure conditions, location, road features, and different times of the year, month, and day is lacking in the literature. Moreover, most of the forecasting models used were Decision Tree, Random Forest, ANN, Naïve Bayes, and SVM. Therefore, this study examines a new method to forecast the severity of traffic accidents by using K-Nearest Neighbors with GNN and presents an extensive analysis of additional features such as the presence of traffic signals, stations, and crossings along with attributes related to location, pressure conditions and timings which fills the research gap. By utilizing an extensive dataset that comprises road accident reports from the US Department of Transportation, traffic cameras, and sensors, we predict the severity of accidents and study the correlations that exist between accident features and the resulting severity or the effect on the traffic flow.

Keywords: RoadGuard, KNN-GNN, severity prediction, spatiotemporal factors

Identification of the Patterns and Prediction of Occurrence of Forest Fires Using Association Rule Mining and Classification Trees

Arnav Patel[1], Baneswar Sarker[2], Jhareswar Maiti[2]

Affiliating Organization: [1]Department of Agricultural and Food Engineering, Indian Institute of Technology Kharagpur, [2]Department of Industrial and Systems Engineering, Indian Institute of Technology Kharagpur

Email Id: sarker.baneswar1991@gmail.com

Abstract: Forest fires, caused by natural or man-made agents, are viewed as one of the most hazardous and destructive disasters that may occur on this planet. A lot of research endeavours have been carried out to observe, forecast, and avert forest fires through the development of prediction models with the implementation of machine learning and artificial intelligence techniques. Ideally, the development of a prediction model should

be preceded by establishing the association and relationship among the features and factors causing forest fires through the identification of rules behind the occurrence of forest fires. In this study, Association Rule Mining, a rule-based machine learner, has been implemented using discretized values of features like Normalised Difference Vegetation Index (NDVI), Land Surface Temperature (LST), and Burned Area to establish a collection of relational rules that elucidate the criteria and conditions of occurrence of forest fires. Multiple rules were generated based on a threshold value of parameters. Finally, Classification Tree has been implemented for the development of a prediction model for the occurrence of forest fires, which has given an accuracy of 87.1% and 79% for the training and testing dataset. The model also indicated LST as the most important variable influencing the occurrence of forest fires, followed by NDVI.

Keywords: Forest Fire, Association Rule Mining, Classification Tree, Normalised Difference Vegetation Index (NDVI), Land Surface Temperature (LST), Burned Area

Leveraging Digital and Factory Automation with Help of a Centrally Located Integrated Plant Operation Centre Outside Plant Premises

Abhineet Raj, Naveen Kumar, Ranadip Das, Neeraj Kumar Sinha

Affiliating Organization: Tata Steel Limited

Email Id: abhineet.raj@tatasteel.com

Abstract: In line with Factories of Future, leveraging digital and factory automation, it is imperative to establish a near site unified command and control operation for Sintering & Raw material bedding and blending plant. With an emphasis on synergy, agile working, cross learning, faster and effective decision making and better coordination amongst all control stations, all six (06) control rooms is shifted to a centrally located integrated Plant Operation Centre. This transformation will be instrumental in future autonomous operation of Plant. Uniqueness: Delinking Talent from Assets Due to the nature of the Iron Making value chain, factories are typically in remote locations, where the best of talent might be scarce and operational hazards are many. By separating the operations control from shopfloor processes, Tata Steel has laid the groundwork to ensure that geographical boundaries do not limit availability of talent, process, safety, environment and work can move anywhere than vice versa. With talent delinked from asset location, expertise is transferred remotely, ensuring rapid and efficient deployment of best practices even when new plants are set up. Operations, Safety and environment have also become safer with lesser people deployed near hazardous zones ✓ Technological enablement ✓ Real time data feed (voice, video & data overlay in unified layer) ✓ Fault Tolerant Architecture through distributed computing ✓ Edge Cluster and Cloud leveraged, digital twin and analytics enabled Business Connect Impact: Reduced number of incidents in dept Savings of 35cr per year Agile decision making, faster deployment Synergy and cross learning Benchmarking with all Sinter plants across India Achieved Best ever productivity & Stack emission. Reduction in Solid fuel rate by 5kg/tns over FY'22.

Analyzing Operators' Cognitive Behaviors in Modern Control Rooms using Eye Tracking

Haider Altaf[1], Jhareswar Maiti[2], Babji Srinivasa[1], Rajagopalan Srinivasan[1]

Affiliating Organization: [1]Indian Institute of Technology Madras, Chennai and [2]Indian Institute of Technology, Kharagpur

Email Id: raj@iitm.ac.in, babji.srinivasan@iitm.ac.in

Abstract: Modern control rooms have transformed into Integrated and Extended Operation Workstations, emphasizing centralized operations in a unified space where operators collaborate (Borås & Sverige, 2021). These workstations feature multiple displays of varying sizes positioned at different distances and heights. However, with the surge in data from automation and AI, operators grapple with information overload on these displays. This information overload has the potential to hinder judgment and decision- making, elevating cognitive workload and the likelihood of errors. Therefore, it's crucial to comprehend operators' cognitive behavior in such environments to boost operational efficiency and safety. Recently, eye-tracking techniques have been used to understand the cognitive behavior of operators in safety-critical workspaces. For instance, an eye-tracking study reported that novices frequently shifted their gaze across different areas on the display, indicating a potential lack of familiarity with the ongoing process abnormality (Wu et al., 2020). Our previous work revealed that operators well-versed in process dynamics concentrated on critical variables relevant to the current situation (Bhavsar et al., 2017). These studies focus on cognitive behavior within traditional control room settings, primarily single-screen setups. This limited focus has constrained our comprehension of operator behavior in modern control rooms with multiple and large overview displays. Moreover, as these larger screens are positioned differently from individual panels, the transition of gaze could potentially introduce cognitive strain (Patterson & Silzars, 2009), an important aspect that current studies may not adequately consider. Our recent studies focus on addressing these gaps. We found encouraging results from recent eye-tracking studies, particularly in the interaction of operators with HMI displayed on multiple screens, resembling modern control rooms (Shajahan et al., 2023). Expanding this work, we proposed a novel methodology to enhance eye-tracking capabilities to study cognitive behavior in workspaces with multiple displays at different locations and heights. The proposed methodology combines eye-tracking data with a three-dimensional (3D) model of a control room, enabling a comprehensive visualization of operator gaze patterns and an understanding of cognitive behavior. We assessed the accuracy and precision of recorded gaze through studies involving human subjects. Furthermore, a case study in a simulated modern control room environment demonstrated the practical applicability of our methodology. This case study offered valuable insights into operator interactions and responses within a modern control room. These insights are crucial for analyzing operators' cognitive behavior and improving human performance in modern control rooms in diverse industrial settings.

Keywords: Modern Control Rooms, cognitive behavior, Eye-tracking, Operator performance, safety.

Human error factors affecting road tanker loading operation in petroleum and chemical storage terminal & plant

Firdaus Quasim[1] and Anand R Marathe[2]

Affiliating Organization: [1]Emerson Electric (India) Pvt. Ltd., [2]Adani Hazira Port Limited

Email Id: firdausquasim@live.in

Abstract: This study looks at the fundamental human screw up factors that influence the efficiency and security of road enormous hauler stacking structures inside engineered and petroleum amassing terminals. The stacking framework is a marvellous action that requires precise execution to hinder potential dangers like spills, openings, and setbacks. Analysing the various parts of human error in this setting is pressing for updating useful trustworthiness and restricting risks related with the transportation of dangerous materials. The assessment recognizes a couple of key human misstep factors, including head shortcoming, lacking planning, nonappearance of correspondence, pomposity, equipment freshness, interference, and dynamic bumbles. Every component is dissected comprehensively to grasp its specific impact on the stacking framework and to propose assigned systems for lightening. Director fatigue emerges as a basic ally of human bumbles, highlighting the meaning of doing genuine preparation and rest periods. Lacking arrangement is watched out for through ideas for broad planning programs that consideration on both specific capacities and situational care. Correspondence slips are examined, complementing the prerequisite for clear and standardized correspondence shows among terminal staff and enormous hauler heads. Pomposity, much of the time coming from routine tasks, is inspected as a logical bet, empowering for the execution of periodic supplemental classes and security drills. Equipment freshness is tended to through simple to utilize plan changes and perpetual readiness on mechanical types of progress. Interference, a regular think about the current fast-moving environment, is freed through the headway from an interference free work culture. The powerful bungles are examined with an emphasis on developing a prosperity first mindset and giving decision help instruments to overseers. The proposed philosophies hope to make a comprehensive construction for directing human misstep factors, thusly dealing with the overall security and capability of road enormous hauler stacking structures in compound and petroleum storing terminals.

Keywords: Road Tanker Loading, Human Error, Chemical Storage Terminal, Petroleum Storage Terminal, Safety, Training, Decision-making.

Blast Furnace Capacity enhancement through Engineering control with comprehensive Safety Measures

Atanu Chatterjee

Affiliating Organization: Vedanta Limited

Email Id: atanututun1@gmail.com

Abstract: In a distinguished steel industry, a strategic initiative is underway to augment blast furnace capacity from 1050m^3 to 1264m^3, aiming to enhance productivity within the existing infrastructure. Originating as a Capacity Expansion and Continuation Project initially conceived for ironmaking, the 1050m^3 blast furnace, slated for operation in March 2014, underwent suspension during partial construction due to productivity considerations. The primary objective of this undertaking is to extend the capacity of the 1050m^3 blast furnace to a 1264m^3 blast furnace, while concurrently transforming or replacing specific equipment and supporting facilities. This transformation is executed with due consideration of risk assessment and control measures through Management of change (MOC). The purpose of MOC is to manage & minimise all the potential consequences of failure and adverse effects associated with the intended changes in Design, Physical, Operational and Procedure. Process Safety Risk Management (PSRM) also consider for managing the operations involving hazardous material to eliminate and control the process related incidents. This was carried out by utilizing existing equipment to the greatest extent feasible. The overarching goals of this project encompass improving cost-effectiveness, reliability, safety, and operational efficiency, all while minimizing investment. Construction acceleration is pursued through the optimization of conditions, while adherence to the original standard criteria in the continued project design remains paramount. In the endeavour to optimize resource utilization, existing structures, purchased equipment, and the initial design are incorporated, considering the prevailing context of plant construction and safety standards. The aim of this project is capacity expansion to achieve a daily molten iron production of 4200 MT/day with the new 1264m^3 blast furnace in safe manner accomplished by repurposing the existing foundation and frame of the 1050m^3 blast furnace.

Keywords: Blast furnace, MOC, PSRM, Molten metal, Risk assessment, Reliability & Safety

Ensuring Safety through ESG: An assessment of Business Responsibility and Sustainability Report

Richa Ahuja

Affiliating Organization: Centre of Excellence in Safety Engineering and Analytics, IIT Kharagpur

Email Id: richa.ahuja76@gmail.com; richa@COE-SEA.iitkgp.ac.in

Abstract: The Business Responsibility and Sustainability Report (BRSR) is a mandatory reporting framework introduced by the Securities and Exchange Board of India based on the nine United Nations Global Compact principles. It requires companies to disclose information on various Environment, Social and Governance (ESG) topics, including their environmental impact, social responsibility, and corporate governance to help investors, subscribers, and other stakeholders make informed decisions. Safety is a core social responsibility of any industry. This study is an assessment of Safety within ESG reporting required in BRSR. Results indicate there are only few safety metrics currently used to assess company's ESG impact. In conclusion, there is a need for further developing safety metrics and using the established metrics for strengthening ESG reporting for sustainable

businesses. The insights from this study would be useful for improving safety by through improved implementation of sustainability initiatives.

Evaluation of Pre-Timed and Vehicle Actuated Signal for Safer Commute on Transport Chowk in Chandigarh

Karan Sharma[1], Richa Ahuja[2], Anubhav Sharma[1]

Affiliating Organization: [1]Punjab Engineering College, Chandigarh; [2] COE-SEA, IIT Kharagpur

Email Id: karan8blp@gmail.com

Abstract: In every road junction network, traffic intersections are the primary source of delays. In developing nations specifically, the majority of traffic junction controllers in use are pre-timed. Significantly less time is wasted, less fuel is used and commute is safer when an actuation control plan is properly planned and adapts to traffic demand. This is a comprehensive study on the design of pre-timed and traffic-actuated signals, along with the development of a visually appealing and user-friendly Excel tool based on an intersection in Chandigarh. First, an exploration study of pre-timed and traffic-actuated signal design principles, investigating their respective advantages and limitations is performed. Then, an Excel based tool is developed to estimate pre-timed signal lengths. Furthermore, simulative analysis was conducted using the PTV VISSIM software to assess the performance of various signal designs. The experiments involved comparing pre-timed signals, traffic-actuated signals with fixed stage sequence and variable cycle time, and traffic-actuated signals with variable stage sequence and variable cycle time using the VAP language in PTV VISSIM. The tool facilitates the analysis of cycle time distribution for both pre-timed and traffic-actuated signals, providing valuable insights for traffic engineers and urban planners. The simulations give useful insights for traffic designers to assess effectiveness and efficiency of different signal designs thereby enabling safer commute of traffic.

Keywords: Pre-timed signal, Traffic-actuated signal, Signal design, Cycle time distribution, Traffic management and Safety Governance

Safety Investigation of Dedicated Cycling Infrastructure in Chandigarh – A Case Study

Karan Sharma[1], Richa Ahuja[2], Anubhav Sharma[1]

Affiliating Organization: [1]Punjab Engineering College, Chandigarh; [2] COE-SEA, IIT Kharagpur

Email Id: richa.ahuja76@gmail.com

Abstract: Active travel by cycling is a desirable mode of transportation in urban areas due to its environmental, social, and economic benefits. Dedicated cycle infrastructure is developed in multiple cities to promote cycling. Despite this, usage patterns have evolved very little. Safety assessment can provide a good starting point in determining factors that

may be responsible for usage of dedicated cycling infrastructure. This study aims to investigate safety of cycle tracks. Safety analysis is performed using Indian Roads Congress codes followed by formulation of star rating using iRAP Vida. Analysis reveals the inconsistencies in the state of current infrastructure from the given guidelines. Study provides useful insights towards improving dedicated cycling infrastructure in Chandigarh, India by visually identifying those problems as well as finding out factors influencing usage of the infrastructure.

Keywords: Road Safety Audit, Cycle Lane, Star rating, iRAP Vida

Comparative Analysis of Maintainability Attributes of an Aero engine

Giri K, Rajiv Nandan Rai, Sanjay Kumar Chaturvedi

Affiliating Organization: Subir Chowdhury School of Quality & Reliability, IIT Kharagpur

Email Id: iamgirikrish@gmail.com

Abstract: The paper makes an attempt to quantify ten maintainability attributes, with a

perspective of maintaining a military aero engine. Based on experience and expert opinion, the relative importance of each maintainability attribute is computed in the form of weights. The results so obtained are represented as fuzzy linguistic variables. A hierarchical relationship between these maintainability attributes is suggested. An evaluation process to represent maintainability of an equipment has been presented. As a practical example, one typical maintenance task, which is common to aero engines is selected for study. Through the evaluation process so established, few Maintainability Indices are derived for the said task. A similar comparison is carried out for four military aero engines in service and the relative standing of maintainability is established. Based on the positive aspects of maintainability and lessons learnt from these engines, the Design for Maintainability of another new aero engine, which is under design and development, is commented upon.

Keywords: Maintainability Indicators, Design Attributes, Military Aero engines, Magnetic Particle Detection

APPENDIX A – CONFERENCE SCHEDULE

Day 1 - 29th January 2024		Venue
8:30 AM to 9:30 AM	Registration	Vikramshila Foyer (Infront of Gargi Auditorium)
9:30 AM -10:30 AM	Inauguration	**Venue: Gargi Auditorium**
10:30 AM -11:15 AM	Keynote	**Venue 1: Gargi Auditorium** **Venue 2: Maitrayee Auditorium**
11:15 AM -11:30 AM	High Tea	Vikramshila Foyer (Infront of Gargi Auditorium)
11:30 AM -1:00 PM	Offline Plenary Keynotes	**Venue 1: Gargi Auditorium** **Venue 2: Maitrayee Auditorium**
11.30 AM -1.30 PM	Student Competition	**Venue:** Department Of Industrial and Systems Engineering
1:00 PM-1:45 PM	Networking Lunch	Vikramshila Foyer (Infront of Gargi Auditorium)
1:45 PM -3:45 PM	Paper Presentation Session 1 (Paper presentation schedule is available in SHADG 2024 website)	**Venue 1: Gargi Auditorium** **Venue 2: Maitrayee Auditorium** **Venue 3: COE-SEA, J.C. Bose Annexe** **Venue 4: ISE Room 1** **Venue 5: ISE Room 2** **Venue 6: SQR Room 1** **Venue 7: SQR Room 2**
2.30 PM – 4.30 PM	Student Workshop	**Venue:** Department Of Industrial and Systems Engineering
3:45 PM - 4:00 PM	Tea Break	Respective Venues

4:00 PM-6:00 PM	Paper Presentation Session 2 (Paper presentation schedule is available in SHADG 2024 website)	**Venue 1: Gargi Auditorium** **Venue 2: Maitrayee Auditorium** **Venue 3: COE-SEA, J.C. Bose Annexe** **Venue 4: ISE Room 1** **Venue 5: ISE Room 2** **Venue 6: SQR Room 1** **Venue 7: SQR Room 2**
6:00 PM -8:00 PM	Online Plenary Keynotes	**Venue 1: Gargi Auditorium** **Venue 2: Maitrayee Auditorium**
8:30 PM-10:00 PM	Gala Dinner	Vikramshila Foyer (Infront of Gargi Auditorium)
30th January 2024 Day 2		**Google Meet Links**
7.30 AM	Registration	Vikramshila Foyer (Infront of Gargi Auditorium)
8:00 AM - 9:30 AM	Online Plenary Keynotes	**Venue 1: Gargi Auditorium** **Venue 2: Maitrayee Auditorium**
9:30 AM - 10:15 AM	Keynote	**Venue 1: Gargi Auditorium** **Venue 2: Maitrayee Auditorium**
10:15 AM - 11:45 AM	Offline Plenary Keynotes	**Venue 1: Gargi Auditorium** **Venue 2: Maitrayee Auditorium**
11:45 AM- 12:00 PM	Tea Break	Respective Venues
12:00 PM - 1:00 PM	Paper Presentation Session 3 (Paper presentation schedule is available in SHADG 2024 website)	**Venue 1: Gargi Auditorium** **Venue 2: Maitrayee Auditorium** **Venue 3: COE-SEA, J.C. Bose Annexe** **Venue 4: ISE Room 1**
1:00 PM- 1:45 PM	Networking Lunch	Vikramshila Foyer (Infront of Gargi Auditorium)
1:45 PM - 3:45 PM	Track Workshops	**Topic:** Prognostics and Health Management. **Venue:** SQR Room 1 **Topic:** Epidemiology of RTI. **Venue:** Gargi Auditorium

		Topic: Econometric Methods. **Venue:** Maitrayee Auditorium
3:45 PM - 4:00 PM	Tea Break	Respective Venues
4:00 PM - 5:00 PM	Panel Discussion	**Venue 1: Gargi Auditorium**
5:00 PM - 6:00 PM	Valedictory Session	**Venue 1: Gargi Auditorium**
6:00 PM - 6:30 PM	Closing Ceremony	**Venue 1: Gargi Auditorium**
6:30 PM - 7:30 PM	High Tea and Networking	Vikramshila Foyer (Infront of Gargi Auditorium)

APPENDIX B – CONFERENCE BROCHURE

IIT Kharagpur

SHADG 2024

HYBRID MODE
International Conference
January 29 & 30, 2024

International Conference on Safety, Health and Analytics-Driven Governance for Sustainable Development (SHADG 2024)

The Centre of Excellence in Safety Engineering and Analytics (CoE-SEA), IIT Kharagpur is organizing SHADG 2024 in collaboration with academic and industry partners. SHADG 2024 aims to provide an inter and multi-disciplinary forum for knowledge sharing, dissemination, networking and international collaboration in fields of safety, health, sustainability, human factors and analytics-driven governance.

About CoE-SEA

The CoE-SEA has been established in July 16, 2020 in IIT Kharagpur under the Institute of Eminence (IoE) scheme of Govt. of India. The CoE-SEA embodies to act as the hub for learning and practice, knowledge creation, standardization, repository, and dissemination of knowledge and information covering the broad domain of safety engineering and management, occupational and environmental health, human factors and industrial ergonomics, disaster management, and allied disciplines. It is a first of its kind focusing in safety analytics and analytics driven governance to protect people and property and promote sustainable development.

Opportunities and Benefits

Inspirational Keynotes: Renowned experts and thought leaders will deliver inspiring keynotes, offering insights into the latest trends, challenges, and innovations.
Thought-Provoking Sessions: Engage in in-depth discussions through a range of interactive sessions, workshops, and panel discussions led by industry experts.
Cutting-Edge Research: Explore the latest research findings and case studies that showcase real-world applications.
World - Best Practices: Witness the world - known best practices from renowned industry professionals.
Networking Opportunities: Connect with like-minded professionals, researchers, and practitioners from various fields to foster collaborations and exchange ideas.

Themes	
Track – I	Safety, Security and Analytics (SSA)
Track – II	Reliability, Maintenance and Analytics (RMA)
Track – III	Health, Epidemiology and Analytics (HEA)
Track – IV	Risk, Resilience, Sustainability and Analytics (RRSA)
Track – V	Human Factors / Ergonomics and Analytics (HFEA)
Track - VI	Analytics-Driven Governance (ADG)

Link to register:
www.coesea.iitkgp.ac.in/shadg24

Tracks

Track I **Safety, Security and Analytics (SSA)**

Safety Engineering, Safety Management, Safety Analytics; Prevention Through Design (PtD); Hazard identification, Probabilistic Risk Assessment, Uncertainty Analysis; Safety Economics; Personal Protective Equipment (PPE); Transportation and Logistics Safety, Fire Safety, Construction Safety, Electrical Safety, Process Safety, Mine Safety, Manufacturing Safety; Nuclear Fuel Cycle Facility Safety; Chemical, Oil and Natural Gas Safety, Structural Safety; Cyber-security, Cyber-risk Management; Industry 4.0/5.0 Technologies, Data, Tools and Techniques for Safety and Security Analysis and Management; Disaster Management: Early Warning System, Emergency Response System, Challenges and Updates in Emergency.

Track II **Reliability, Maintenance and Analytics (RMA)**

Reliability Engineering, Reliability Assessment and Management, Reliability Design, Reliability prediction; Maintenance Engineering, Preventive and Predictive Maintenance, Remaining Useful Life (RUL), Condition Monitoring, Condition based Maintenance, Fault Diagnosis & Prognosis, Intelligent Asset Maintenance; Life Cycle Cost, Facility Integrity, Asset Management; Reliability and Maintenance Optimization; Industry 4.0/5.0 Technologies, Data, Tools and Techniques for Reliability and Maintenance Analysis and Management.

Track III **Health, Epidemiology and Analytics (HEA)**

Occupational Health, Industrial Hygiene, Health Analytics; Global Health Challenges; Environmental Health Risks, Climate Change and Health; Epidemiology, Injury Prevention, Accidental Injury and Damage, Sustainable Healthcare Systems, Affordable Healthcare, Musculoskeletal Disorders, Occupational Diseases, Job Stress, Noise and Hearing Loss; Tools and Techniques for Safety and Security Management; Industry 4.0/5.0 Technologies, Data, Tools and Techniques for Health Engineering and Management; Trauma and Critical Care during Disaster, Health Emergency Scenarios Among Health Care Settings.

Track IV **Risk, Resilience, Sustainability and Analytics (RRSA)**

Business and Industrial Risk, Risk Perception, Risk-based Decisions; Resilience Engineering, Complexity and Emergence, Organizational Resilience and Risk Management; Economic, Social and Environmental Sustainability; Impact of Safety, Security and Disaster Management; Agile system, Sustainable Supply Chain; System Analysis Methods, Life Cycle Assessment and Management; Environmental, Social and Governance (ESG) and Sustainable Development; Industry 4.0/5.0 Technologies, Data, Tools and Techniques for Resilience and Sustainability Engineering and Management.

Track V **Human Factors / Ergonomics and Analytics (HFEA)**

Human Factors Engineering, Human Competency and Capability, Human Error and Behaviour, Cognitive Ergonomics; Digital Human Modelling, Human-Centric Design and User Experience (UX); Human Factors in Technology and Digital Interfaces; Workplace Ergonomics and Productivity; Public Policy and Health Economics; Disability Risk Prediction and Explanatory Models, Work Disability Prevention; Situational Awareness, Human sensing Technology, Cognitive information Processing; Industry 4.0/5.0 Technologies, Data, Tools and Techniques for Human Factors Engineering and Management.

Track VI **Analytics-Driven Governance (ADG)**

Leadership, Policy, Planning and Shared Decision-making; Monitoring, Evaluation and Learning (MEL); Standards, Acts, Audit, Management Information System (MIS); Resource Optimization; Real-time Monitoring, Decision Support System; Cyber Physical System Support, Artificial Intelligence and Intelligent System, Safety Technology, Smart Safety and Health; Smart Transport and Logistics, Intelligent Asset Management; Industry 4.0/5.0 Technologies, Data, Tools and Techniques for Governance.

Venue

Vikramshila Building, IIT Kharagpur, Kharagpur, West Bengal 721302
January 29 – 30, 2024

Centre of Excellence in Safety Engineering and Analytics
2nd floor, J C Bose Annex Building, Ramanujan Complex
Indian Institute of Technology Kharagpur, Kharagpur 721302, West Bengal, India

Submission Guidelines:

- Paper should be up to 6 pages length, including references and appendices with a clear abstract (150-250 words) outlining the objectives, methodology, key findings, and contributions of the paper.
- If interested only in submitting the extended abstract, it should not exceed one A4 size page (printable area) with Times New Roman style with font size of 12 and 1.5 spacing.
- Prepare your paper in .pdf format for submission.
- Electronic paper to be submitted at the following URL: www.coesea.iitkgp.ac.in/shadg24/

Publication:

Accepted full papers will be published in the conference proceedings or as a book chapter in edited books (based on further peer reviews and acceptance). Some selected papers may be published in the international journal of repute, subjected to further blind review and acceptance.

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Contact Us:
Ms. Sween Josco, Event Manager,
mailtosween@gmail.com
Mr. Pritam Ash, JA,
ashpritam@adm.iitkgp.ac.in

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