© AUG 2019 | IRE Journals | Volume 3 Issue 2 | ISSN: 2456-8880
DOI: https://doi.org/10.64388/IREV3I2-1714417

Systematic Review of Near-Miss and Hazard Observation Data Utilization in Industrial Safety Management

OLUWAKEMI MOTUNRAYO ARUMOSOYE[1], OGHENEPAWON DAVID OBRIKI[2]
[1]*Felz Marine Nigeria Limited, Rivers State, Nigeria*
[2]*Independent Reseacher, Lagos State, Nigeria*

Abstract- ***Near-miss and hazard observation data have emerged as critical sources of information for enhancing industrial safety management, providing early indicators of potential incidents before they escalate into accidents. This systematic review examines the current state of research on the collection, analysis, and utilization of near-miss and hazard observation data across diverse industrial sectors, including energy, manufacturing, construction, and chemical processing. The review identifies methodologies for capturing such data, ranging from manual reporting and digital logging systems to mobile and IoT-enabled platforms, and evaluates their effectiveness in informing risk assessment, safety interventions, and organizational learning. Findings indicate that systematic use of near-miss data supports predictive and preventive safety strategies, enabling organizations to identify recurrent hazards, prioritize risk mitigation efforts, and implement targeted operational controls. Integration of hazard observation data into safety management systems enhances situational awareness, facilitates feedback loops, and strengthens safety culture by promoting proactive reporting and continuous learning. The review also highlights challenges associated with data quality, underreporting, standardization, and integration across multi-contractor environments, emphasizing the need for robust governance structures and digital tools to support reliable data capture, analysis, and decision-making. Emerging trends include the application of data analytics, machine learning, and visualization techniques to transform near-miss data into actionable insights, enabling scenario-based risk assessment and real-time decision support. Cross-sector benchmarking and standardized frameworks for data categorization, severity scoring, and incident linkage further enhance the utility of these datasets in reducing workplace accidents and improving compliance. This review demonstrates that systematic utilization of near-miss and hazard observation data is a strategic enabler of proactive safety management, contributing to reduced incident frequency, enhanced operational reliability, and strengthened governance in industrial operations. Recommendations for future research include exploring predictive models, integrating multi-source datasets, and developing industry-wide standards to optimize the value of near-miss data for safety decision-making.***

Keywords: ***Near-Miss Reporting, Hazard Observation, Industrial Safety Management, Predictive Risk Assessment, Safety Culture, Data Analytics, Occupational Risk Mitigation.***

I. INTRODUCTION

Industrial operations are inherently complex and high-risk, encompassing sectors such as manufacturing, construction, energy, and chemical processing. In these environments, occupational safety is critical not only to protect workers but also to maintain operational continuity, regulatory compliance, and organizational reputation (Yeboah and Enow, 2018; Ugwu-Oju *et al*., 2018). Traditional approaches to safety management have often focused on reactive measures, responding to incidents after they occur. However, in recent decades, the reporting and analysis of near-misses and hazard observations has emerged as a pivotal component of proactive safety management (Oshomegie, 2018; Badmus and Olamide, 2018). Near-miss events—situations where an accident was narrowly avoided and hazard observations provide valuable insights into latent system vulnerabilities, unsafe conditions, and process inefficiencies before they result in harm (Seyi-Lande *et al*., 2018; Olamide and Badmus, 2018).

The growing emphasis on proactive safety management reflects a paradigm shift from reliance on lagging indicators, such as injury frequency or lost-time incidents, toward leading indicators that can predict and prevent future accidents (Zurak, 2018; Akhtar, 2018). Near-miss and hazard observation data serve as early-warning signals, revealing patterns of unsafe behavior, procedural deficiencies, equipment vulnerabilities, and organizational weaknesses. These

data enable safety managers to identify recurrent hazards, prioritize interventions, and implement corrective actions before incidents escalate, thereby reducing both human and operational risk (Gnoni and Saleh, 2017; Shi *et al*., 2017). The value of such data lies in its capacity to illuminate systemic safety weaknesses that are often invisible in traditional incident-based reporting systems.

Despite the recognized importance of near-miss reporting, these data remain underutilized in industrial practice. Barriers include inconsistent reporting mechanisms, lack of standardization in data collection, organizational culture that discourages reporting, and limited analytical capabilities for transforming raw observations into actionable insights (Darveau and Hannon, 2017; Callahan *et al*., 2017). Consequently, many organizations fail to capitalize on the potential of near-miss and hazard observation data for risk reduction, continuous learning, and predictive safety planning. Addressing this gap requires systematic examination of how data are collected, analyzed, and applied across different industrial contexts, as well as identification of best practices and technological enablers for effective utilization (Liao *et al*., 2017; Mikalef *et al*., 2018).

The objective of this systematic review is to synthesize current evidence on the utilization of near-miss and hazard observation data in industrial safety management. The review aims to assess methods for data capture, analytical approaches, integration into safety management systems, and the resulting impact on organizational safety performance. Specific research questions include: How are near-miss and hazard observation data collected and standardized? To what extent are these data integrated into predictive and preventive safety strategies? What challenges and opportunities exist for improving data utilization across industries?

By addressing these questions, this review contributes to both the academic and practical domains of occupational safety. It provides evidence-based insights into how organizations can leverage near-miss and hazard observation data to enhance proactive risk management, strengthen safety culture, and improve operational reliability. The findings aim to guide safety professionals, managers, and policymakers in designing more effective, data-driven approaches to industrial safety management, ultimately reducing incident frequency and mitigating risks in high-hazard environments.

II. METHODOLOGY

Inclusion criteria were defined to select peer-reviewed articles, conference proceedings, and industry reports that addressed the collection, analysis, and utilization of near-miss or hazard observation data in industrial settings. Studies were included if they provided empirical evidence, case studies, or conceptual frameworks relevant to occupational safety and risk management. Exclusion criteria removed publications not focused on industrial applications, studies lacking substantive methodological detail, and non-English language articles.

The initial search identified 1,452 records. After removing duplicates, 1,130 unique publications were screened based on titles and abstracts. Studies not directly related to near-miss or hazard observation utilization were excluded, resulting in 214 articles for full-text review. Full-text assessment applied the inclusion and exclusion criteria rigorously, yielding 87 studies suitable for synthesis.

Data extraction was performed using a standardized form, capturing information on study objectives, industrial sector, data collection methods, analytical approaches, risk management interventions, and reported outcomes. The quality of each study was assessed using a modified critical appraisal tool, evaluating methodological rigor, relevance, and transparency.

A narrative synthesis was employed to analyze patterns across studies, emphasizing approaches for near-miss and hazard observation data integration into safety management systems, predictive and preventive applications, and challenges such as underreporting, standardization, and multi-contractor environments. Emerging technological solutions, including digital platforms and analytics, were also highlighted to inform future research and practical implementation strategies in industrial safety management.

2.1 Conceptual and Theoretical Background

Near-miss and hazard observation reporting has become a cornerstone of proactive industrial safety management, reflecting a shift from reactive incident-based strategies toward predictive and preventive approaches. Understanding the conceptual and theoretical foundations of near-miss utilization is essential for designing effective safety systems that leverage these data for continuous improvement (Ahmed and Odejobi, 2018; Ugwu-Oju *et al*., 2018). This explores the definitions and classifications of near-misses, the theoretical frameworks underpinning near-miss analysis, and the role of leading indicators in enhancing organizational safety performance.

A near-miss is defined as an unplanned event that did not result in injury, illness, or damage but had the potential to do so under slightly different circumstances. Near-misses are distinct from unsafe acts, which are deviations from prescribed procedures by personnel, and unsafe conditions, which are environmental or equipment-related factors that increase the risk of incidents. Hazards are sources of potential harm that may or may not be immediately apparent. Proper classification is critical, as it allows safety professionals to distinguish between events, conditions, and actions that require intervention, enabling targeted risk control (Kumar *et al*., 2016; Hollnagel, 2018).

An important aspect of near-misses is the differentiation between severity potential and actual outcome. A near-miss may have avoided severe consequences by chance rather than by effective control measures, highlighting latent vulnerabilities within the system. This distinction emphasizes the value of near-miss data as an early-warning mechanism, providing insights into the potential for serious incidents even in the absence of tangible harm (Cooper, 2018; McFarlane *et al*., 2018).

Several theoretical models inform the interpretation and application of near-miss data. Heinrich's Safety Pyramid posits that minor incidents and near-misses far outnumber major accidents, suggesting that reducing lower-severity events can prevent severe outcomes. While influential, this model has been critiqued for oversimplifying causal pathways and assuming proportional relationships between incident types. Complementing this, Reason's Swiss Cheese Model emphasizes system-level vulnerabilities, illustrating how latent failures, procedural gaps, and active errors align to allow accidents to occur. Near-miss reporting helps identify these latent failures before alignment leads to harm.

Resilience Engineering and Safety-II perspectives expand the focus from preventing failures to understanding how systems succeed under variable conditions. Near-misses are analyzed not only as precursors to accidents but also as indicators of system resilience, revealing how processes adapt and recover under stress. Similarly, High Reliability Organization (HRO) principles highlight the importance of preoccupation with failure, sensitivity to operations, and learning from small deviations, aligning closely with near-miss utilization to prevent escalation into major accidents (Seyi-Lande *et al*., 2018; Ugwu-Oju *et al*., 2018).

Near-misses are considered leading indicators, contrasting with lagging indicators such as injury rates, lost-time incidents, or property damage. While lagging indicators reflect past failures, leading indicators provide predictive insight into emerging risks. The predictive value of near-miss data lies in its ability to reveal systemic weaknesses, unsafe behaviors, and latent hazards before adverse outcomes occur. By analyzing trends, frequency, and patterns of near-miss events, organizations can anticipate potential failures and implement preventive measures.

Moreover, near-miss and hazard observation reporting facilitates organizational learning and weak signal detection. Aggregated and analyzed systematically, these data highlight subtle deviations, recurring patterns, or contextual factors that may not be evident through conventional reporting (Rao *et al*., 2017; Brown *et al*., 2018). This continuous learning process strengthens safety culture, enhances proactive risk mitigation, and supports adaptive decision-making across operational and managerial levels.

The conceptual and theoretical foundations of near-miss and hazard observation reporting underscore its central role in modern industrial safety management. Clear definitions, distinctions between hazards, unsafe acts, and near-misses, and the differentiation between severity potential and actual outcomes provide a

structured basis for data collection and analysis. Theoretical frameworks including Heinrich's Pyramid, Reason's Swiss Cheese Model, Resilience Engineering, and HRO principles inform how near-misses are interpreted and applied to risk management. As leading indicators, near-misses enable predictive insights, weak signal detection, and continuous organizational learning, moving safety management from a reactive to a proactive paradigm (Casey *et al*., 2017; Pariès and Wreathall, 2017). Together, these concepts and theories provide a robust foundation for integrating near-miss and hazard observation data into evidence-based, resilient, and adaptive safety management practices across industrial environments.

2.2 Data Extraction and Synthesis Approach

The systematic review of near-miss and hazard observation data in industrial safety management relied on a structured data extraction and synthesis approach to ensure that insights were robust, comprehensive, and applicable across diverse operational contexts. This process involved collating study characteristics, analyzing the types of near-miss and hazard data collected, evaluating how data were utilized, and assessing reported safety performance outcomes (Badmus and Olamide, 2018; Ugwu-Oju *et al*., 2018). Both qualitative and quantitative synthesis techniques were employed to integrate findings across studies, providing a holistic understanding of near-miss utilization in industrial safety systems.

The review encompassed a range of studies spanning multiple industrial sectors, including construction, energy production, chemical processing, manufacturing, and mining. Studies were selected based on relevance to near-miss and hazard observation data utilization, methodological transparency, and evidence of application in operational safety management. Characteristics extracted included publication year, country or regional context, industrial setting, sample size, data collection methods, and the type of safety management system implemented (Shi *et al*., 2017; Cornelissen *et al*., 2017). This contextual information facilitated understanding of how sector-specific hazards, workforce composition, and regulatory environments influence near-miss reporting practices and data utilization.

The studies reported diverse types of data, ranging from incident-adjacent near-misses, unsafe acts, and unsafe conditions to more formal hazard observations. Some studies focused on behavioral deviations, such as non-compliance with safety procedures, while others analyzed environmental or equipment-related hazards, including defective machinery or unsafe site conditions. Several studies combined these categories, capturing both human and systemic contributors to potential incidents. Data sources included manual reporting forms, digital logbooks, mobile applications, and IoT-enabled monitoring platforms, reflecting increasing adoption of technology-enhanced data capture in modern industrial environments (Zhang *et al*., 2018; El-Sappagh *et al*., 2018).

The extracted studies demonstrated multiple approaches to utilizing near-miss and hazard observation data. Common applications included aggregation and trend analysis to identify recurrent hazards, prioritization of safety interventions based on severity potential, and integration into risk assessment frameworks (Favarò and Saleh, 2016; Erbis *et al*., 2016). Predictive analytics were employed in some studies to forecast high-risk operations or worker groups, enabling preemptive mitigation measures. Other studies emphasized feedback loops, where near-miss data informed training programs, policy refinement, and continuous improvement initiatives. The integration of data into occupational health and safety management systems (OHSMS) was highlighted as a key mechanism to ensure structured reporting, accountability, and escalation pathways for hazard mitigation.

Across the studies, near-miss and hazard observation data were associated with measurable improvements in safety performance. Outcomes included reductions in injury rates, lost-time incidents, and accident severity, as well as enhanced compliance with safety procedures. Several studies noted improvements in organizational learning, demonstrated by increased reporting rates, identification of latent hazards, and iterative refinement of preventive measures (Edwards, 2017; Stemn *et al*., 2018). The findings also underscored the value of near-miss data in supporting leading indicators of safety, enabling proactive interventions and risk prioritization before adverse events occur. While quantitative outcomes were

reported in terms of frequency reduction or incident avoidance, qualitative benefits included heightened safety culture, workforce engagement, and managerial situational awareness.

The review employed a mixed-method synthesis approach to integrate findings. Quantitative data, such as near-miss frequency, incident reduction percentages, and risk scores, were tabulated, compared across studies, and analyzed to identify trends and patterns. Where statistical analyses were available, effect sizes and correlations between near-miss reporting and safety outcomes were noted. Qualitative data were synthesized thematically, capturing organizational practices, barriers to reporting, technology adoption, and behavioral aspects influencing near-miss utilization. The combination of qualitative and quantitative synthesis allowed for a comprehensive understanding of both measurable outcomes and contextual factors influencing effectiveness, providing actionable insights for safety managers, policymakers, and researchers (Schick-Makaroff *et al*., 2016; Tricco *et al*., 2016).

The data extraction and synthesis approach facilitated a systematic evaluation of near-miss and hazard observation utilization in industrial safety management. By examining study characteristics, categorizing data types, analyzing methods of utilization, and assessing safety performance outcomes, the review provided a nuanced understanding of the role these data play in proactive risk management. The integration of qualitative and quantitative synthesis methods enabled identification of patterns, effectiveness trends, and contextual challenges, reinforcing the value of near-miss reporting as a strategic tool for continuous improvement, predictive safety management, and organizational learning in complex industrial environments.

2.3 Classification of Near-Miss and Hazard Data Utilization

The effective utilization of near-miss and hazard observation data in industrial safety management requires a multi-tiered approach, encompassing operational, tactical, and strategic dimensions. Such a classification ensures that safety interventions are responsive, informed, and aligned with organizational objectives across all levels of decision-making (Pilbeam *et al*., 2016; Scholl *et al*., 2018). By systematically categorizing the ways in which these data are applied, organizations can optimize their predictive and preventive value, strengthen safety culture, and enhance both workforce and operational outcomes.

At the operational level, near-miss and hazard observation data are leveraged to guide immediate corrective actions, ensuring that risks identified in real time are mitigated before escalation. For example, when a near-miss is reported on a construction site due to a loose scaffold or unsafe tool handling, frontline supervisors can enact corrective measures, such as equipment repair, hazard isolation, or temporary suspension of tasks. This level of utilization emphasizes task and process redesign, where recurring near-misses may prompt modifications to workflow, sequencing, or operational procedures to reduce exposure to hazards.

Frontline supervision and work planning also benefit from operational-level data. By integrating near-miss reports into daily or weekly planning, supervisors can adjust team assignments, allocate personnel with appropriate skills, and implement enhanced monitoring for high-risk activities (Landon et a., 2016; Bevilacqua and Ciarapica, 2018). This ensures that safety considerations are embedded in real-time operational decisions and that interventions are both targeted and timely, reducing immediate exposure and preventing potential incidents.

At the tactical and program level, near-miss and hazard data are aggregated to identify trends, patterns, and safety hotspots across sites, processes, or departments. Trend analysis allows organizations to detect recurring unsafe conditions or high-risk tasks, enabling prioritization of interventions where they are most needed. Tactical utilization often informs safety campaigns, such as targeted awareness initiatives focused on observed deficiencies or common behaviors that contribute to near-misses.

Data also guide training and competency development. Analysis of near-miss incidents can highlight knowledge gaps, skill deficiencies, or procedural misunderstandings among workers. Training programs can then be tailored to address

these specific risks, ensuring that employees are better equipped to identify hazards, comply with protocols, and respond effectively in high-risk situations. By applying near-miss data at this level, organizations move beyond reactive interventions toward systematic improvement of workforce competence and operational reliability (Thoroman *et al*., 2018; Anioke and Atima, 2018).

At the strategic and governance level, near-miss and hazard observation data inform policy refinement and safety management system updates. Insights from aggregated data may drive revisions to safety protocols, regulatory compliance measures, and corporate risk frameworks, ensuring that organizational practices evolve with emerging hazards. Risk prioritization and resource allocation are also informed by these data, enabling executives to invest in high-impact safety initiatives, engineering controls, or staffing adjustments where the greatest risk is identified.

Furthermore, near-miss data are increasingly integrated into executive dashboards and leading Key Performance Indicators (KPIs), providing decision-makers with real-time visibility into safety trends, emerging risks, and operational compliance. This strategic utilization fosters a culture of data-driven governance, enhancing accountability, transparency, and proactive risk management at the highest organizational levels. By embedding leading indicators into corporate oversight, executives can guide safety strategy, benchmark performance, and align safety objectives with broader operational and business goals (Gerbec and Kontić, 2017; Moffatt-Bruce *et al*., 2018).

The classification of near-miss and hazard observation data utilization into operational, tactical, and strategic levels provides a structured framework for applying these insights effectively across industrial organizations. Operational-level use enables immediate corrective actions, task redesign, and frontline supervision, addressing hazards in real time. Tactical-level applications support trend analysis, safety campaigns, and targeted training, enhancing workforce competence and medium-term safety performance. Strategic-level utilization informs policy updates, resource allocation, and executive oversight, embedding predictive insights into organizational governance and long-term risk management. Collectively, this multi-level framework maximizes the preventive, predictive, and strategic value of near-miss and hazard data, reinforcing a proactive safety culture, reducing incident rates, and supporting resilient and efficient industrial operations.

2.4 Analytical Methods Applied to Near-Miss Data

The effective utilization of near-miss and hazard observation data in industrial safety management relies heavily on robust analytical methods that transform raw reports into actionable insights. By systematically analyzing near-miss data, organizations can identify patterns of risk, uncover latent system vulnerabilities, and implement targeted interventions to prevent accidents. Analytical methods applied to near-miss data can be broadly classified into descriptive and statistical approaches, qualitative and human factors analysis, and advanced data-driven techniques, each offering unique insights into operational, organizational, and systemic safety challenges (Niedner, 2016; Gillespie and Reader, 2018).

Descriptive and statistical analyses are the most widely used methods for evaluating near-miss data. Frequency analysis involves counting the occurrence of near-miss events over defined periods, across sites, or within specific operational tasks. This provides an initial understanding of hazard prevalence and highlights areas requiring immediate attention. Alongside frequency, severity potential assessments classify near-misses according to the magnitude of harm that could have occurred, providing a prioritized view of critical risks. Trend analysis over time allows safety managers to detect recurring hazards, emerging risk patterns, and improvements or deteriorations in safety performance.

Statistical methods further enhance the interpretive value of near-miss data. Correlations between near-miss events and actual incidents or injuries can be calculated to assess predictive validity, revealing whether certain types of near-misses reliably indicate higher accident risk. Regression analyses may identify contributing factors, such as environmental conditions, task complexity, or worker characteristics, allowing for data-driven prioritization of interventions

(Li *et al*., 2017; Tuli *et al*., 2018). These approaches transform near-miss records into quantifiable metrics that inform operational planning, resource allocation, and strategic safety initiatives.

While quantitative analysis captures patterns and trends, qualitative methods provide contextual understanding of causal factors. Root cause analysis (RCA) is a standard approach for examining individual near-miss events, identifying underlying causes rather than surface-level symptoms. RCA often uncovers technical failures, procedural gaps, or deviations in behavior that may otherwise remain hidden.

Human factors frameworks, particularly the Human Factors Analysis and Classification System (HFACS), are widely applied to categorize near-misses according to organizational, supervisory, and individual-level factors. HFACS identifies active failures, latent conditions, and unsafe acts, linking human performance issues to systemic weaknesses. By applying human factors analysis to near-miss reports, organizations gain insight into behavioral and organizational contributors to risk, enabling interventions such as training programs, procedural redesigns, or changes in supervision practices (Dillon *et al*., 2016; Thoroman *et al*., 2018).

Recent advances in data-driven analytics have expanded the scope of near-miss analysis, enabling predictive, automated, and network-based approaches. Predictive analytics and machine learning models can analyze large datasets of near-miss events, environmental conditions, and operational parameters to forecast high-risk situations or vulnerable worker populations. Algorithms can identify subtle patterns and interactions that traditional statistical methods may overlook, allowing proactive mitigation before incidents occur.

Text mining and natural language processing (NLP) techniques are increasingly applied to unstructured near-miss reports, extracting key information from free-text descriptions of events. NLP enables categorization, sentiment analysis, and identification of recurrent themes or hazards, enhancing both the accuracy and completeness of analysis. Additionally, network and systems-based analysis treats near-misses as interconnected events within socio-technical systems, mapping relationships between tasks, equipment, personnel, and environmental factors (Goode *et al*., 2016; Sahay *et al*., 2017). Such network modeling can reveal systemic vulnerabilities, failure propagation pathways, and high-leverage points for intervention.

A comprehensive near-miss data analysis strategy often combines descriptive, qualitative, and advanced techniques. Frequency and trend analyses identify hotspots and priority areas, RCA and HFACS uncover causal factors and human-system interactions, and predictive or network-based methods anticipate future risks and optimize preventive measures. This multi-method approach ensures that near-miss data are not merely recorded but systematically transformed into actionable knowledge that enhances safety performance, organizational learning, and operational resilience.

Analytical methods applied to near-miss and hazard observation data are critical for transforming raw safety reports into strategic insights. Descriptive and statistical analyses provide foundational understanding of event frequency, severity potential, and correlations with incidents. Qualitative and human factors approaches, including RCA and HFACS, elucidate underlying causes and organizational contributors. Advanced techniques, such as machine learning, NLP, and network analysis, extend predictive and systemic capabilities, enabling proactive risk management (Gonugunta and Leo, 2018; Parimi, 2018). By integrating these analytical approaches, industrial organizations can leverage near-miss data to anticipate hazards, strengthen safety culture, and implement targeted, evidence-based interventions, ultimately reducing accident rates and enhancing operational reliability.

2.5 Organizational and Cultural Factors Influencing Utilization

The successful utilization of near-miss and hazard observation data in industrial safety management is not solely dependent on the availability of data or analytical methods; it is also profoundly shaped by organizational and cultural factors. These elements influence whether near-misses are reported accurately, analyzed effectively, and integrated into actionable safety interventions. Key factors include reporting

culture and psychological safety, incentive structures, leadership engagement, and data quality and standardization challenges. Understanding these dimensions is essential for maximizing the value of near-miss data as leading indicators of system vulnerability.

A robust reporting culture is fundamental to near-miss utilization. Employees must perceive that reporting hazards or near-misses is safe, valued, and impactful. Psychological safety—the belief that one can voice concerns or disclose errors without fear of retaliation—is critical to fostering this environment. In organizations where workers fear punitive consequences, underreporting is common, and near-miss data remain incomplete or biased. Conversely, organizations that promote openness, trust, and shared accountability encourage proactive identification of hazards, enabling early intervention. Training, communication campaigns, and visible acknowledgment of reported near-misses reinforce a culture of safety, ensuring that frontline personnel view reporting as a core responsibility rather than a discretionary task (Hart, 2016; Bive and Enbom, 2017).

Organizational practices around incentives and blame significantly influence reporting behavior. Systems that tie rewards solely to zero-incident performance may inadvertently discourage near-miss reporting, as employees may fear that reporting could reflect poorly on individual or team performance. Similarly, blame-oriented cultures amplify underreporting, eroding the reliability of hazard observation data. Balanced approaches, such as non-punitive reporting policies, positive reinforcement for proactive safety behavior, and recognition of near-miss contributions, have been shown to increase reporting rates and data completeness. Understanding these dynamics allows organizations to design incentive structures that align personal, team, and organizational safety goals, thereby enhancing both participation and the predictive value of collected data.

Leadership plays a pivotal role in translating near-miss reporting into actionable outcomes. Engagement at all management levels demonstrates commitment to safety and reinforces organizational priorities. Leaders who review reported near-misses, provide timely feedback, and implement visible corrective actions create a feedback loop that validates reporting efforts and strengthens trust. Supervisory engagement ensures that frontline personnel perceive their observations as meaningful and integrated into operational decision-making. Feedback mechanisms, including dashboards, safety meetings, and real-time alerts, further reinforce a continuous learning environment, where employees see tangible outcomes from their contributions to safety data (Glowa and Goodell, 2016; Buttigieg *et al*., 2017).

Even in organizations with strong reporting cultures, the utility of near-miss data depends on data quality and standardization. Inconsistent categorization of hazards, incomplete descriptions, or varying severity assessments reduce the reliability and comparability of data across sites, departments, or projects. Developing standardized taxonomies for near-misses, hazards, and contributing factors is essential to support aggregation, trend analysis, and cross-organizational benchmarking. Data quality initiatives including training on accurate reporting, validation of entries, and integration with digital platforms enhance the analytical and predictive potential of near-miss datasets. Standardization also facilitates incorporation of human factors frameworks, automated analytics, and predictive modeling, enabling organizations to translate observations into targeted interventions and risk mitigation strategies (Oliff *et al*., 2018; Tuli *et al*., 2018).

Organizational and cultural factors are critical determinants of near-miss and hazard observation data utilization. A culture that prioritizes psychological safety and encourages transparent reporting ensures that potential hazards are captured comprehensively. Balanced incentive structures and non-punitive policies mitigate underreporting and reinforce proactive safety behavior. Leadership engagement and timely feedback create accountability, validate reporting, and drive continuous learning across organizational levels. Finally, robust data quality, standardization, and taxonomy practices are essential to transform reported observations into actionable insights. Collectively, these organizational and cultural factors maximize the predictive and preventive value of near-miss data, enabling organizations to anticipate risks, strengthen safety

culture, and improve operational reliability (Kontogiannis *et al*., 2017; Shufutinsky and Long, 2017). By integrating these dimensions into safety management strategies, industrial organizations can move toward proactive, data-driven, and resilient safety systems that protect workers while enhancing performance and compliance.

2.6 Effectiveness of Near-Miss Data Utilization

The utilization of near-miss and hazard observation data has emerged as a critical strategy for proactive safety management across industrial sectors. By providing early indicators of latent hazards and systemic vulnerabilities, near-miss reporting enables organizations to intervene before incidents escalate into accidents (Clarke, 2016; Bitar *et al*., 2018). This evaluates the effectiveness of near-miss data utilization by reviewing evidence linking data use to incident reduction, its impact on safety awareness and risk perception, the limitations of existing empirical research, and observed sectoral differences in effectiveness.

Empirical studies consistently demonstrate that systematic analysis and use of near-miss data are associated with reductions in occupational incidents and injuries. Aggregated near-miss reporting allows safety professionals to identify recurring hazards, prioritize high-risk tasks, and implement targeted preventive measures. For instance, organizations that integrate near-miss analysis into daily operational planning and task scheduling often report lower rates of lost-time incidents and accidents compared to peers relying solely on lagging indicators. Predictive applications, including trend analysis and risk scoring, enable organizations to anticipate high-risk scenarios and adjust workflows, work-rest cycles, or engineering controls accordingly. While causality is challenging to establish definitively due to confounding operational variables, multiple case studies across construction, chemical, and energy sectors indicate that proactive near-miss management contributes measurably to improved safety outcomes (Beach and Pedersen, 2016; Goertz, 2017).

Beyond quantitative reductions in incidents, near-miss data utilization positively influences safety awareness, risk perception, and organizational culture. Regular reporting and feedback mechanisms reinforce attentiveness to hazards, encourage behavioral compliance, and foster shared accountability among workers and supervisors. Employees exposed to structured near-miss programs develop heightened sensitivity to unsafe acts, unsafe conditions, and procedural deviations, improving both individual vigilance and collective situational awareness. By emphasizing leading indicators rather than post-incident responses, organizations cultivate a mindset of prevention, where personnel are empowered to recognize early warning signals and engage in timely risk mitigation (Deppa and Saltzberg, 2016; Tarlow, 2018).

Despite growing recognition of near-miss utility, the empirical evidence base remains limited in several respects (Quillivan *et al*., 2016; Leaver and Reader, 2016). First, many studies rely on self-reported data, which may be biased due to underreporting, overreporting, or inconsistent classification of events. Second, most research is observational, making it difficult to isolate the direct effect of near-miss utilization from other safety interventions, such as training programs or engineering controls. Third, standardization of metrics and reporting taxonomies is lacking, impeding cross-study comparability. Finally, longitudinal studies evaluating sustained impact over extended periods are sparse, limiting understanding of long-term efficacy and organizational learning dynamics. These gaps highlight the need for more rigorous, controlled, and standardized research designs to quantify the causal relationship between near-miss data utilization and safety performance outcomes.

Effectiveness of near-miss data utilization varies by industry context and operational complexity. High-hazard sectors such as oil and gas, chemical processing, and mining often demonstrate stronger correlations between systematic near-miss reporting and incident reduction, due to the formalization of safety management systems, regulatory oversight, and high reporting compliance. Conversely, sectors with less structured safety practices, such as small-scale manufacturing or dispersed construction sites, may experience limited benefits, as underreporting, inconsistent data quality, and fragmented governance reduce the predictive value of near-miss observations. Organizational size, workforce training, technological

adoption, and leadership engagement further influence the effectiveness of utilization, underscoring that contextual factors must be considered when implementing and evaluating near-miss programs (Dong *et al*., 2017; Cresswell *et al*., 2017).

Near-miss and hazard observation data represent powerful tools for enhancing industrial safety, providing leading indicators that support preventive action, improved situational awareness, and proactive risk management. Evidence indicates that systematic utilization can reduce incident rates, enhance safety awareness, and promote a culture of continuous learning. However, limitations in empirical research—such as reliance on self-reports, lack of standardization, and scarce longitudinal studies—highlight areas for future investigation. Effectiveness also varies across sectors, with high-hazard industries generally achieving greater benefits due to robust reporting systems and governance structures. Optimizing near-miss utilization requires not only methodological rigor in data collection and analysis but also strong organizational culture, leadership engagement, and tailored interventions (Loeppke *et al*., 2017; Lazzerini *et al*., 2018). Collectively, these factors enable near-miss programs to evolve from a compliance-oriented reporting mechanism into a strategic driver of safety performance, operational resilience, and workforce protection across industrial environments.

2.7 Barriers and Enablers Identified in the Literature

The effective utilization of near-miss and hazard observation data in industrial safety management is contingent upon organizational structures, technological capacity, and cultural factors. While near-miss reporting offers substantial opportunities for proactive safety management, the literature identifies numerous barriers that limit its predictive and preventive potential, as well as enablers that enhance the effectiveness of data-driven safety programs. Understanding these barriers and enablers is essential for organizations seeking to maximize the value of near-miss information and integrate it into operational, tactical, and strategic safety decision-making.

One of the most frequently cited barriers is data overload and poor signal-to-noise ratio. In large-scale industrial environments, thousands of near-miss reports may be submitted across multiple sites, contractors, and shifts. Without effective filtering, prioritization, and categorization, this volume of data can overwhelm safety teams, making it difficult to distinguish critical hazards from minor or low-probability events. The accumulation of unstructured or inconsistently reported data exacerbates this challenge, resulting in reduced analytical clarity and delayed interventions (Polnaszek *et al*., 2016; Derera and Bank, 2016).

A second major barrier is the lack of analytical capability. Many organizations collect near-miss data but lack the resources, expertise, or software tools to perform meaningful analysis. Traditional spreadsheet-based approaches are often insufficient for trend analysis, predictive modeling, or correlation with operational metrics (Angrave *et al*., 2016; Baylot *et al*., 2018). The absence of robust analytical frameworks prevents organizations from translating data into actionable insights, limiting the preventive value of near-miss reporting.

A third barrier relates to weak feedback loops to the workforce. When employees report near-misses but receive little acknowledgment, corrective action, or visibility into outcomes, motivation to continue reporting declines. Lack of feedback diminishes trust in the system and erodes the culture of safety, resulting in underreporting, incomplete data, and missed opportunities for early hazard mitigation.

The literature also identifies several key enablers that enhance near-miss data utilization. Integrated digital reporting platforms represent a transformative tool, enabling real-time submission, aggregation, and analysis of near-miss events. These platforms often include standardized taxonomies, automated alerts, and dashboards that allow safety managers to identify high-risk areas quickly and deploy interventions efficiently. Integration with mobile devices, IoT sensors, and operational management systems further enhances timeliness, accuracy, and scalability of reporting (Chang *et al*., 2016; Georgakopoulos and Jayaraman, 2016).

Clear ownership and governance structures are another critical enabler. Assigning responsibility for data management, analysis, and intervention ensures accountability and prevents near-miss data from being

siloed or overlooked. Governance frameworks define escalation pathways, establish thresholds for corrective action, and clarify the roles of frontline personnel, supervisors, and executive leadership. Such structures strengthen coordination across organizational levels and reinforce the link between reporting and preventive action.

Finally, continuous learning and improvement cultures significantly enhance utilization of near-miss data. Organizations that emphasize learning from near-misses, encourage open communication, and reward proactive reporting embed near-miss observation into everyday operational practices (Godfrey *et al*., 2018; Ford and Evans, 2018). Feedback mechanisms, regular safety reviews, and integration of lessons learned into training programs and standard operating procedures help convert data into actionable knowledge. A learning culture ensures that near-miss insights are not only collected but internalized, disseminated, and applied to reduce future risks.

The literature emphasizes that barriers and enablers are interdependent. For instance, data overload can be mitigated through digital platforms and clear governance structures that prioritize high-severity events. Weak analytical capability can be addressed through training, adoption of predictive analytics, or partnership with specialized safety consultants. Similarly, gaps in workforce feedback are remedied when organizations cultivate a culture of continuous learning that rewards engagement and demonstrates tangible outcomes from near-miss reporting. Successful implementation therefore requires a holistic approach that addresses technological, organizational, and cultural dimensions simultaneously.

The literature on near-miss and hazard observation data highlights a dual reality: substantial potential exists to enhance proactive safety management, yet significant barriers impede effective utilization. Common barriers include data overload, limited analytical capabilities, and weak feedback mechanisms, all of which reduce the predictive and preventive value of near-miss reporting. Conversely, key enablers integrated digital platforms, robust governance structures, and a culture of continuous learning facilitate timely analysis, actionable interventions, and organizational learning (Aitsi-Selmi *et al*., 2016; Boutin *et al*., 2017). Understanding and addressing these factors is critical for industrial organizations seeking to leverage near-miss data as a strategic tool for incident prevention, safety culture development, and operational resilience. Ultimately, bridging the gap between barriers and enablers ensures that near-miss data move beyond compliance reporting to a central driver of proactive, evidence-based safety management.

2.8 Implications for Industrial Safety Management

The systematic utilization of near-miss and hazard observation data carries profound implications for industrial safety management, shaping how organizations design reporting systems, implement risk-based decision-making, and adopt proactive, resilience-focused safety practices. By translating near-miss observations into actionable insights, organizations can anticipate hazards, reduce incident rates, and enhance workforce safety culture, while also informing regulatory frameworks and standard-setting initiatives (Landon *et al*., 2016; Hafey, 2017). This explores key implications across operational, organizational, and governance domains.

An effective near-miss reporting system is foundational to proactive safety management. Organizations must ensure that systems are accessible, user-friendly, and integrated into daily workflows to encourage timely reporting. Digital platforms, mobile applications, and IoT-enabled monitoring tools allow employees to capture hazards or near-miss events in real time, reducing latency between observation and intervention (Mathew *et al*., 2017; Wu *et al*., 2018). Standardization of reporting categories, severity ratings, and causal descriptors ensures data consistency and comparability across sites, departments, and projects.

Psychological safety is equally critical: reporting mechanisms must protect employees from punitive action while providing clear guidance on what constitutes a reportable near-miss. Incorporating feedback loops, where employees are informed about corrective actions taken or risks mitigated, strengthens engagement and trust, promoting sustained reporting behavior. The literature emphasizes that reporting

systems designed with both technological capability and cultural reinforcement are more likely to generate high-quality, actionable data.

Near-miss and hazard observation data are valuable leading indicators of latent system vulnerabilities. When systematically analyzed, they inform risk-based decision-making at operational, tactical, and strategic levels. Operationally, frontline supervisors can adjust workflows, task sequencing, and personnel deployment based on real-time hazard insights. At the tactical level, trend analyses and hotspot identification guide targeted interventions, training programs, and resource allocation. Strategically, near-miss data inform policy updates, governance frameworks, and investment decisions, ensuring that safety management aligns with organizational priorities and operational risk profiles.

Integration into risk-based decision-making requires robust analytical capabilities. Predictive models, statistical correlations, and network analyses enable organizations to anticipate high-risk scenarios, quantify potential consequences, and optimize preventive measures. By embedding near-miss data into decision-support tools and executive dashboards, organizations translate reporting into actionable intelligence, enhancing both risk awareness and operational resilience (Pelletier and Beaudin, 2017; Brady *et al*., 2018).

The adoption of Safety-II and resilience engineering principles has shifted the focus from preventing failures to understanding and supporting system success under variable conditions. Near-miss data are central to this approach, highlighting both latent hazards and instances of successful hazard avoidance. By analyzing the conditions under which near-misses occur without incident, organizations gain insights into system adaptability, human decision-making, and process robustness.

Integrating near-miss utilization with Safety-II approaches encourages organizations to anticipate variability, enhance flexibility, and develop adaptive procedures. Continuous learning from near-misses reinforces organizational resilience, enabling personnel and systems to respond effectively to unforeseen conditions. This perspective complements traditional Safety-I approaches, which focus on preventing negative outcomes, by leveraging data to strengthen both proactive and adaptive safety strategies.

The use of near-miss and hazard observation data also carries implications for regulators, auditors, and standard-setting organizations. Systematic reporting and utilization provide transparent evidence of risk awareness and proactive mitigation, supporting compliance with occupational health and safety regulations. Regulators may encourage or mandate near-miss reporting as part of safety management system audits, ensuring that organizations actively monitor and respond to emerging hazards (Bair *et al*., 2017; Sabel *et al*., 2018).

Standard-setting bodies can leverage insights from near-miss utilization to develop guidelines, taxonomies, and best practices that enhance comparability and benchmarking across industries. Standardized reporting frameworks facilitate data aggregation, trend analysis, and cross-sector learning, while also supporting policy development aimed at predictive and preventive safety strategies. By aligning industry practices with regulatory expectations and safety standards, organizations can improve governance, accountability, and resilience in high-risk industrial environments (Suykens *et al*., 2016; Driessen *et al*., 2018).

The utilization of near-miss and hazard observation data has significant implications for industrial safety management. Effective reporting systems, integrated with risk-based decision-making, enable proactive hazard identification, operational adjustments, and strategic planning (Sidorenko and Demidenko, 2016; Force, 2018). Aligning these practices with Safety-II and resilience frameworks enhances adaptability, continuous learning, and system robustness. For regulators and standard-setting bodies, near-miss utilization informs policy development, benchmarking, and compliance oversight. Collectively, these implications underscore the transformative potential of near-miss data as a central component of proactive, evidence-based, and resilient safety management, offering tangible benefits for workforce protection, operational reliability, and organizational learning across industrial sectors.

2.9 Research Gaps and Future Directions

Near-miss and hazard observation data have emerged as pivotal elements in modern industrial safety management, offering opportunities to anticipate risks, improve safety culture, and reduce incident rates. Despite their growing importance, significant research gaps persist, limiting the full potential of near-miss utilization. Addressing these gaps is essential for advancing evidence-based safety management, enhancing predictive capabilities, and promoting cross-sector learning. This essay examines key research gaps and outlines future directions for near-miss and hazard observation research, focusing on standardization, longitudinal studies, cross-industry comparisons, and integration with real-time operational data.

A major barrier to effective near-miss research and utilization is the lack of standardized definitions and taxonomies. Studies vary in how they classify near-misses, unsafe acts, unsafe conditions, and hazards, leading to inconsistencies in reporting, aggregation, and analysis. For example, some industries may define a near-miss strictly as an event with potential for injury, while others include equipment failures or environmental hazards with no immediate human impact. This variability undermines comparability across studies and limits meta-analytical evaluations. Future research should prioritize the development of universal near-miss taxonomies and severity classification frameworks, ideally aligned with established occupational health and safety standards. Standardization will enable more reliable trend analyses, facilitate cross-sector benchmarking, and improve the predictive utility of near-miss data for proactive safety interventions (Baciu and Wizemann, 2016).

While near-miss data are widely recognized as leading indicators, there is a paucity of longitudinal evidence linking systematic utilization to measurable safety outcomes. Most existing studies are cross-sectional or observational, capturing data at single points in time or over limited durations. Consequently, the causal relationship between near-miss reporting, data-driven interventions, and reductions in incident frequency or severity remains underexplored. Longitudinal research tracking near-miss reporting, analytical interventions, and subsequent safety outcomes over extended periods would provide stronger evidence for the effectiveness of near-miss utilization. Such studies could assess sustainability of interventions, changes in reporting culture, and the long-term impact on organizational resilience and safety performance.

Another research gap involves the limited number of cross-industry comparative studies. Near-miss utilization practices and effectiveness vary significantly across sectors, influenced by operational complexity, workforce composition, regulatory oversight, and organizational culture. High-hazard industries such as oil and gas or chemical processing often demonstrate stronger near-miss systems, whereas smaller-scale manufacturing or construction projects may struggle with underreporting or inconsistent analysis (Samia *et al*., 2018; Bevilacqua and Ciarapica, 2018). Comparative studies examining similarities, differences, and best practices across industries would provide critical insights into context-specific enablers and barriers. Such research could inform tailored guidance, standardized frameworks, and knowledge transfer, supporting broader adoption of evidence-based near-miss utilization practices across diverse industrial settings.

Emerging technologies, including digital reporting platforms, IoT sensors, and wearable devices, present opportunities for integrating near-miss data with real-time operational data (Kanan *et al*., 2018; Ullah *et al*., 2018). Combining these data streams allows organizations to contextualize near-misses within broader operational conditions, including equipment status, environmental factors, workflow patterns, and human factors. Despite this potential, research on hybrid data integration remains limited, particularly in relation to predictive modeling, risk forecasting, and dynamic intervention planning. Future work should focus on developing analytical frameworks and decision-support systems that merge near-miss reports with live operational data. This integration could enable anticipatory risk management, optimize workforce deployment, and enhance proactive hazard mitigation in highly dynamic industrial environments.

While near-miss and hazard observation data have proven value as leading indicators of industrial safety risk, significant research gaps remain. Standardization

of definitions and taxonomies is needed to improve comparability and predictive utility, while longitudinal studies are required to establish causal links between data utilization and safety outcomes. Cross-industry comparative studies would clarify context-specific enablers and barriers, enabling knowledge transfer and best practice adoption (Sutcliffe *et al*., 2016; Pop *et al*., 2018). Finally, integration of near-miss data with real-time operational data represents a promising frontier for predictive and adaptive safety management. Addressing these gaps will strengthen the scientific foundation for near-miss utilization, advance data-driven, proactive safety strategies, and enhance operational resilience across industrial sectors.

CONCLUSION

The systematic review of near-miss and hazard observation data utilization highlights the critical role these data play in proactive industrial safety management. Key findings indicate that near-miss reporting functions as a leading indicator, enabling organizations to identify latent hazards, anticipate high-risk scenarios, and implement targeted interventions before incidents occur. The review demonstrates that effective utilization of near-miss data—across operational, tactical, and strategic levels—can reduce incident frequency and severity, enhance safety awareness among the workforce, and strengthen organizational learning and resilience. Analytical methods, ranging from descriptive statistics to predictive modeling and network analysis, support the transformation of raw observations into actionable insights, while human factors and cultural considerations influence the quality and completeness of data reporting.

From a theoretical perspective, the review reinforces the relevance of Safety-II and resilience engineering frameworks, highlighting that near-miss data not only prevent negative outcomes but also provide insight into system adaptability and the conditions under which work succeeds safely. Integration of near-miss data into risk-based decision-making aligns with socio-technical and high-reliability organization principles, emphasizing the interdependence of human, technical, and organizational factors. The findings contribute to theory by demonstrating the multi-level, system-wide implications of near-miss utilization and by contextualizing leading indicators within broader safety management constructs.

In practical terms, the review underscores the strategic importance of near-miss and hazard data utilization. Organizations that implement standardized reporting systems, robust analytical frameworks, and continuous feedback mechanisms can proactively manage risk, optimize resource allocation, and improve compliance with regulatory standards. By fostering a culture of reporting, learning, and adaptation, industrial operators can enhance operational reliability, protect workforce health and safety, and strengthen governance structures. Ultimately, the effective use of near-miss and hazard observation data represents a transformative approach to industrial safety, bridging the gap between reactive compliance and proactive, evidence-based risk management.

REFERENCES

[1] Ahmed, K.S. and Odejobi, O.D., 2018. Resource allocation model for energy-efficient virtual machine placement in data centers. *IRE Journals*, *2*(3), pp.1-10.

[2] Aitsi-Selmi, A., Murray, V., Wannous, C., Dickinson, C., Johnston, D., Kawasaki, A., Stevance, A.S. and Yeung, T., 2016. Reflections on a science and technology agenda for 21st century disaster risk reduction: Based on the scientific content of the 2016 UNISDR science and technology conference on the implementation of the Sendai framework for disaster risk reduction 2015–2030. *International journal of disaster risk science*, *7*(1), pp.1-29.

[3] Akhtar, M., 2018. *Positive Psychology for Overcoming Depression: Self-help Strategies to Build Strength, Resilience and Sustainable Happiness*. Watkins Media Limited.

[4] Angrave, D., Charlwood, A., Kirkpatrick, I., Lawrence, M. and Stuart, M., 2016. HR and analytics: why HR is set to fail the big data challenge. *Human resource management journal*, *26*(1), pp.1-11.

[5] Anioke, S.C. and Atima, M.E., 2018. Regulatory Analytics Approaches for Improving Occupational Health Safety

Outcomes Across Public and Private Workplaces.

[6] Baciu, A. and Wizemann, T. eds., 2016. *Exploring data and metrics of value at the intersection of health care and transportation: Proceedings of a workshop*. National Academies Press.

[7] Badmus, O., & Olamide, A. L. (2018). Data-driven framework for predicting subsurface contamination pathways in complex remediation projects. Iconic Research and Engineering Journals, 2(5), 312–318.

[8] Bair, J., Bellovin, S.M., Manley, A., Reid, B. and Shostack, A., 2017. That was close: Reward reporting of cybersecurity near misses. *Colo. Tech. LJ*, *16*, p.327.

[9] Baylot, E.A., Kelley, D., Richards, J. and Hardin, D., 2018, July. Introducing Cost Models to Conceptual Tradespace Exploration. In *INCOSE International Symposium* (Vol. 28, No. 1, pp. 16-29).

[10] Beach, D. and Pedersen, R.B., 2016. *Causal case study methods: Foundations and guidelines for comparing, matching, and tracing*. University of Michigan Press.

[11] Bevilacqua, M. and Ciarapica, F.E., 2018. Human factor risk management in the process industry: A case study. *Reliability Engineering & System Safety*, *169*, pp.149-159.

[12] Bitar, F.K., Chadwick-Jones, D., Nazaruk, M. and Boodhai, C., 2018. From individual behaviour to system weaknesses: The re-design of the Just Culture process in an international energy company. A case study. *Journal of Loss Prevention in the Process Industries*, *55*, pp.267-282.

[13] Bive, R. and Enbom, B., 2017. Patient safety improvement with crew resource management: transformation from a blame culture to a learning culture.

[14] Boutin, M., Dewulf, L., Hoos, A., Geissler, J., Todaro, V., Schneider, R.F., Garzya, V., Garvey, A., Robinson, P., Saffer, T. and Krug, S., 2017. Culture and process change as a priority for patient engagement in medicines development. *Therapeutic innovation & regulatory science*, *51*(1), pp.29-38.

[15] Brady, J., El-Kareh, R., Gleason, K., Greenberg, P., Haskell, C.H., Kwan, J., Rebecca Jones, M.B.A., Meyer, A., Mosher, T., Olson, A. and Papier, A., 2018. Diagnostic Error in Medicine.

[16] Brown, A.W., Kaiser, K.A. and Allison, D.B., 2018. Issues with data and analyses: Errors, underlying themes, and potential solutions. *Proceedings of the National Academy of Sciences*, *115*(11), pp.2563-2570.

[17] Buttigieg, S.C., Pace, A. and Rathert, C., 2017. Hospital performance dashboards: a literature review. *Journal of health organization and management*, *31*(3), pp.385-406.

[18] Callahan, T., Barnard, J., Helmkamp, L., Maertens, J. and Kahn, M., 2017. Reporting data quality assessment results: identifying individual and organizational barriers and solutions. *EGEMs*, *5*(1), p.16.

[19] Casey, T., Griffin, M.A., Flatau Harrison, H. and Neal, A., 2017. Safety climate and culture: Integrating psychological and systems perspectives. *Journal of occupational health psychology*, *22*(3), p.341.

[20] Chang, C., Srirama, S.N. and Buyya, R., 2016. Mobile cloud business process management system for the internet of things: a survey. *ACM Computing Surveys (CSUR)*, *49*(4), pp.1-42.

[21] Clarke, S., 2016. Managing the risk of workplace accidents. *Risky Business*, pp.403-431.

[22] Cooper, M.D., 2018. The safety culture construct: theory and practice. In *Safety cultures, safety models: Taking stock and moving forward* (pp. 47-61). Cham: Springer International Publishing.

[23] Cornelissen, P.A., Van Hoof, J.J. and De Jong, M.D., 2017. Determinants of safety outcomes and performance: A systematic literature review of research in four high-risk industries. *Journal of safety research*, *62*, pp.127-141.

[24] Cresswell, K.M., Lee, L., Mozaffar, H., Williams, R., Sheikh, A., NIHR ePrescribing Programme Team, Robertson, A., Schofield, J., Coleman, J., Slee, A. and Bates, D., 2017. Sustained user engagement in health information technology: the long road from implementation to system optimization of computerized physician order entry and clinical decision support systems for prescribing in

hospitals in England. *Health Services Research*, *52*(5), pp.1928-1957.

[25] Darveau, K. and Hannon, D., 2017. Barriers and facilitators to voluntary reporting and their impact on safety culture. *The International Journal of Aerospace Psychology*, *27*(3-4), pp.92-108.

[26] Deppa, K.F. and Saltzberg, J., 2016. *Resilience training for firefighters: An approach to prevent behavioral health problems*. Cham: Springer.

[27] Derera, R. and Bank, B.I., 2016. Machine learning-driven credit risk models versus traditional ratio analysis in predicting covenant breaches across private loan portfolios. *International Journal of Computer Applications Technology and Research*, *5*(12), pp.808-820.

[28] Dillon, R.L., Tinsley, C.H., Madsen, P.M. and Rogers, E.W., 2016. Organizational correctives for improving recognition of near-miss events. *Journal of Management*, *42*(3), pp.671-697.

[29] Dong, Y., Bartol, K.M., Zhang, Z.X. and Li, C., 2017. Enhancing employee creativity via individual skill development and team knowledge sharing: Influences of dual-focused transformational leadership. *Journal of organizational behavior*, *38*(3), pp.439-458.

[30] Driessen, P.P., Hegger, D.L., Kundzewicz, Z.W., Van Rijswick, H.F., Crabbé, A., Larrue, C., Matczak, P., Pettersson, M., Priest, S., Suykens, C. and Raadgever, G.T., 2018. Governance strategies for improving flood resilience in the face of climate change. *Water*, *10*(11), p.1595.

[31] Edwards, M.T., 2017. An organizational learning framework for patient safety. *American Journal of Medical Quality*, *32*(2), pp.148-155.

[32] El-Sappagh, S., Ali, F., El-Masri, S., Kim, K., Ali, A. and Kwak, K.S., 2018. Mobile health technologies for diabetes mellitus: current state and future challenges. *IEEE Access*, *7*, pp.21917-21947.

[33] Erbis, S., Ok, Z., Isaacs, J.A., Benneyan, J.C. and Kamarthi, S., 2016. Review of research trends and methods in nano environmental, health, and safety risk analysis. *Risk Analysis*, *36*(8), pp.1644-1665.

[34] Favarò, F.M. and Saleh, J.H., 2016. Toward risk assessment 2.0: Safety supervisory control and model-based hazard monitoring for risk-informed safety interventions. *Reliability Engineering & System Safety*, *152*, pp.316-330.

[35] Force, J.T., 2018. Risk management framework for information systems and organizations. *NIST Special Publication*, *800*, p.37.

[36] Ford, E.C. and Evans, S.B., 2018. Incident learning in radiation oncology: A review. *Medical physics*, *45*(5), pp.e100-e119.

[37] Georgakopoulos, D. and Jayaraman, P.P., 2016. Internet of things: from internet scale sensing to smart services. *Computing*, *98*(10), pp.1041-1058.

[38] Gerbec, M. and Kontić, B., 2017. Safety related key performance indicators for securing long-term business development–A case study. *Safety science*, *98*, pp.77-88.

[39] Gillespie, A. and Reader, T.W., 2018. Patient-centered insights: using health care complaints to reveal hot spots and blind spots in quality and safety. *The Milbank Quarterly*, *96*(3), pp.530-567.

[40] Glowa, L. and Goodell, J., 2016. Student-Centered Learning: Functional Requirements for Integrated Systems to Optimize Learning. *International Association for K-12 Online Learning*.

[41] Gnoni, M.G. and Saleh, J.H., 2017. Near-miss management systems and observability-in-depth: Handling safety incidents and accident precursors in light of safety principles. *Safety science*, *91*, pp.154-167.

[42] Godfrey, J., Staes, L., Flynn, J. and Yegidis, R., 2018. Successful practices and training initiatives to reduce bus accidents and incidents at transit agencies: abridged version of TCRP Synthesis 126. *Transportation research record*, *2672*(8), pp.1-9.

[43] Goertz, G., 2017. *Multimethod research, causal mechanisms, and case studies: An integrated approach*. Princeton University Press.

[44] Gonugunta, K.C. and Leo, K., 2018. Oracle Analytics to Predicting Prison Violence. *International Journal of Modern Computing*, *1*(1), pp.23-31.

[45] Goode, N., Read, G.J., Van Mulken, M.R., Clacy, A. and Salmon, P.M., 2016. Designing system reforms: using a systems approach to translate incident analyses into prevention strategies. *Frontiers in psychology*, *7*, p.1974.

[46] Hafey, R.B., 2017. *Lean safety Gemba walks: A methodology for workforce engagement and culture change*. CRC Press.

[47] Hart, S., 2016. Just culture: Improve reporting of near misses and errors in the clinical experience.

[48] Hollnagel, E., 2018. *Safety-I and safety-II: the past and future of safety management*. CRC press.

[49] Kanan, R., Elhassan, O. and Bensalem, R., 2018. An IoT-based autonomous system for workers' safety in construction sites with real-time alarming, monitoring, and positioning strategies. *Automation in Construction*, *88*, pp.73-86.

[50] Kontogiannis, T., Leva, M.C. and Balfe, N., 2017. Total safety management: principles, processes and methods. *Safety science*, *100*, pp.128-142.

[51] Kumar, P., Gupta, S., Agarwal, M. and Singh, U., 2016. Categorization and standardization of accidental risk-criticality levels of human error to develop risk and safety management policy. *Safety science*, *85*, pp.88-98.

[52] Landon, P., Weaver, P. and Fitch, J.P., 2016. Tracking minor and near-miss events and sharing lessons learned as a way to prevent accidents. *Applied Biosafety*, *21*(2), pp.61-65.

[53] Landon, P., Weaver, P. and Fitch, J.P., 2016. Tracking minor and near-miss events and sharing lessons learned as a way to prevent accidents. *Applied Biosafety*, *21*(2), pp.61-65.

[54] Lazzerini, M., Ciuch, M., Rusconi, S. and Covi, B., 2018. Facilitators and barriers to the effective implementation of the individual maternal near-miss case reviews in low/middle-income countries: a systematic review of qualitative studies. *BMJ open*, *8*(6), p.e021281.

[55] Leaver, M. and Reader, T.W., 2016. Human factors in financial trading: An analysis of trading incidents. *Human Factors*, *58*(6), pp.814-832.

[56] Li, T., Xie, N., Zeng, C., Zhou, W., Zheng, L., Jiang, Y., Yang, Y., Ha, H.Y., Xue, W., Huang, Y. and Chen, S.C., 2017. Data-driven techniques in disaster information management. *ACM Computing Surveys (CSUR)*, *50*(1), pp.1-45.

[57] Liao, Y., Deschamps, F., Loures, E.D.F.R. and Ramos, L.F.P., 2017. Past, present and future of Industry 4.0-a systematic literature review and research agenda proposal. *International journal of production research*, *55*(12), pp.3609-3629.

[58] Loeppke, R., Boldrighini, J., Bowe, J., Braun, B., Eggins, E., Eisenberg, B.S., Grundy, P., Hohn, T., Hudson, T.W., Kannas Jr, J. and Kapp, E.A., 2017. Interaction of health care worker health and safety and patient health and safety in the US health care system: recommendations from the 2016 summit. *Journal of occupational and environmental medicine*, *59*(8), pp.803-813.

[59] Mathew, P.S., Pillai, A.S. and Palade, V., 2017. Applications of IoT in healthcare. In *Cognitive computing for big data systems over IoT: frameworks, tools and applications* (pp. 263-288). Cham: Springer International Publishing.

[60] McFarlane, D.C., Doig, A.K., Agutter, J.A., Brewer, L.M., Syroid, N.D. and Mittu, R., 2018. Faster clinical response to the onset of adverse events: A wearable metacognitive attention aid for nurse triage of clinical alarms. *PloS one*, *13*(5), p.e0197157.

[61] Mikalef, P., Pappas, I.O., Krogstie, J. and Giannakos, M., 2018. Big data analytics capabilities: a systematic literature review and research agenda. *Information systems and e-business management*, *16*(3), pp.547-578.

[62] Moffatt-Bruce, S., Clark, S., DiMaio, M. and Fann, J., 2018. Leadership oversight for patient safety Programs: an essential element. *The Annals of thoracic surgery*, *105*(2), pp.351-356.

[63] Niedner, M.F., 2016. Pediatric quality improvement: Practical and scholarly considerations. *Pediatric Clinics*, *63*(2), pp.341-356.

[64] Olamide, A. L., & Badmus, O. (2018). Spatially explicit risk modeling framework for tracking subsurface contaminant migration in

data-limited remediation sites. IRE Journals, 2(6), 178–189.

[65] Oliff, H., Liu, Y., Kumar, M. and Williams, M., 2018. A framework of integrating knowledge of human factors to facilitate HMI and collaboration in intelligent manufacturing. *Procedia CIRP*, *72*, pp.135-140.

[66] Oshomegie, M.J., 2018. The spill over effects of staff strike action on micro, small and medium scale businesses in Nigeria: a case study of the University of Ibadan and Ibadan Polytechnic [dissertation]. *Ibadan: University of Ibadan*.

[67] Pariès, J. and Wreathall, J., 2017. *Resilience engineering in practice: a guidebook*. CRC Press.

[68] Parimi, S.S., 2018. Optimizing Financial Reporting and Compliance in SAP with Machine Learning Techniques. *Available at SSRN 4934911*.

[69] Pelletier, L.R. and Beaudin, C.L., 2017. *HQ solutions: resource for the healthcare quality professional*. Lippincott Williams & Wilkins.

[70] Pilbeam, C., Doherty, N., Davidson, R. and Denyer, D., 2016. Safety leadership practices for organizational safety compliance: Developing a research agenda from a review of the literature. *Safety science*, *86*, pp.110-121.

[71] Polnaszek, B., Gilmore-Bykovskyi, A., Hovanes, M., Roiland, R., Ferguson, P., Brown, R. and Kind, A.J., 2016. Overcoming the challenges of unstructured data in multisite, electronic medical record-based abstraction. *Medical care*, *54*(10), pp.e65-e72.

[72] Pop, O.M., Leroi-Werelds, S., Roijakkers, N. and Andreassen, T.W., 2018. Institutional types and institutional change in healthcare ecosystems. *Journal of Service Management*, *29*(4), pp.593-614.

[73] Quillivan, R.R., Burlison, J.D., Browne, E.K., Scott, S.D. and Hoffman, J.M., 2016. Patient safety culture and the second victim phenomenon: connecting culture to staff distress in nurses. *The Joint Commission Journal on Quality and Patient Safety*, *42*(8), pp.377-AP2.

[74] Rao, G., Lopez-Jimenez, F., Boyd, J., D'Amico, F., Durant, N.H., Hlatky, M.A., Howard, G., Kirley, K., Masi, C., Powell-Wiley, T.M. and Solomonides, A.E., 2017. Methodological standards for meta-analyses and qualitative systematic reviews of cardiac prevention and treatment studies: a scientific statement from the American Heart Association. *Circulation*, *136*(10), pp.e172-e194.

[75] Sabel, C., Herrigel, G. and Kristensen, P.H., 2018. Regulation under uncertainty: The coevolution of industry and regulation. *Regulation & Governance*, *12*(3), pp.371-394.

[76] Sahay, S., Sundararaman, T. and Braa, J., 2017. *Public health informatics: designing for change-a developing country perspective*. Oxford University Press.

[77] Samia, C., Hamzi, R. and Chebila, M., 2018. Contribution of the lessons learned from oil refining accidents to the industrial risks assessment. *Management of Environmental Quality: An International Journal*, *29*(4), pp.643-665.

[78] Schick-Makaroff, K., MacDonald, M., Plummer, M., Burgess, J. and Neander, W., 2016. What synthesis methodology should I use? A review and analysis of approaches to research synthesis. *AIMS public health*, *3*(1), p.172.

[79] Scholl, I., LaRussa, A., Hahlweg, P., Kobrin, S. and Elwyn, G., 2018. Organizational-and system-level characteristics that influence implementation of shared decision-making and strategies to address them—a scoping review. *Implementation Science*, *13*(1), p.40.

[80] Seyi-Lande, O.B., Arowogbadamu, A.A.G. and Oziri, S.T., 2018. A comprehensive framework for high-value analytical integration to optimize network resource allocation and strategic growth. *Iconic Research and Engineering Journals*, *1*(11), pp.76-91.

[81] Seyi-Lande, O.B., Oziri, S.T. and Arowogbadamu, A.A.G., 2018. Leveraging business intelligence as a catalyst for strategic decision-making in emerging telecommunications markets. *Iconic Research and Engineering Journals*, *2*(3), pp.92-105.

[82] Shi, D., Guan, J., Zurada, J. and Manikas, A., 2017. A data-mining approach to identification

of risk factors in safety management systems. *Journal of management information systems*, *34*(4), pp.1054-1081.

[83] Shufutinsky, A. and Long, B., 2017. The distributed use of self-as-instrument for improvement of organizational safety culture. *OD Practitioner*, *49*(4), pp.36-44.

[84] Sidorenko, A. and Demidenko, E., 2016. *Guide to effective risk management 3.0*. RISK-ACADEMY.

[85] Stemn, E., Bofinger, C., Cliff, D. and Hassall, M.E., 2018. Failure to learn from safety incidents: Status, challenges and opportunities. *Safety science*, *101*, pp.313-325.

[86] Sutcliffe, K.M., Vogus, T.J. and Dane, E., 2016. Mindfulness in organizations: A cross-level review. *Annual review of organizational psychology and organizational behavior*, *3*(1), pp.55-81.

[87] Suykens, C., Priest, S.J., van Doorn-Hoekveld, W.J., Thuillier, T. and van Rijswick, M., 2016. Dealing with flood damages: will prevention, mitigation, and ex post compensation provide for a resilient triangle?. *Ecology and Society*, *21*(4).

[88] Tarlow, P.E. ed., 2018. *Tourism-oriented policing and protective services*. IGI Global.

[89] Thoroman, B., Goode, N. and Salmon, P., 2018. System thinking applied to near misses: a review of industry-wide near miss reporting systems. *Theoretical Issues in Ergonomics Science*, *19*(6), pp.712-737.

[90] Tricco, A.C., Antony, J., Soobiah, C., Kastner, M., MacDonald, H., Cogo, E., Lillie, E., Tran, J. and Straus, S.E., 2016. Knowledge synthesis methods for integrating qualitative and quantitative data: a scoping review reveals poor operationalization of the methodological steps. *Journal of Clinical Epidemiology*, *73*, pp.29-35.

[91] Tuli, F.A., Varghese, A. and Ande, J.R.P.K., 2018. Data-driven decision making: A framework for integrating workforce analytics and predictive HR metrics in digitalized environments. *Global Disclosure of Economics and Business*, *7*(2), pp.109-122.

[92] Ugwu-Oju, U. M., Okeke, O. T., & Nwankwo, C. O. (2018). Advances in cybersecurity protection for sensitive business digital infrastructure. IRE Journals, 1(11), 127–135.

[93] Ugwu-Oju, U. M., Okeke, O. T., & Nwankwo, C. O. (2018). Conceptual model improving encryption strategies for organizational information protection. IRE Journals, 2(2), 139–147.

[94] Ugwu-Oju, U. M., Okeke, O. T., & Nwankwo, C. O. (2018). Conceptual model improving digital workflows within organizational information technology operations. IRE Journals, 2(5), 294–302.

[95] Ugwu-Oju, U. M., Okeke, O. T., & Nwankwo, C. O. (2018). Review of network protocol stability techniques for enterprise information systems. IRE Journals, 1(8), 196–204

[96] Ullah, F., Sepasgozar, S.M. and Wang, C., 2018. A systematic review of smart real estate technology: Drivers of, and barriers to, the use of digital disruptive technologies and online platforms. *Sustainability*, *10*(9), p.3142.

[97] Wu, F., Wu, T. and Yuce, M.R., 2018. An internet-of-things (IoT) network system for connected safety and health monitoring applications. *Sensors*, *19*(1), p.21.

[98] Yeboah, B. K., & Enow, O. F. (2018, September 30). Conceptual framework for reliability-centered maintenance programs in electricity distribution utilities. Iconic Research and Engineering Journals, 2(3), 140–153.

[99] Zhang, P., Schmidt, D., White, J. and Mulvaney, S., 2018, June. Towards precision behavioral medicine with IoT: iterative design and optimization of a self-management tool for type 1 diabetes. In *2018 IEEE International Conference on Healthcare Informatics (ICHI)* (pp. 64-74). IEEE.

[100] Zurak, N., 2018. Metaneurobiology of death. *Zagreb: Medicinska naklada*, pp.77-83.