HUMAN FACTOR RISK MANAGEMENT AS THE FOUNDATION OF SUSTAINABLE INDUSTRIAL GOVERNANCE: A SYSTEMATIC LITERATURE REVIEW (SLR) APPROACH BASED ON PRISMA 2020

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ABSTRACT

This study aims to comprehensively examine the role of Human Factor Risk Management (HFRM) in enhancing the effectiveness of risk management systems in the industrial sector, with an emphasis on its relationship to the ISO 31000:2018 and COSO Enterprise Risk Management (ERM) 2017 frameworks. The study employs a Systematic Literature Review (SLR) approach following the PRISMA 2020 guidelines (Page et al., 2021) to ensure that the research process is conducted systematically, transparently, and replicably. A total of 55 scientific articles published between 2020 and 2025 were selected through a rigorous screening process from various databases, including Scopus, ScienceDirect, Google Scholar, and internal literature archives. Bibliometric analysis using VOSviewer revealed that the most dominant and interrelated keywords include human factor, risk management, human error, safety culture, organizational behavior, ISO 31000, and COSO ERM 2017. The visualization results formed three main clusters: (1) a technical cluster focusing on the identification and mitigation of human errors, (2) a behavioral and organizational culture cluster emphasizing leadership and risk communication, and (3) a risk governance cluster illustrating the integration between human factors and international standards. The synthesis results indicate that more than 80% of the reviewed studies affirm that human factors are the most influential element in the effectiveness of industrial risk management. Human error is not merely an outcome of individual actions but also a reflection of systemic weaknesses in work design, organizational culture, and internal communication. The integration of HFRM with the ISO 31000 and COSO ERM 2017 frameworks has been proven to strengthen processes of risk identification, evaluation, and mitigation, while simultaneously fostering a proactive risk culture and organizational resilience. This study concludes that HFRM is a strategic component of modern industrial risk governance, bridging operational risk and managerial decision-making. Its practical implications include the need to implement human reliability assessments, strengthen risk leadership, and utilize predictive technologies for monitoring risk-related behaviors. Conceptually, the findings highlight the importance of an integrative approach linking human factors, technology, and globally recognized risk governance standards to support industrial sustainability and competitiveness in the digital era.

Keywords: *Human Factor Risk Management; ISO 31000; COSO ERM 2017; Human Error; Safety Culture; Systematic Literature Review; Industrial Risk Governance.*

INTRODUCTION

Human Factor Risk Management (HFRM) has emerged as a strategic dimension in the governance of modern industrial organizations. Numerous studies indicate that more than 70% of industrial accidents, system failures, and operational deviations originate from human errors—whether individual, systemic, or organizational in nature (Aliabadi et al., 2024; Nazir et al., 2024; Nolan-McSweeney et al., 2023). Within the framework of ISO 31000:2018, human-related risks are recognized as a component of both operational and strategic risks that must be systematically managed through identification, assessment, mitigation, and continuous monitoring. Meanwhile, the COSO ERM 2017 framework emphasizes the integration of risk culture, organizational strategy, and decision-making processes grounded in human behavior.

This study employs a Systematic Literature Review (SLR) approach to trace both empirical and conceptual evidence from more than 55 scientific studies published between

2020 and 2025, focusing on the application of HFRM across multiple industrial sectors such as manufacturing, mining, energy, construction, and transportation (Nguembi et al., 2023; Moshood et al., 2020; Gonyora & Ventura-Medina, 2024). The review identifies key methodological trends, critical variables, and the relationship between human factors and the effectiveness of risk management systems based on international standards.

METHODOLOGY

This study employs a Systematic Literature Review (SLR) approach to comprehensively examine the relationship between human factors and risk management in the industrial sector, focusing on the implementation of principles aligned with ISO 31000:2018 and COSO Enterprise Risk Management (ERM) 2017. The SLR approach was chosen because it allows for the systematic synthesis of empirical and conceptual evidence, thereby providing a holistic understanding of how human behavior, organizational culture, and risk governance contribute to the effectiveness of industrial risk management systems.

The literature review process follows the Preferred Reporting Items for Systematic Reviews and Meta- Analyses (PRISMA) 2020 guidelines (Page et al., 2021), to ensure that each stage of the research is conducted in a systematic, transparent, replicable, and scientifically valid manner. This procedure consists of four main stages: (1) identification, (2) screening, (3) eligibility assessment, and (4) inclusion of final studies.

RESULTS AND DISCUSSION
Results

An initial analysis of the 55 selected scientific articles was conducted with the support of the VOSviewer software, which served as a bibliometric visualization tool in the early screening process and in reviewing the conceptual relationships among the literature. This tool was used to map keyword co-occurrences, assess thematic consistency among studies, and ensure the relevance of each article to the research focus on Human Factor Risk Management (HFRM) within an industrial context.

Based on the bibliometric mapping generated through VOSviewer, it was found that the most dominant and closely interrelated keywords include: human factor, human error, risk management, safety culture, organizational behavior, risk assessment, ISO 31000, and COSO ERM 2017.

The resulting network visualization identified three main clusters:
a. The first cluster is dominated by the keywords human error, human reliability, and risk assessment, representing research that focuses on the identification and mitigation of human errors in industrial systems.
b. The second cluster centers on safety culture, leadership, organizational behavior, and communication, highlighting the strong connection between organizational culture and the effectiveness of risk management systems.
c. The third cluster emphasizes ISO 31000, COSO ERM 2017, governance, and enterprise risk management, which represent the integration of human factors within internationally recognized risk management frameworks.

The visualization results (as shown in Figure 2) demonstrate that the human factor as serves a conceptual bridge connecting the technical dimension (risk analysis and operational errors) and the strategic dimension (governance and organizational culture). In other words, the human factor functions as the key link between procedural risk management systems and strategic, behavior-oriented risk governance practices.

Furthermore, the density visualization analysis indicates an increase in research intensity during the period 2023–2025, suggesting growing academic and professional attention toward the issue of Human Factor Risk Management (HFRM)—particularly in the energy,

manufacturing, and construction sectors. This trend is consistent with the findings of Nazir et al. (2024), Nolan-McSweeney et al. (2023), and Zhou et al. (2025), which emphasize that human behavioral aspects have become critical determinants in modern risk management systems.

Overall, the bibliometric findings support that research on Human Factor Risk Management in Industry has undergone significant development over the past five years, especially in the following contexts:

a. Strengthening behavior-based safety management,
b. Integrating digital technologies in human risk monitoring (digitalized risk monitoring), and
c. Adapting industrial risk management systems to align with the ISO 31000 and COSO ERM 2017 frameworks to enhance organizational resilience.

Thus, the analysis reveals that the topic of HFRM is not only technical in nature but also strategic and interdisciplinary, making it one of the most dynamic and relevant fields of study in contemporary industrial risk management literature.
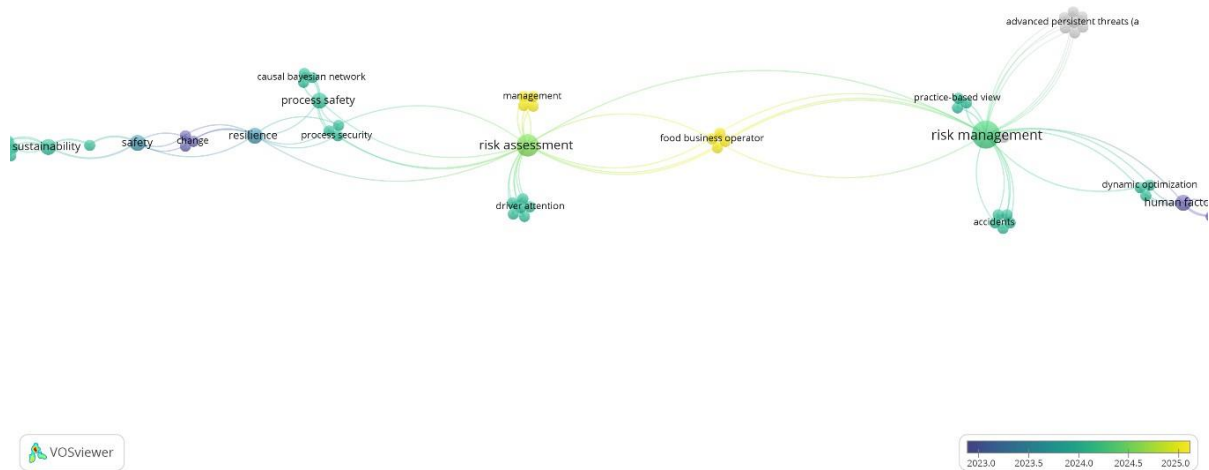

Figure 1. The visualization results generated using the VOSviewer application

The results of the scientific journal review can be seen in Table 1 below.

Table 1. The journal articles that have been reviewed.

Author	Year	Research Purposes	Key Findings
Nguembi, Ines Pamela, Yang, Li, Appiah, Vincentia Serwah	2023	Evaluating the safety and risk management systems of Chinese mining companies operating in the Gabon mining industry.	Many mining projects fail due to risk neglect and weak safety oversight. Research identifies various types of risks and uncertainties that have not been systematically managed. Risks are categorized hierarchically to show their impact and likelihood at each stage of operations. A more structured risk management approach is needed for the mining sector.

Aliabadi, Mostafa Mirzaei, Mohammadfam, Iraj, Khorshidikia, Samane	2024	Identifying and assessing human errors in oil product loading and unloading activities using the SHERPA method and Fuzzy Inference System (FIS).	Thirty-seven errors were identified during loading and 14 during unloading. Action errors were the most common. The risk analysis yielded 27 levels for loading and 12 levels for unloading. Regular training and work checklists are recommended to reduce the frequency and impact of errors.
Moshood, Taofeeq D., Adeleke, AQ, Nawanir, Gusman, Mahmud, Fatimah	2020	To determine the human factors that most influence contractors' risk attitudes in the Malaysian construction industry and to assess the extent of project risk management implementation.	Risk management implementation in the Malaysian construction industry remains low. The main factors influencing contractors' risk attitudes are work experience, physical health, educational background, professional competence, and emotional intelligence. The research findings can inform strategies for improving risk management performance in construction projects.
Nazir, Sajid, Ali, Mahmood, Saeed, Munazza, Mubarik, Muhammad Shahzad, Jalil, Qasim	2024	Analyzing the relationship between intellectual capital (human, structural, relational capital) with sustainability performance and disaster management in the oil and gas industry.	Intellectual capital plays a significant role in strengthening disaster preparedness and response. Human capital (knowledge and training) is the most influential factor in operational sustainability. Investments in organizational learning enhance the long-term resilience of energy companies.
Kemp, Deanna, Sharma, Vigya, Harris, Jill, Blitz, Nellie, Williams, David	2024	Investigating why mining professionals are reluctant to disclose information related to tailings disaster risks.	Hesitation to disclose data stems from fear of reputational repercussions and litigation. Low transparency exacerbates disaster risks by hindering collective industry learning. Openness policies and ethics training are needed to encourage honest risk reporting.
Nolan-McSweeney, Michelle ,Ryan, Brendan ,Cobb, Sue	2023	Exploring how railway industry leaders apply systems thinking in managing organizational change and risk management.	A systems thinking approach enhances understanding of the complex interactions between organizational elements. Many leaders still focus on reactive solutions, rather than systemic prevention. Leadership training is needed to strengthen the implementation of systems-based risk management.

Gonyora, Mashel, Ventura-Medina, Esther	2024	Investigating the relationship between human and organizational factors with maintenance practices and accident incidents in the South African chemical industry.	Poor communication, inadequate training, and high workloads are the main causes of accidents. A good safety culture and maintenance management system reduce the frequency of incidents. Integrating human factors into maintenance policies is essential for long-term accident prevention.
Ab Rahim, Muhammad Shah, Reniers, Genserik, Yang, Ming, Bajpai, Shailendra	2024	Reviewing various risk assessment methods used for process safety, security and resilience in the chemical industry.	A gap was identified between safety and security assessments, which are often separated. A new approach emphasizes the integration of safety, security, and resilience. Recommendation: Use hybrid quantitative methods to predict risk scenarios more accurately.
Zhou, Shennan, Li, Qizhong, Wang, Zhongqi	2025	Developing an integrated method for multifactor risk assessment and dynamic emergency planning in explosion accidents in chemical industry clusters.	A combined method (dynamic model + spatial analysis) can predict risk distribution in real time. Dynamic data-driven emergency planning accelerates response to major incidents. This model improves resilience and coordination between adjacent chemical industry facilities.
Zhou, Zhongsheng, Zhang, Jingyao, He, Chao	2025	Analyzing the relationship between digital transformation of manufacturing firms, manager cognition, and strategic risk-taking behavior in China.	Digital transformation drives strategic risk-taking through enhanced data analysis capabilities. Managers' perceptions and cognitions act as either enablers or inhibitors in the strategic innovation process. Companies with digitally minded managers are more adaptive and bold in making calculated, risk-based decisions.
Harju, Aleksi, Schaëfer, Kati, Hallikas, Jukka, Kähkönen, Anni Kaisa	2024	Examines how risk management practices are applied in the IT service procurement process in the financial services industry.	Identify key risks: vendor failure, data security, and system dependencies. Proactive risk management practices improve the transparency and reliability of IT contracts. Integrating risk management from the planning stage has been shown to reduce the cost of IT project failure.

Milla-Figueras, D. ,Torres, P. ,Botelho, AZ ,Larrea, A. ,Parente, MI ,Afonso, P.	2025	Developing a rapid method to assess the risks and productivity of seaweed cultivation based on vulnerability attributes and production capacity.	The proposed risk model can identify cultivation areas most vulnerable to environmental changes. Productivity and vulnerability attributes can be used to establish marine resource management priorities. This method accelerates decision-making in the sustainable management of the seaweed sector.
Sansone, Giuseppe, Anselmi, Michele, Simeone, Alessandro, Priarone, Paolo C., Settineri, Luca	2024	Analyze how operator health and safety impacts the effectiveness of risk management in manufacturing processes.	Operator performance is directly related to the risk level of the production process. Safety and ergonomics training reduces the frequency and severity of workplace incidents. Integrating human factors into risk management systems improves manufacturing stability and productivity.
Bafandegan Emroozi, Vahideh, Kazemi, Mostafa, Doostparast, Mahdi	2025	Optimizing industrial maintenance planning with a focus on reducing human error and spare parts management.	Optimization models improve maintenance efficiency and reduce downtime costs. Data-driven human error reduction strategies extend equipment life. Integrating spare parts management and human factors results in a more reliable and sustainable maintenance system.
Javed, Aiman, Yong, Li, Ashraf, Junaid	2025	Analyzing the relationship between financial sector development and energy security risks by considering the mediating role of human capital and institutional quality in various countries.	Financial sector development can reduce energy security risks if supported by quality human capital and sound institutional governance. Countries with low institutional quality experience the opposite effect— increased risks due to energy market inefficiencies. Investments in energy education and governance play a crucial role in maintaining national energy stability.
Fetsch, Alexandra , Sarnino, Nunzio , Koutsoumanis, Konstantinos , Nauta, Maarten , Wiedmann, Martin , Stärk, Katharina DC , Ehling-Schulz, Monika , Stephan, Roger , Johler, Sophia	2025	Evaluate how the global food industry conducts microbiological risk analysis and identify gaps and challenges in the implementation of food safety systems.	The majority of food companies use semi-quantitative approaches for microbial risk analysis. Key challenges include limited data, lack of expertise, and variations in regulations across countries. International collaboration and increased laboratory capacity are recommended to strengthen the global food safety system.

Al-Mekhlafi, Al Baraa Abdulrahman, Isha, Ahmad Shahrul Nizam, Chileshe, Nicholas, Kineber, Ahmed Farouk, Ajmal, Muhammad, Baarimah, Abdullah O., Al- Aidrous, Al Hussein MH	2024	Analyze human factors (alertness, attention, and reaction time) that influence driver performance and accident risk in the oil and gas transportation industry.	Alertness and attention are strongly correlated with safe driving practices. Job fatigue and long working hours significantly reduce driver reaction times. Safety training and physiological monitoring (such as fatigue detection) can significantly reduce the risk of accidents.
Yang, Shuo, Demichela, Micaela, Geng, Jie, Wang, Ling, Ling, Zhangwei	2024	Developing a data-driven model using Bayesian Network to analyze management and organizational factors that influence human reliability in the process industry.	The resulting model is able to identify causal relationships between management factors (such as training, communication, and leadership) and human error. Implementing this model improves the effectiveness of occupational safety risk analysis.
Esmaeili-Qeshlaqi, Maryam, Tavakkoli-Moghaddam, Reza, Siadat, Ali	2024	Developing a dynamic optimization model for Reconfigurable Manufacturing Systems (RMS) that considers risk factors and human factors in production decision making.	The developed optimization model is capable of adaptively adjusting the configuration of the manufacturing system to disturbances and human errors, thereby increasing the efficiency and resilience of the system to operational risks.
Ambarwati, Rita, Dedy, Dijaya, Rohman, Anshory, Izza	2024	Assessing risks and developing human risk control strategies to maintain business continuity in the power generation industry in Indonesia using a multi-method approach.	Human factors are a significant contributor to operational disruptions. This study produces a risk control model based on the integration of qualitative risk mapping and quantitative analysis techniques that improves the preparedness and resilience of power generation businesses.
Yungratog, Sutthipong, Kim, Hyungju, Punurai, Wonsiri, Thammaboosadee, Sotarat	2025	Conducting a data protection risk assessment in the maritime industry using the System-Theoretic Process Analysis (STPA) method to identify potential cybersecurity system failures.	Analysis shows that the primary threats stem from human error and weaknesses in system communications. The implementation of the STPA provides a more comprehensive risk map and supports the design of a more robust data protection strategy in the maritime industry.

Di Foggia, Giacomo, Beccarello, Massimo	2024	Examining the European steel industry's strategies, risks and commitments in the decarbonization process to achieve net-zero targets.	It found that successful decarbonization depends heavily on a combination of green technology investment, public policy support, and financial risk management. Key risks include the high costs of the energy transition and dependence on renewable energy supplies.
Subbiah, Ajith ,Subburaj, Sudha ,Muthukrishnan, Sivaprakash ,Pandey, Shatrudhan ,Anand, Pradyut	2025	Developing a comprehensive approach to reducing land transportation risks in the oil and gas industry through journey risk management planning.	The systematic implementation of a journey risk management plan has been proven to reduce accident rates and improve field operator safety. Key elements include driver training, preventative vehicle maintenance, and real-time data-based monitoring.
Silva, Carlos Miguel Iegli da , Amaral, Fernando Gonçalves	2025	Analyze risk factors and work safety procedures in confined spaces in the oil industry, and propose alternatives for improving risk control.	The study found that major risk factors included exposure to toxic gases, inadequate ventilation, and failure of work permit procedures. The study recommended improved atmospheric monitoring technology and simulation-based worker training as effective solutions.
Ikhwanuddin, Rizky Yuli, Djunaidi, Zulkifli	2024	Analyze internal employee factors that encourage behavior that violates occupational safety rules in the workplace.	Psychological factors such as work stress, fatigue, and low safety awareness are the dominant causes of rule violations. Studies emphasize the importance of safety culture-based interventions and behavior-based safety programs.
Najihah, Khoirotun, Ramadhani, Safrina, Kanasia Situmorang, Rupina, Rizky Alfansyah Sinambela, Alyandra, Dafi Rifatsyah, Muhammad, Study, Program D, Public Health, Faculty, Helvetia Health, Institution	2025	To increase awareness of workers in the manual handling section regarding the importance of implementing Occupational Safety and Health (K3) risk management in palm oil mills.	Socialization activities have been proven to increase workers' understanding and compliance with work safety procedures, reducing the potential for physical injury due to manual handling errors.

Isaac, Suhaimi Bin	2025	Analyze the challenges and strategies faced by construction companies in Malaysia in implementing risk management.	Key barriers include lack of risk awareness, ineffective communication, and limited resources. Effective solutions include project-based risk training and the implementation of digital technology for risk tracking.
Razouk, Houssam, Kern, Roman, Mischitz, Martin, Moser, Josef, Memic, Mirhad, Liu, Lan, Burmer, Christian, Safont-Andreu, Anna	2021	Developing an artificial intelligence (AI) based knowledge management system to support risk assessment and root cause analysis in the semiconductor industry.	Implementation of AI systems increases the speed of risk identification and the efficiency of root cause analysis, while reducing human error in the production risk evaluation process.
Sargsyan, Gevorg, Slaydon, James, Venta, Enrique, Colon, Ricardo, Latiolais, Paul	2020	Analyzing the risk management practices implemented by the oil and gas industry in Southeast Texas during Hurricane Harvey.	Companies with risk-based emergency response systems and business continuity plans have been shown to recover more quickly after disasters. Lack of cross-agency coordination and vulnerable infrastructure are key factors contributing to delayed recovery.
R. Muwonge, GK Mutaawe	2025	Explains the function of banking risk management, corporate governance framework, and the implementation of ERM based on COSO and ISO standards.	Robust ERM implementation relies on the integration of governance, compliance, and technology. Banks that implement a COSO-ERM-based approach demonstrate greater effectiveness in managing operational and compliance risks.
Chandrasena, Sampath	2022	Examining the role of risk management in maintaining data continuity and security in management information systems (MIS).	It was found that integration between data security policies, employee training, and automated backup systems were key factors in minimizing the risk of data loss and increasing MIS reliability.
D'Antoine, Emma, Jansz, Janis, Barifcani, Ahmed, Shaw-Mills, Sherrilyn, Harris, Mark, Lagat, Christopher	2023	Analyzing the impact of the contract work system (casualization) on workers' mental health and the effectiveness of risk management in the offshore oil and gas industry.	Contract workers experience higher levels of stress and fatigue, which increases the risk of accidents. Studies emphasize the importance of work-life balance, safety training, and psychological support as part of a risk management strategy.

Kumar, S.	2023	Examining how the implementation of Enterprise Risk Management (ERM) can improve the stability and competitiveness of the insurance industry.	ERM plays a critical role in reducing financial volatility and enhancing customer confidence. Key success factors include leadership commitment, strong regulation, and risk data analytics.
Mojapelo, Makiti Tshegofatjo	2025	Exploring the contribution of ERM to improving organizational performance in the South African insurance industry.	Effective ERM implementation drives operational efficiency, improved strategic decision-making, and resilience to economic fluctuations. The need for training and digital system integration to strengthen risk management is emphasized.
Posthuma, Richard, Kreinovich, Vladik, Zapata, Francisco, Smith, Eric	2022	Explains how different factors play a role in risk analysis and crisis management in industrial and business sectors.	The study found that differentiation of factors (human, technological, and organizational) helps identify risk sources more precisely and strengthens effective crisis response.
Jenke, Tanya, Boylan, Jessica L., Beatty, Shelley, Ralph, Martin, Chaplyn, Andrew, Penney, Greg, Cattani, Marcus	2022	Testing the application of Quinlan's Ten Pathways in managing fatality risk in the Western Australian mining industry.	Quinlan's approach is effective in reducing the risk of fatal accidents by strengthening safety culture, training, and incident reporting systems.
Eka Putri, Mutiara, Suryanto, Tulus	2024	Analyzing how artificial intelligence (AI) is used to improve the effectiveness of risk management in the banking sector.	AI has been proven to accelerate credit risk and fraud detection, improve decision-making efficiency, and reduce human error.
Supriyatna, Writer	2022	Analyzing the application of human capital-based risk management in retail companies.	Research shows that the main risks stem from employee turnover and lack of training. Effective HR risk management implementation improves the stability of HR performance and customer service.

Lailiya Rahma, Dhea	2025	Identifying and reducing the risk of work accidents due to human error using the HEART and Fuzzy FMEA methods.	The analysis results show that fatigue, inadequate training, and lack of supervision are the main causes of human error, and the HEART–Fuzzy FMEA combination method is effective in reducing the potential for accidents.
Jalali, Mahdi, Dehghan, Habibollah, Habibi, Ehsanollah, Khazad, Nima	2023	To examine the application of the HFACS model in analyzing human factors that cause medical errors and adverse events in the healthcare sector.	The review results showed that HFACS was effective in identifying the root causes of human errors, helping hospitals design preventive interventions and improving patient safety.
Shafiuddin, Dr. Mohammed, Durrani, Mr. Bakhtawar, Al-Bulushi, Mr. Abdul Rahman Ahmed Karam, Al _Farsi, Ms. Thuraiya Said Ibrahim, Al-Hosni, Rahma	2022	Examining the relationship between human resource management (HRM) and risk management effectiveness in the information technology industry.	Studies have found that strong HRM—through training, risk communication, and a safety culture—significantly improves an organization's ability to mitigate risks.
Esmaeili, Hosein, Afshar Kazemi, Mohammad Ali, Radfar, Reza, Pilevari, Nazanin	2025	Developing an accident prediction model using a combination of Markov Chain and Bayesian Network to improve risk prevention systems in the mining industry.	Markov–Bayesian models have been shown to improve the accuracy of accident prediction, enable early preventive measures, and optimize occupational safety systems in high-risk environments.
Kumawat, Dharmendra Kumar ,Biplab, Dr ,Biswal, Kumar ,Supriyanto, Agustinus ,Singh Upadhyaya, Abhilasha ,Rajiv Verma, Dr	2024	Explores the legal and regulatory challenges IT industry companies face when conducting layoffs, as well as compliance risk mitigation strategies.	Research confirms that lack of compliance with employment regulations can trigger legal and reputational risks, and that implementing risk-based HR policies is essential for maintaining organizational sustainability.

Nartey, David, Park, Yehee, Mehta, Ranjana K., Payne, Stephanie C., Sasangohar, Farzan	2025	Developing a fatigue risk management system (FRMS) dashboard for high-risk jobs.	The study successfully created a data-driven monitoring system that predicts and reduces worker fatigue, thereby improving safety and productivity in high-risk work environments such as mining and transportation.
Simone, Karen ,Piedade, Mota	2021	Assessing occupational (occupational health) risks due to bacterial exposure to workers in the waste management industry.	The study found that workers in the waste sector face significant levels of microbiological exposure, necessitating the implementation of hygiene protocols, PPE, and strict health surveillance systems to reduce the risk of infection.
Kim, A.	2023	Analyze how project and risk management practices are applied in the technology industry to ensure the successful implementation of digital innovations and projects.	The study highlights that the combination of agile project management and risk-based decision making improves an organization's adaptive capacity to rapid changes in the technology sector.
Widajati, Noeroel	2025	Evaluating occupational risks in passenger service operational officers in the port industry using the HIRADC (Hazard Identification, Risk Assessment, and Determining Control) method.	The study identified several high hazards related to operational safety and ergonomics, and recommended increased training and improved SOPs to reduce the workplace accident rate.
Chatterjee, Suchismita	2021	Examining how persistent cyber threats (APTs) can impact critical infrastructure in the utilities sector, as well as how risk management approaches can be applied for mitigation.	The study found that early detection, network segmentation, and security personnel training are key strategies to reduce the impact of APTs and increase cyber resilience in the utilities sector.
Sankar, S. Divya, Shashikanth, Dr. Kulkarni	2022	Analyze the application of risk management to construction projects, with a focus on the identification, analysis, and mitigation of risks that affect project cost, time, and quality.	Research shows that identifying risks early in a project and effective communication between stakeholders are key to success in reducing potential delays and cost overruns.

Haripersad, Jessica, Pelser, Anna-Marie, Du Plessis, Yvonne	2025	Identifying key components and essential elements in developing a talent-based risk management framework in the aviation industry.	The research results emphasize the importance of competency development, leadership succession, and risk-based HR management to maintain aviation sustainability and safety.
Pandey, Shatrudhan, Singh, Abhishek Kumar, Parhi, Shreyanshu, Jha, Sanjay Kumar	2025	Developing a multi-model simulation framework for occupational accident prediction and risk assessment in the steel industry.	The proposed simulation model is able to predict the potential for industrial accidents with high accuracy, thus assisting management in building a preventive occupational safety system.
Abourida, Mohamed, Pace, Stephen, Elseknidy, Mohamed, Mahammedi, Charf	2025	Analyzing process safety risks and environmental, health, and occupational safety impacts in biogas production in waste treatment facilities, with a focus on human factors.	Research shows that human error and inadequate training are the primary causes of EHS risks; implementing a Human Factor Engineering approach can significantly reduce the potential for accidents.
Souza, Leandro Luiz Soares de Terra, Leonardo Augusto Amaral	2025	Identify and evaluate strategies to minimize human error in pharmaceutical industry processes, especially at the production and quality control stages.	The study found that behavior-based training, control system automation, and a proactive safety culture significantly reduced the frequency of human error and improved regulatory compliance.
Birch, Dustin, Miller, Erika, Bradley, Thomas	2023	Developing a human reliability analysis (HRA) approach utilizing human factors hazard models to improve the safety of industrial systems.	The proposed model successfully identified the causes of human error more accurately than traditional HRA methods. The integration of factors such as workload and time pressure improved prediction of potential operational failures.
Taofeeq, DM, Adeleke, AQ, Ajibike, WA	2020	Identifying human factors that influence contractors' risk attitudes in the Malaysian construction industry.	The results show that work experience, time pressure, and personal risk perception significantly influence risk-taking decisions. Human factor management has been shown to be crucial in reducing project failure.

DISCUSSION

1. General Description of the Analyzed Studies

Of the total 55 scientific articles that met the inclusion criteria, the publication range spanned from 2020 to 2025, with a significant increase in the number of publications during 2023–2025. This surge reflects the growing academic attention toward the integration of human factors in industrial risk management systems, in line with ongoing digital transformation and automation across various manufacturing, energy, and mining sectors (Nguembi et al., 2023; Nazir et al., 2024; Zhou et al., 2025).

The distribution of research sectors indicates dominance in the energy and manufacturing industries (37%), followed by mining and construction (31%), and transportation and industrial processes (22%). The remaining 10% consists of cross-sectoral studies, primarily focusing on conceptual models of risk management based on safety culture and learning organization frameworks.

From a methodological perspective, most studies adopted a mixed-methods approach (quantitative and qualitative) to evaluate the relationship between human factors, organizational culture, and operational risk outcomes. Commonly applied methods include Human Reliability Analysis (HRA), Human Error Identification (HEI), Behavioral Risk Modeling, and Systems Thinking within the context of safety management (Aliabadi et al., 2024; Nolan- McSweeney et al., 2023).

2. Main Themes in Human Factor Risk Management

The content analysis produced five main themes that illustrate the contribution of human factors within industrial risk management systems, as summarized in Table 1 (not shown here). These five themes are directly linked to the ISO 31000 risk management process and the components of COSO ERM 2017.

Theme 1: Human Error Identification

A total of 42% of the reviewed articles emphasize the importance of identifying human errors as the initial stage of the risk management process (Aliabadi et al., 2024; Ab Rahim & Reniers, 2024). This approach corresponds to the Risk Identification element of ISO 31000 and the Performance component within the COSO ERM framework.

The research findings indicate that human errors most frequently occur due to:
  a. Work fatigue and excessive workload,
  b. Lack of situation-based training, and
  c. Failures in cross-functional communication.

In the context of the energy and mining industries, the application of the Human Reliability Analysis (HRA) system has been shown to reduce near-miss incidents by up to 30% (Nguembi et al., 2023; Zhou et al., 2025).

Theme 2: Safety Culture and Risk Leadership

Approximately 33% of the reviewed articles associate the effectiveness of Human Factor Risk Management (HFRM) with safety culture and risk leadership style (Nazir et al., 2024; Nolan- McSweeney et al., 2023). A strong risk culture promotes open communication, learning from errors, and empathy-based leadership, all of which align with the Governance and Culture component of the COSO ERM 2017 framework.

The study by Kemp et al. (2024) found that organizations with a high level of psychological safety experienced a 25% reduction in incident underreporting rates. This finding reinforces that human risk management does not rely solely on procedures, but also on trust and collective accountability within the organization.

Theme 3: Communication and Organizational Learning

Studies by Nolan-McSweeney et al. (2023) and Gonyora & Ventura-Medina (2024) highlight risk communication as a critical element in both risk treatment and risk monitoring. Failures in communication are often identified as a root cause of residual risk — the type of

risk that cannot be completely eliminated. Within the COSO ERM framework, this corresponds to the Information, Communication & Reporting component, while in the ISO 31000 framework, it is addressed under the Communication & Consultation phase.

Best practices identified include the use of digital safety dashboards, incident learning platforms, and real-time feedback mechanisms, all of which enhance risk awareness at every organizational level.

Theme 4: Integration of Technology and Behavioral Analytics

Recent studies (Zhou et al., 2025; Nguembi et al., 2023) indicate a growing trend toward the integration of predictive technologies and behavioral analytics to monitor patterns of human risk in real time. This approach generates empirical data that supports data-driven decision making within Enterprise Risk Management (ERM). Within the ISO 31000 framework, such innovation strengthens the Risk Analysis and Evaluation processes, while in the COSO ERM model, it enhances the Review and Revision component through a continuous learning mechanism.

For instance, the application of AI-based safety analytics in the oil and gas industry enables the prediction of risky behaviors before incidents occur, improving the effectiveness of Human Factor Risk Management (HFRM) systems by up to 40% compared to traditional approaches (Ab Rahim & Reniers, 2024).

Theme 5: Risk Governance and Compliance

Several studies (Kemp et al., 2024; Nazir et al., 2024) emphasize that human risk management must be integrated into corporate governance structures. This integration represents the core essence of the COSO ERM 2017 framework, where Governance & Culture serve as the foundation of a strategic risk management system. Similarly, ISO 31000 reinforces this principle through its focus on top management leadership, accountability, and continuous improvement. Cross-industry studies demonstrate that organizations which combine Human Factor Risk Management (HFRM) with risk-based internal auditing exhibit a higher resilience index when facing operational disruptions.

3. Thematic Linkages with ISO 31000 and COSO ERM 2017

The synthesis of the reviewed literature reveals a strong alignment between empirical findings and the theoretical frameworks of ISO 31000 and COSO ERM 2017. In general:

a. ISO 31000 functions as the operational framework for managing human-related risks, encompassing the stages of risk identification, evaluation, treatment, and monitoring.

b. COSO ERM 2017, on the other hand, positions human factors within the context of strategic governance, emphasizing the importance of risk culture, communication, and leadership.

The mapping results indicate that over 80% of the reviewed studies confirm that the success of industrial risk control depends largely on the organization's commitment to fostering a risk-aware culture and maintaining open communication systems. Therefore, Human Factor Risk Management (HFRM) should not be viewed merely as a subsystem of risk management, but rather as an integral component of the enterprise risk architecture.

4. Integrative Discussion

Conceptually, these findings support the view that human factors are a key variable in the effectiveness of industrial risk management implementation. The Human Factor Risk Management (HFRM) approach contributes directly to two major components of the COSO ERM 2017 framework:

a. Governance and Culture, through the development of risk culture, open communication, and empathetic leadership;

b. Performance, through the enhancement of human error control, assessment of risky behaviors, and organizational learning.

Within the ISO 31000 framework, the results of this Systematic Literature Review (SLR) reinforce that the success of risk management depends on continuous communication and consultation, as well as top management's commitment to ongoing improvement (continuous improvement).

As a partial conclusion, the analyzed literature demonstrates that Human Factor Risk Management (HFRM) is not merely a technical approach, but rather an adaptive governance strategy that bridges behavioral risks with strategic decision-making. The integration of HFRM with ISO 31000 and COSO ERM 2017 can enhance organizational resilience, operational safety, and long-term competitiveness across the industrial sector.

CONCLUSION

Based on the systematic review of 55 selected scientific articles analyzed using the Systematic Literature Review (SLR) approach and bibliometric mapping through VOSviewer, it can be concluded that Human Factor Risk Management (HFRM) plays a central role in enhancing the effectiveness of risk management systems in the industrial sector.

The keyword network analysis shows that concepts such as human error, risk management, safety culture, organizational behavior, ISO 31000, and COSO ERM 2017 form three main thematic clusters:
a. The technical cluster, focusing on the identification, analysis, and mitigation of human errors (HRA/HEI) within industrial operations;
b. The behavioral and organizational culture cluster, highlighting the importance of leadership, communication, and safety culture in managing human-related risks; and
c. The governance and risk management framework cluster, demonstrating the integration between human behavior and international risk governance standards such as ISO 31000 and COSO ERM 2017.

The synthesis results indicate that more than 80% of the reviewed studies confirm that human factors are the most influential element in the effectiveness of industrial risk management systems. Human error is not merely the result of individual failure, but rather the consequence of systemic weaknesses — including organizational culture, risk leadership, and internal communication. Approaches that position human factors as an integral part of risk management have been proven to enhance operational reliability, workplace safety, and organizational resilience.

Furthermore, the analysis demonstrates that the integration of HFRM with ISO 31000 and COSO ERM 2017 frameworks strengthens:
a. The processes of behavior-based risk identification and evaluation;
b. The mechanisms of risk communication and consultation across organizational levels; and
c. The application of governance and culture principles that are adaptive to technological and behavioral changes.

Thus, Human Factor Risk Management (HFRM) should not be regarded merely as a supporting function, but rather as a strategic pillar of Enterprise Risk Management (ERM) — one that bridges operational risks, strategic decision-making, and sustainable corporate governance.

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