A Critical Review on Recommender System for the Mitigation of Occupational Health and Safety Issues in Cement Industries

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Abstract:

The cement industry is one of the most hazardous industries, with millions of workers worldwide exposed to occupational health and safety hazards. This paper presents a critical review of the use of recommender systems for the mitigation of occupational health and safety hazards in the cement industry. The recommender system aims to provide recommendations for exposure monitoring and control measures to limit exposures, reduce hazards, and prevent chronic health disorders resulting from workplace conditions. By utilizing the recommender system, industrial health and safety professionals can document workplace conditions, manage health hazard inventory efficiently, and provide data to occupational health physicians and nurses for appropriate exposure-based medical surveillance. The data collected by these sensors can be processed and analyzed by the intelligent recommender system to identify potential hazards and provide timely recommendations for exposure control. By analyzing historical data on exposures, incidents, and control measures, the system can identify patterns and trends, enabling it to provide more accurate and tailored recommendations for each specific scenario. The paper concludes by discussing the potential benefits and limitations of using recommender systems for occupational health and safety in the cement industry.

Keyword: Recommender System, Occupational Health and Safety, Cement

Introduction:

Occupational safety and health (OSH) focus on safeguarding the well-being of workers, encompassing their physical, mental, and social aspects. Each year, a significant number of individuals worldwide suffer injuries or fatalities due to workplace accidents or illnesses(*World Statistic*, n.d.). Among various industries, the construction sector stands out as particularly

hazardous, with an occupational fatality rate five times higher than that of the manufacturing industry(*International Labour Standards on Occupational Safety and Health*, n.d.). Throughout history, people have dedicated themselves to mitigating construction accidents, employing diverse strategies ranging from institutional reforms to technological advancements. In recent times, there has been a notable shift toward leveraging smart technologies to enhance OSH in the construction domain (Sepasgozar et al., 2023).

Smart technologies like artificial intelligence (AI) (Christenko et al., 1831), the Internet of Things (IoT) (Damaševiˇ, 2023), and big data analytics offer promising avenues for accident prevention, safety training enhancement, and worker health monitoring. For instance, AI can effectively identify potential hazards, while the IoT enables tracking of workers' movements and exposure to risks. Furthermore, through comprehensive analysis of large-scale data, big data analytics can uncover patterns related to accidents and injuries.

Recommender systems (RS) have gained significant development in the field of decision support systems (DSS). Originally applied in e-commerce (Aparicio et al., 2021; Guo et al., 2014; Khan et al., 2021), RS are now utilized in various domains such as e-learning (Dahdouh et al., 2019; Jena et al., 2023), e-government, e-business, e-tourism (Bedi et al., 2014; Massimo & Ricci, 2022), e-library, e-resource services, and e-group activities as well as in COVID-19 prevention through awareness (Kiran, 2021). These modern RS extend beyond the traditional recommendation of products in online stores.

The architecture of recommender systems incorporates essential modules: knowledge extraction, domain knowledge representation, and profiling recommendations (Fayyaz et al., 2020). To support these modules, specific ontologies need to be formulated. This includes a domain ontology, task ontology, and recommendation profile ontology. Recommendations in the system are expressed as processes outlined using the BPMN notation, requiring the indexing of procedures based on an ontology.

In the context of designing a task ontology, it is necessary to analyze the safety situation in individual workplaces according to OHS regulations. The domain ontology should align with the terminology defined in standards such as PN-N-18001 (Occupational Health and Safety

Management Systems — Requirements), PN-N-18002 (Occupational Health and Safety Management Systems — General guidelines for risk assessment), PN-N-18004 (Occupational Health and Safety Management Systems — Guidelines), PN-N-18011 (Occupational Health and Safety Management Systems — Guidelines for audits), and PN -EN ISO 12100 (Machine safety — basic notions, general designing principles, risk assessment, and risk reduction).

According to a study by the International Labour Organization (ILO), approximately 150 million workers worldwide are exposed to occupational health and safety hazards in the cement industry, with 20 million at risk of respiratory diseases like asthma and chronic obstructive pulmonary disease (COPD) (Cabrera-Ormaza, 2018). This industry also poses other common health risks such as noise-induced hearing loss, musculoskeletal disorders, and skin diseases. The ILO estimates that these injuries and illnesses cost the global economy around $100 billion annually, not to mention the toll on human lives (*ILO: Work Hazards Kill Millions, Cost Billions*, n.d.). Therefore, implementing effective measures to ensure workplace safety and occupational health and safety is crucial, particularly in high-risk environments like cement manufacturing.

Workers in cement factories face various health hazards, including exposure to high temperatures, noise, and cement particles emitted during operations, with the packing and crusher sections having higher concentrations (Rahmani et al., 2018). To address these risks, the development of an intelligent recommender system for occupational health and safety in cement industries is necessary. The recommender system must aim to provide recommendations for exposure monitoring and control measures to limit exposures, reduce hazards, and prevent chronic health disorders resulting from workplace conditions. By utilizing the recommender system, industrial health and safety professionals can document workplace conditions, manage health hazard inventory efficiently, and provide data to occupational health physicians and nurses for appropriate exposure-based medical surveillance.

Prevention through design concepts is essential in developing the intelligent recommender system. By integrating occupational health and safety considerations into the design phase, potential accidents and occupational diseases can be prevented, safeguarding workers and positively impacting the company's safety record and reputation. However, addressing health and safety, health, safety, and management in the cement industry requires significant technical,

organizational, and financial resources, along with a solid legal framework. Furthermore, the challenges brought about by the Fourth Industrial Revolution necessitate updating traditional risk assessment procedures.

To effectively address these challenges and prioritize the safety and health of workers, the recommended system should incorporate wearable and low-cost sensors for exposure monitoring. These sensors can be integrated into personal protective equipment (PPE) like respiratory masks or clothing, providing real-time data on worker exposure levels (Márquez-Sánchez et al., 2021; Patel et al., 2022). Parameters such as airborne particulate matter, temperature, humidity, and noise levels can be measured, offering valuable insights into working conditions.

The data collected by these sensors can be processed and analyzed by the intelligent recommender system to identify potential hazards and provide timely recommendations for exposure control (Ramzan et al., 2019). For instance, if elevated levels of airborne cement particles are detected in a specific area of the cement plant, the system can suggest implementing engineering controls like improved ventilation or dust suppression techniques. Additionally, it can generate alerts and notifications to remind workers to use proper PPE or take breaks to minimize exposure.

Furthermore, the intelligent recommender system can employ machine learning algorithms to continuously learn and improve its recommendations over time(Zhang et al., 2021). By analyzing historical data on exposures, incidents, and control measures, the system can identify patterns and trends, enabling it to provide more accurate and tailored recommendations for each specific scenario. Implementing such an intelligent recommender system brings several benefits to the cement industry. It enhances the ability to proactively address occupational health and safety concerns, reducing the likelihood of accidents, injuries, and chronic health disorders among workers (Construction & Council, 2017). Moreover, it promotes a culture of safety by providing real-time guidance and ensuring compliance with occupational health and safety regulations. The integration of wearable sensors and the collection of exposure data also contribute to a more comprehensive understanding of occupational hazards in the cement industry, supporting evidence-based decision-making, evaluating existing control measures, and guiding the development of more effective risk mitigation strategies(Choi et al., 2017).

Importance of Occupational Health and Safety in Cement Industries:

Occupational health and safety plays a critical role in ensuring the health and well-being of workers in various industries, including the cement industry. Cement manufacturing processes involve several occupational hazards, such as dust, noise, and chemical exposures, which can have severe health implications for workers. Therefore, implementing effective occupational health and safety practices is of utmost importance in cement manufacturing plants to mitigate these risks and ensure a safe working environment.

The International Labour Organization (ILO) recognizes the importance of protecting workers from sickness, disease, and injury in the workplace, as stated in its Constitution. However, the reality for many workers is far from this ideal. Global estimates indicate that around 2.78 million work-related deaths occur each year, with 2.4 million of them related to occupational diseases. These tragedies not only cause immense suffering for workers and their families but also have significant economic costs for enterprises, countries, and the world. The associated expenses, such as compensation, lost work days, interrupted production, training, healthcare, and more, account for approximately 3.94% of the world's annual GDP(*ILO: Work Hazards Kill Millions, Cost Billions*, n.d.; *International Labour Standards on Occupational Safety and Health*, n.d.).

To address these challenges, the ILO has developed more than 40 standards specifically focused on occupational safety and health, along with over 40 Codes of Practice. These instruments aim to establish coherent national policies, promote safety and health culture, and provide guidelines for governments, employers, and workers. Key instruments include the Promotional Framework for Occupational Safety and Health Convention, 2006 (No. 187), which promotes the adoption of national policies through dialogue among stakeholders, and the Occupational Safety and Health Convention, 1981 (No. 155), which calls for comprehensive policies and actions to improve working conditions and promote occupational safety and health.

Additionally, the ILO has specific instruments related to occupational safety and health in various branches of economic activity, such as commerce and offices, dock work, construction, mines, agriculture, and more. These instruments address industry-specific hazards and provide measures for the protection of workers. Furthermore, the ILO has conventions focused on protection against

specific risks, including radiation, occupational cancer, air pollution, asbestos exposure, and chemical safety.

It is important to note that ILO Codes of Practice, while not legally binding, offer practical guidelines for different stakeholders and sectors. They provide recommendations on safety and health measures, hazards, and sector-specific guidelines.

Overall, the ILO's standards and instruments on occupational safety and health play a crucial role in preventing work-related accidents, diseases, and injuries. They serve as essential tools for governments, employers, and workers to establish practices that ensure maximum safety in the workplace.

Current Occupational Health and Safety Practices in Cement Industries:

In cement industries, there are several current occupational health and safety practices in place to address the specific hazards associated with cement manufacturing. These practices include:

1. Personal Protective Equipment (PPE): Workers are provided with appropriate PPE, such as masks, goggles, and gloves, to protect themselves against inhalation of dust particles, eye injuries, and chemical exposures.

2. Ventilation Systems: Adequate ventilation systems are installed throughout the cement plants to control and remove airborne contaminants, including dust, fumes, and gases, from the work environment. This helps in reducing the concentration of harmful substances and maintaining a clean air quality.

3. Regular Monitoring: Regular monitoring of air quality, noise levels, and chemical concentrations is conducted to identify potential health hazards and take necessary corrective actions. Monitoring ensures that the exposure levels are within permissible limits and helps in identifying areas that require additional controls or improvements.

4. Training and Awareness: Workers are trained on occupational health and safety practices to create awareness about the potential hazards associated with their work areas. They are educated about the proper use of PPE, safe handling of chemicals, and the importance of maintaining good health and safety practices in their day-to-day activities.

Challenges Faced in Implementing Occupational health and safety Practices:

Despite the existence of these practices, there are several challenges faced in implementing occupational health and safety in cement industries:

1. Lack of Awareness: Limited understanding of the potential health risks associated with cement manufacturing processes among workers and management can hinder the adoption of appropriate health and safety practices. Effective communication and training programs are essential to create awareness and educate the workforce about the hazards and necessary preventive measures.

2. Cost and Resource Constraints: Implementing comprehensive occupational health and safety measures requires investments in infrastructure, equipment, and regular monitoring systems. Some cement industries, especially smaller ones, may face financial challenges in allocating resources for implementing and maintaining these practices. Finding cost-effective solutions and exploring government support or incentives can help overcome this challenge.

3. Resistance to Change: Resistance to change from workers and management, particularly when existing practices have been in place for a long time, can impede the adoption of new occupational health and safety practices. It is important to involve and engage all stakeholders in the decision-making process and communicate the benefits of implementing improved health and safety practices to gain their support.

4. Complex Work Environment: Cement manufacturing involves multiple processes and work areas, each with its unique hazards. Managing and implementing consistent health and safety practices across all areas can be challenging due to the complexity of the work environment. Customized solutions and risk assessments tailored to specific work areas can help address this challenge effectively.

Design and Development of the Recommender System:

To overcome these challenges and enhance occupational health and safety practices in cement industries, a recommender system can be developed. The recommender system can assist cement industries in identifying and implementing appropriate measures by utilizing data collected from various sources, such as real-time monitoring systems, historical records, and expert knowledge. The system can offer the following functionalities:

1. Risk Assessment: By analyzing real-time and historical data, the system can assess the level of risks associated with different processes, work areas, and exposure factors. This assessment can help prioritize the implementation of health and safety practices based on the severity of risks, enabling efficient resource allocation.

2. Personalized Recommendations: The system can generate personalized recommendations for workers, supervisors, and management based on their roles and responsibilities. These recommendations can include specific PPE requirements, work practices, and training needs, ensuring that each individual receives tailored guidance for maintaining their safety.

3. Continuous Monitoring: The recommender system can integrate with existing monitoring systems to provide real-time updates on air quality, noise levels, and chemical concentrations. It can alert relevant personnel when thresholds are exceeded and suggest appropriate corrective actions, enabling prompt response to potential hazards.

Benefits of the Recommender System:

Implementing a recommender system in cement industries can bring several benefits:

1. Enhanced Occupational Safety: The personalized recommendations and continuous monitoring provided by the system can significantly improve workplace safety. Workers will be equipped with the right protective measures, and their awareness of potential hazards will be heightened, reducing the likelihood of accidents and health issues.

2. Cost Optimization: By prioritizing health and safety practices based on risk assessment, the recommender system can help optimize resource allocation. It ensures that investments are directed towards critical areas that require immediate attention, maximizing the effectiveness of available resources.

3. Improved Compliance: The recommender system can assist in ensuring compliance with occupational health and safety regulations by providing a structured approach to managing health and safety practices and monitoring. It helps organizations meet regulatory requirements and maintain a safe working environment.

4. Knowledge Sharing: The system can act as a knowledge repository, accumulating data and recommendations over time. This knowledge can be shared across different cement plants and industries, fostering continuous improvement in occupational health and safety practices. Sharing best practices and lessons learned can contribute to industry-wide advancements in safety.

Literature Review:

(Andreasik, 2017) proposed the architecture of a system called Compliance OHS-CBR, which recommends preventive/corrective procedures in the occupational health and safety management system in an enterprise. The system consists of four modules: an ontology of the workplace OHS profile, an ontology of preventive/corrective procedure indexation, a recording system of the monitoring process of non-compliance with the requirements of OHS, and a recommending engine consistent with the CBR methodology. The essence of the approach presented in this paper is the integration of the monitoring system of the analysis process of non-compliance with the requirements of OHS at the workplace with the case-based reasoning process. The paper concludes that this is a new approach that uses the monitoring system to acquire the knowledge required to represent cases in the CBR methodology. The ontologies OP-OHS and OP-CPI shown in the paper will be described in detail in the author's future work. Furthermore, the paper does not explicitly mention any limitations of the proposed system or methodology.

(Amrina et al., 2020) proposed a fuzzy multi-criteria approach to evaluate the sustainable maintenance performance in the cement industry. The approach identifies 16 key performance

indicators (KPIs) divided into three factors of economic, social, and environmental. The relationships amongst the KPIs are determined using the Interpretive Structural Modeling (ISM) method. The Fuzzy Analytic Network Process (FANP) method is then used to determine the importance weight of KPIs. The occupational health and safety are regarded as the most important indicator, followed by working environment, and lighting and ventilation. The evaluation model can be used by the cement companies to assess their performance on sustainable maintenance.

(Caggiano et al., 2022) have proposed a machine learning-based framework for monitoring the health of manufacturing operators in an Industry 4.0 context. The framework utilizes wearable sensors to collect physiological data, manufacturing-related data, and environmental data to assess the level and type of health risk for the operator. The proposed methodology involves complex input data classification using a Google Net deep learning network and fuzzy logic inference system. The framework is integrated within a cloud manufacturing platform that can collect and process online data from various sensors and manufacturing equipment for occupational health risk assessment to enable prompt action and prevent fatalities. The effectiveness of the proposed platform was validated through a simulated industrial case study involving manufacturing-related risks in CNC machining processes using cutting fluids.

(Arana-Landín et al., 2023) studied the impact of Industry 4.0 technologies on occupational health and safety risks, with a focus on new emerging risks generated. The authors conducted a literature analysis, a survey of 130 managers and technicians of pioneering companies in the development of Industry 4.0 technologies, and a multiple case study through 37 in-depth interviews. The findings suggest that the analyzed technologies help to reduce physical and mechanical occupational health and safety risks, but their impact depends on the type of technology and the method of application. However, new emerging risks (mainly psychosocial and mechanical) have been detected in all technologies except in Internet of Things. The paper concludes that there is a need to investigate in more detail the effects of the integration of Industry 4.0-based applications on OHS and to generate knowledge in this field.

(Jarota, 2023) discusses the proposed European Union regulations on artificial intelligence from an occupational health and safety perspective. The authors argue that the proposed model for regulating AI by the EU legislator is insufficient and there is no clear indication of the employer's obligations towards employees concerning occupational health and safety. They suggest introducing a responsive method of regulation in EU law, whereby the employer's application of

employee health protection standards would be reviewed by the Authority to ensure that the objectives of the regulation are met. The article concludes that the introduction of the principle that humans control AI and not the other way around is certainly welcome and that AI should not be a tool used beyond human control. The authors also note that the use of AI in the workplace can cause fears of being assessed by an algorithm or losing one's job due to the algorithm, which can lead to conflict among employees and discrimination in the working environment.

(Ramos et al., 2020) propose that the implementation of Integrated Management Systems (IMSs) can help organizations, particularly Small and Medium-Sized Enterprises, to efficiently reduce risks and increase productivity in Occupational Health and Safety (OH&S) risk management. The success of the integration of risk management in OH&S depends on both technical and human aspects. The analysis of accidents was particularly relevant in understanding the evolution of occupational accidents over the years in terms of number and severity, relating them to the implementation/maturity of the OH&S management system. The study found that although the frequency of accidents has increased since 2009, the severity has been reduced. The most frequent cause of accidents was "Imprudence/distraction," representing 52% of the overall accidents, followed by "non-compliance with the rules," which was associated with 34% of the accidents recorded.

(Fan & Xu, 2021) employed a deep learning algorithm and mathematical model to assess and analyze the health risks associated with occupational exposure to toxic chemicals in coal mines. The research focused on four working areas within a mine located in Shanxi Province. Gas samples were collected from the working environment, and calculations were made based on the employees' lung condition and the levels of harmful gas components. By doing so, a risk index for each area was obtained. The experimental findings revealed a significant increase in induced airflow velocity of the chute and guide chute with higher coal cutting amounts, resulting in higher levels of harmful substances in the working environment. The deep learning mathematical model utilized in this study proved to be highly effective and accurate in assessing the health risks posed by toxic chemicals in coal mines. Furthermore, it contributed to the overall risk assessment. To analyze toxic and harmful gases and dust, three methods were employed: the risk assessment method, the risk assessment method, and the fuzzy comprehensive evaluation method.

(Mehta et al., 2012) studied that occupational exposures to biological dusts, mineral dusts, gases/fumes, and VGDF (vapors, gases, dusts, or fumes) were associated with the incidence of

chronic obstructive pulmonary disease (COPD) of at least moderate severity in a Swiss working adult population. The risk of stage II1 COPD was predominantly observed in males over the age of 40 years and remained elevated even among nonsmokers. The research design had several strengths, including a prospective study design, the use of a GPJEM (general population job exposure matrix) with semiquantitative estimates for exposure, and comprehensive control for confounding variables. However, there are some limitations to consider, such as the use of prebronchodilator spirometric measurements to define COPD, which may have resulted in misclassification of participants with asthma. Additionally, the study was conducted in a Swiss population, which may limit its generalizability to other populations. Overall, this study provides evidence supporting the association between occupational exposures to dusts, gases, and fumes and the incidence of COPD, highlighting the importance of considering workplace environments in the prevention and management of this respiratory disease.

(Dabbagh & Yousefi, 2019) have proposed a hybrid decision-making approach based on Failure Mode and Effect Analysis (FMEA), Fuzzy Cognitive Map (FCM), and Multi-Objective Optimization on the basis of Ratio Analysis (MOORA) for assessing and prioritizing Occupational Health and Safety (OHS) risks. The approach helps in identifying and prioritizing risks with the aim of providing corrective/preventive measures to minimize the negative consequences of OHS risks. The results from the implementation of the proposed approach in a manufacturing company reveal that the score at issue can overcome some of the drawbacks of the traditional Risk Priority Number (RPN) in the conventional FMEA, which finally provides a full and distinct risk prioritization.

(Maalouf & Hoque, 2022) worked on the identification of organizational factors that contribute to enhanced occupational health and safety (OHS) performance within the garment industry of Bangladesh. The study employs a small-N fuzzy set qualitative comparative analysis (fsQCA) to discern the pathways linking selected garment suppliers to their OHS performance. Two distinct pathways are revealed: Pathway 1, which highlights Leadership as a causal condition, and Pathway 2, which emphasizes Buyers as a relevant causal condition. Additionally, three common causal conditions are identified for both pathways: Accountability, Auditing, and Training. By focusing on interdependent organizational factors and pathways, this study adds to the ongoing discourse surrounding the enhancement of OHS conditions in supplier factories located in developing countries. The garment industry in Bangladesh has faced pressure from international buyers and

local government entities to improve working conditions and OHS outcomes. While prior studies have primarily relied on large-N statistical analyses and average effect sizes, this study delves into the interplay of organizational factors and pathways. Purposeful sampling was employed to select 14 cases, deliberately maximizing variations in causal conditions and output to facilitate pathway identification. The conceptual framework utilized in this research is the organizational triangle model, which incorporates structure, culture, and processes as influential forces on OHS outcomes. Furthermore, the article suggests that establishing long-term relationships and partnerships with international buyers plays a significant role in enhancing OHS performance within Pathway 2, compensating for the absence of active leadership and management commitment.

(Stefana et al., 2022) proposed a risk-based framework called IMPROSafety to integrate Occupational Safety and Health (OSH) and process safety. The framework covers all the steps of the risk management process, including hazard identification, risk estimation, risk evaluation, and risk treatment. The focus on the risk concept allows prioritizing attention on several dimensions that analysts should investigate in depth, including the occurrence probability of scenarios, consequence severity, temporal evolution, spatial extension, and the number of workers involved. The paper presents a case study about three real unwanted events occurred in the steel and iron industry in the last decades to offer a preliminary application of the framework. The investigation of six scenarios highlights the most dominant event sequences and risk dimensions that should receive prioritized attention for developing effective risk reduction controls.

(Ma et al., 2021) proposed an integrated analysis framework (IAF) to identify and evaluate potential risk factors in construction projects. The framework uses machine learning to mine safety risk factors from heterogeneous data and calculates the initial importance of risk factors based on two judgment categories. The concept of cascading effect is introduced to establish an activity-on-the-node (AON) network to further evaluate the negative impact of risk factors on project safety. The IoF and IoR of risk factors in RF calculation are introduced as the disturbance term of activating cascade effect. The AON network corresponding to the three projects is established to analyze the impact of task "failure" induced by risk factors on the whole project. The case study results show that machine learning can more efficiently mine the associated risk factors and effects with cascading failures, which indicates that the data-based safety risk factor analysis is more objective and accurate. In conclusion, the IAF is an effective attempt to mine the potential risk

factors in heterogeneous documents by machine learning and is a supplement to the risk management knowledge system.

(Stefana & Paltrinieri, 2021) proposed a framework called ProMetaUS for selecting and ranking models for Dynamic Risk Management (DRM) based on desired uncertainty conditions. The framework is based on a meta-learning system that acquires knowledge from datasets and relates it to performance measures of the models. The proposed framework provides safety managers, practitioners, and researchers with a dynamic tool for incorporating further models, evidence, and information when available, without requiring expertise and competencies in all the existing models and data mining techniques. The paper presents a case study about Oxygen Deficiency Hazard (ODH) assessment by means of @RISK to offer a preliminary application of the framework in the safety field. The proposed framework was tested on five training datasets, and three models predicting the time trend of the indoor O_2 concentration by volume were evaluated. The paper concludes that the proposed framework can be used to rank models based on desired uncertainty conditions and can be extended to other safety-related domains.

(Wu et al., 2021) presented a conceptual framework that combines computer vision and ontology techniques to facilitate the management of safety by semantically reasoning hazards and corresponding mitigations in construction sites. The framework uses computer vision to detect visual information from on-site photos while the safety regulatory knowledge is formally represented by ontology and semantic web rule language (SWRL) rules. Hazards and corresponding mitigations can be inferred by comparing extracted visual information from construction images with pre-defined SWRL rules. The example of falls from height is selected to validate the theoretical and technical feasibility of the developed conceptual framework. Results show that the proposed framework operates similar to the thinking model of safety managers and can facilitate on-site hazard identification and prevention by semantically reasoning hazards from images and listing corresponding mitigations. The article concludes that the proposed framework can support safety inspection by automatically reasoning hazards from on-site photos and listing corresponding mitigation suggestions.

(Amponsah-Tawiah et al., 2016) proposed the importance of implementing effective occupational health and safety management practices to mitigate turnover intention within the mining industry. The study reveals a negative relationship between various dimensions of occupational health and safety management and turnover intention. Specifically, safety leadership and safety facility

emerge as significant predictors of turnover intention. The commitment displayed by safety leaders in formulating policies and supervising occupational health and safety in the workplace greatly influences employees' inclination to leave their positions. The mining industry, recognized for its inherent dangers and hazards, has received limited attention regarding the relationship between occupational health and safety and turnover intentions. To address this gap, the study collected quantitative data from 255 mine workers in the Ghanaian mining industry, employing standardized questionnaires to measure occupational health and safety management and turnover intentions. The findings demonstrate negative correlations between dimensions such as safety leadership, supervision, safety facilities and equipment, safety procedures, and turnover intention. Moreover, safety leadership and safety facility emerge as significant predictors of turnover intention. In conclusion, the study emphasizes the crucial role of safety leadership in reducing turnover intention within organizations and effectively administering occupational health and safety measures. It underscores the importance for employers in the mining sector to prioritize comprehensive occupational health and safety management, thereby fostering a safe work environment and promoting employee retention.

(Vishal Chaudhary et al., 2022) wrote a review article that summarizes the state-of-the-art smart FMR engineered with different dimensional nanomaterials and nanocomposites to combat airborne health hazards, especially due to infectious outbreaks and air contamination. The article discusses the challenges associated with conventional FMRs and how FMRs engineered with functional nanomaterials can address these challenges due to their smart features. The article also highlights the potential sustainable solutions and prospects for "point-of-action" intelligent operation of Internet-of-nano-things (IoNT) driven intelligent face masks to combat airborne health hazards. Therefore, the paper does not involve any specific methods.

(Chi et al., 2014) proposed the use of ontology-based text classification to assist Job Hazard Analysis (JHA) in the construction industry. The authors propose using existing construction safety documents that contain possible safe approaches as references for drafting new JHAs, which can reduce manual effort. They simulate the logic of JHA to develop the construction safety domain ontology and transform the logic into a text classification problem. The end result of this research is a construction safety domain ontology and its underlying knowledge base. The authors conclude that ontology-based text classification can effectively match safe approaches identified

in existing resources with unsafe scenarios, which can serve as initial references and enrich the solution space when performing JHA.

Conclusion and Future Work:

Continued research and development in recommender systems can further enhance workplace safety and pave the way for healthier work environments in cement industries and beyond. The data collected by these sensors can be processed and analyzed by the intelligent recommender system to identify potential hazards and provide timely recommendations for exposure control. By analyzing historical data on exposures, incidents, and control measures, the system can identify patterns and trends, enabling it to provide more accurate and tailored recommendations for each specific scenario. Further research can focus on developing more advanced algorithms for the recommender system, integrating it with other occupational health and safety systems, and testing its effectiveness in real-world scenarios.

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