buildings

MDPI

Review

Catalysing Construction Safety: A Comparative Analysis of Technological Advancements across High-Risk Industries

Adeeb Sidani [1], João Poças Martins [1,2,*] and Alfredo Soeiro [1]

[1] CONSTRUCT-Faculty of Engineering, University of Porto, 4200-465 Porto, Portugal; adeeb.sidani@fe.up.pt (A.S.); avsoeiro@fe.up.pt (A.S.)
[2] BUILT CoLAB, 4150-003 Porto, Portugal
* Correspondence: jppm@fe.up.pt

Abstract: This article presents a comprehensive review of the safety status and technological development in high-risk industries, with a focus on construction, mining, agriculture, transportation, healthcare, and energy sectors. The objective is to analyse and compare the current safety practices, challenges, and advancements in these industries to identify common trends, knowledge gaps, and potential areas for improvement. The review explores the incidence of accidents, associated costs, traditional safety methods, limitations, and emerging technologies employed to enhance safety across multiple industries. This review aims to provide insights and lessons that can be applied to enhance safety practices in the construction industry. The findings highlight the critical role of technological advancements in mitigating risks and fostering a culture of safety across diverse sectors.

Keywords: occupational health and safety; technological development; high-risk industries; comparative analysis; construction industry

Citation: Sidani, A.; Poças Martins, J.; Soeiro, A. Catalysing Construction Safety: A Comparative Analysis of Technological Advancements across High-Risk Industries. *Buildings* **2023**, *13*, 2885. https://doi.org/10.3390/buildings13112885

Academic Editor: Antonio Caggiano

Received: 17 October 2023
Revised: 10 November 2023
Accepted: 16 November 2023
Published: 19 November 2023

1. Introduction

1.1. Background and Significance of Studying Safety Status and Technological Development in Various Industries

The safety status and technological development in industries play crucial roles in ensuring the well-being of workers, preventing accidents, and improving overall operational efficiency. Understanding the current state of safety practices and the advancements in technology across different sectors is critical for identifying areas of improvement and implementing effective strategies to mitigate risks.

This review will comprehensively analyse the safety status and technological development across a spectrum of high-risk industries, namely construction, mining, agriculture and livestock, transportation, healthcare manufacturing, and energy. Each of these industries presents a unique set of challenges and opportunities related to safety, and examining their safety practices and technological integration can provide valuable insights. These industries are selected based on their diverse operational characteristics and the degree of hazards their workforce faces daily. By comparing the safety strategies, challenges, and advancements in these industries, the authors aim to uncover common trends, knowledge gaps, and innovative solutions that can be adapted to enhance safety practices in the construction industry.

The construction industry, known for its high-risk nature, can significantly benefit from the lessons and experiences of other industries that have successfully harnessed technological innovations [1]. By examining how advanced monitoring systems, automation, robotics, and remote-controlled machinery have contributed to safety enhancements in fields such as mining, agriculture and livestock, transportation, manufacturing, and energy, the potential impact of similar technologies in construction can be anticipated. Through this exploration, the authors aspire to pave the way for a safer and more technologically sophisticated construction sector, safeguarding workers and fostering a culture of safety.

This industry has traditionally relied on conventional safety methods, but the limitations of these approaches have led to a growing interest in exploring innovative solutions [2].

The mining industry faces inherent hazards such as cave-ins, explosions, and exposure to harmful substances [3]. Efforts to improve safety have led to the adoption of advanced monitoring systems, automation, and remote-controlled machinery to reduce the risk to workers [4].

The agriculture and livestock industry is characterised by physical labour, heavy machinery, and exposure to environmental factors [5]. Accidents in agriculture can result in severe injuries or fatalities. Technological advancements, including precision agriculture and farm automation, have been implemented to enhance worker safety and productivity [6].

The transportation industry, encompassing the road, air, rail, and maritime sectors, faces various safety challenges [7]. With the increasing reliance on technology, safety measures such as collision avoidance systems, driver monitoring, and fatigue detection technologies have been developed to minimise accidents and protect the lives of workers and the general public [7].

The manufacturing sector involves diverse operations, machinery, and materials, presenting potential hazards such as machinery accidents, ergonomic issues, and chemical exposures [8]. Advances in automation, robotics, and machine learning have led to safer work environments, reduced human error, and improved overall productivity [4].

The energy industry, including oil and gas, nuclear, and renewable energy sectors, poses unique safety challenges due to the nature of operations and exposure to hazardous substances [9]. Stringent safety protocols, remote monitoring systems, and technological innovations are vital to ensure the well-being of workers and prevent catastrophic incidents.

Safety culture, an integral part of health and safety management, involves fostering a work environment in which safety is a shared value and responsibility. A strong safety culture encourages employees and employers to prioritise safety, follow best practices, and actively participate in safety initiatives [10]. The authors will explore how safety culture plays a pivotal role in each industry and how it contributes to safety performance.

Based on Eurostat data from 2020, shown in Figure 1, the construction industry has the highest number of fatalities, injuries, and lost workdays due to accidents. The transportation industry has the second-highest number of fatalities, followed by the agriculture and livestock industry. The mining and healthcare industries have the lowest number of fatalities. Moreover, the healthcare, transportation, and agriculture industries have the highest number of non-fatal accidents [10].

Moreover, Table 1 shows the highest occurring health and safety hazards in each of the five industries. The most common hazards across all industries are falls, exposure to hazardous substances, and overexertion. Other hazards that are specific to certain industries include machinery accidents (construction, mining, agriculture), vehicle accidents (transportation), radiation, stress and psychological problems (health care), and cave-ins and explosions (mining) [10,11]. Highlighting the primary risks in each sector not only informs about the unique hazards in each industry but also sets the stage for further analysis and comparison of safety practices and technological interventions. Figure 2 illustrates the percentages of hazards in each industry. Falls are the most common type of accident in all five industries, accounting for at least 20% of accidents in each industry. Exposure to hazardous substances is the second most common type of accident in the construction, mining, agriculture, and healthcare industries. Overexertion is the second most common type of accident in the transportation and healthcare industries. Machinery accidents are the third most common type of accident in all five industries [10–12]. The "other" category includes a variety of other hazards, such as electrical hazards, fires, and vehicle accidents.

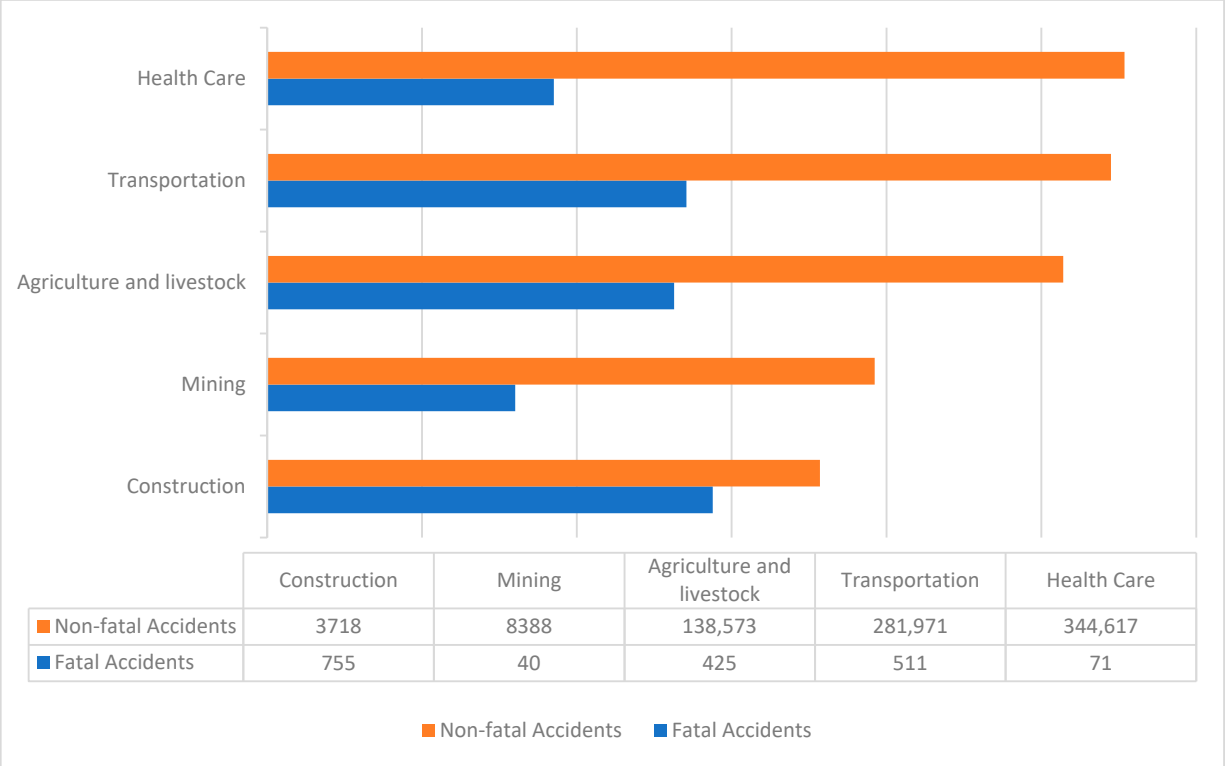


Figure 1. Fatal and non-fatal accidents at work, EU, 2020.

Table 1. Highest occurring hazards according to each industry, Source: Eurostat, 2021; OSHA Europa, 2023.

Industry	Highest Occurring H&S Hazards
Construction	Falls, exposure to hazardous substances, overexertion, machinery accidents
Mining	Falls, exposure to hazardous substances, cave-ins, explosions
Agriculture and livestock	Falls, exposure to hazardous substances, machinery accidents, animal bites
Transportation	Vehicle accidents, falls, exposure to hazardous substances, overexertion
Health care	Musculoskeletal disorders (MSDs); exposure to infectious diseases; slips, trips, and falls; violence and aggression; chemical exposure; radiation exposure; stress and mental health

1.2. Purpose and Objectives of the Article

The main objective of this article is to review best practices in health and safety from various industrial activities, allowing for a meaningful comparison with the Architecture, Engineering, Construction, and Operations (AECO) sector. The primary goal is to identify tools and methods capable of addressing the well-known issues affecting construction safety by closely examining health and safety approaches in industries such as mining, agriculture and livestock, transportation, manufacturing, and health care. The authors aim to extract insights that can facilitate effective safety strategies within construction. This examination will not only inform safety practices but also pave the way for a safer and more efficient construction sector through the implementation of lessons learned from diverse industries. Thus, the concrete objectives of the article are as follows:

- Evaluate Safety Status and Methods: Assess the current safety status and traditional health and safety methods in each industry, highlighting their limitations and areas for improvement. This includes a review of accident rates, fatalities, injuries, and the effectiveness of existing safety methods.
- Analyse Technological Advancements: Explore technological advancements and innovative solutions in the respective industries, discussing their impact on accident prevention, worker protection, and operational efficiency.
- Identify Common Challenges and Knowledge Transfer: Identify common challenges and trends across industries, analysing the potential for cross-industry knowledge transfer and collaboration. This involves a comparative analysis of safety practices to find commonalities and opportunities for collaboration.
- Highlight Gaps and Research Needs: Identify gaps in safety practices and technological adoption, providing insights for future research and development efforts to improve safety practices and promote technological innovation.

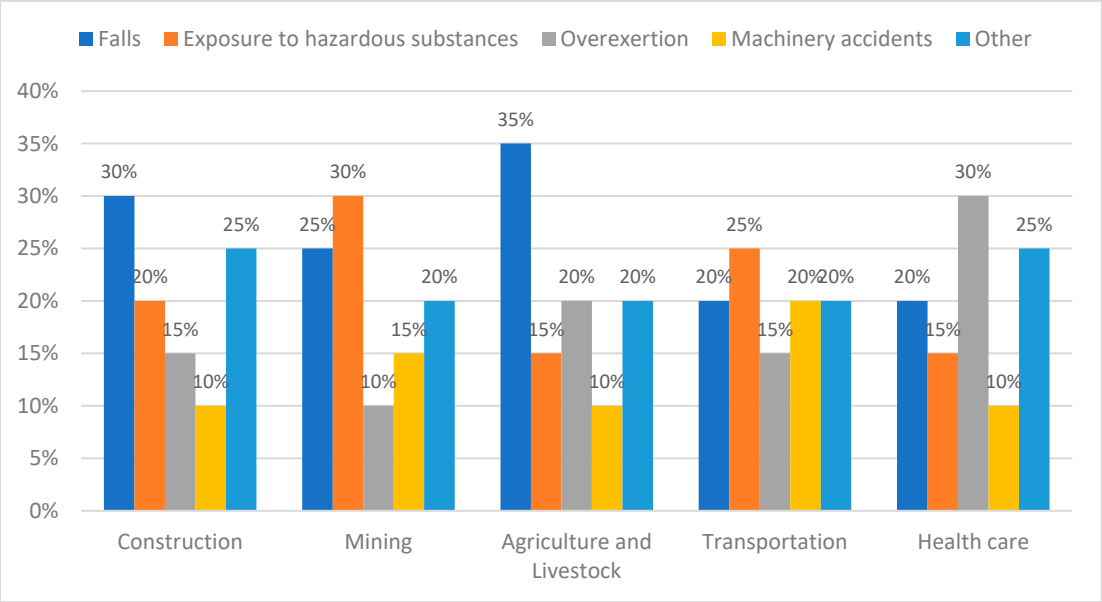


Figure 2. Relative proportion of hazards according to each industry, EU, 2020.

By examining the safety status and technological advancements in various industries, this article aims to contribute to the existing body of knowledge and promote a holistic understanding of effective safety practices across sectors. The following section will identify the methodology adopted to conduct the comparative analysis. Afterwards, the article will delve into each industry's safety status, methods, technological advancements, and implications for the construction sector. Finally, the article will present a summary of the main findings and recommendations that might be applied in the construction sector and future studies.

2. Methodology

This section outlines the approach taken to conduct the comparative analysis of safety status and technological development across high-risk industries.

2.1. Data Collection

For this review, a systematic literature search was conducted using academic databases, namely PubMed, IEEE Xplore, Scopus, and Science Direct, and relevant industry-specific journals. The search terms included combinations of industry names (construction, mining, agriculture, transportation, manufacturing, and health care), occupational health and safety, accidents, and emerging technologies. This process aimed to gather peer-reviewed

articles and research papers that address safety challenges and technological solutions in each industry.

2.2. Data Selection

From the collected literature, priority was given to recent studies (within the last five years) that presented empirical data, case studies, or comprehensive reviews of safety practices and technological advancements in the selected industries. To ensure the inclusion of high-quality and pertinent literature, specific criteria were established for article selection. The criteria were as follows:

- Relevance: Articles that directly addressed safety challenges and technological solutions within the specified industries. Articles that were irrelevant or loosely related were excluded from the analysis.
- Recency: The search focused on the recent studies published within the last five years. This focus on recency was maintained to provide insights into the most current industry practices.
- Empirical Data and Case Studies: The inclusion of empirical data and case studies was emphasised. These types of articles were considered particularly valuable as they offer practical insights into safety practices and technological advancements.
- Language: To ensure consistent understanding and analysis, the authors considered only articles written in English.

2.3. Data Analysis

The 49 articles selected were thoroughly reviewed and categorised based on industry focus, safety practices discussed, technological solutions explored, and outcomes reported. To conduct the comparative analysis, the following techniques were employed:

- Content Analysis: A systematic examination of the content within selected articles to identify recurring themes, safety challenges, and technological solutions.
- Cross-Industry Pattern Recognition: Identification of common trends and innovations across the various industries, allowing for the comparison of safety approaches and technological adoption.
- Qualitative Comparative Analysis: A qualitative assessment of similarities and differences in safety practices and technological advancements.
- Quantitative Data Extraction: Where available, relevant quantitative data from studies, such as accident rates, technology adoption percentages, or injury statistics, were extracted and compared.

These techniques were instrumental in deriving meaningful insights and comparisons across high-risk industries. The comparative analysis aimed to uncover patterns, challenges, and opportunities that could inform safety strategies in the construction industry.

2.4. Synthesis and Interpretation

The findings from the literature were synthesised to create a cohesive overview of safety practices and technological developments in each industry. The comparative analysis aimed to extract key insights, lessons, and potential cross-industry applications that could inform safety strategies in the construction industry. The interpretation involved a critical examination of the impact of emerging technologies on safety culture and operational efficiency within each sector.

2.5. Limitations

It is important to note that this review relies on the availability and quality of published literature. The scope of the study is limited to the articles and resources accessed during the research period. Additionally, the interpretation of findings may be influenced by the perspective of the authors and the biases inherent in the selected literature.

This methodology guided the approach to gathering, analysing, and synthesising information from a wide range of sources, enabling a comprehensive comparison of safety practices and technological advancements across high-risk industries.

3. Safety Status and Technological Development in High-Risk Industries

This section presents a concise description of the experimental results, their interpretation, and the experimental conclusions that can be drawn from the review of each industry. The section is organised into sub-chapters containing an assessment of each industry.

3.1. Mining Industry

3.1.1. Safety Challenges in Mining Operations

Mining operations face a range of safety challenges due to the nature of the work environment and the inherent hazards associated with mining activities. These most occurring mining operation risks are the following:

1. Cave-ins and Roof Falls: Underground mining exposes workers to the risk of cave-ins and roof falls, which can result in serious injuries or fatalities. Proper roof support systems, monitoring technologies, and training programs are essential to mitigate these risks [13].
2. Explosions and Fires: The presence of flammable gases, dust, and ignition sources in mining operations can lead to explosions and fires. Effective ventilation systems, gas monitoring, and strict adherence to safety protocols are crucial to prevent such incidents [14].
3. Exposure to Harmful Substances: Miners are often exposed to harmful substances such as silica dust, asbestos, and toxic gases, which can cause respiratory diseases and long-term health issues. Proper ventilation, personal protective equipment (PPE), and monitoring systems are critical to minimising exposure [15].

3.1.2. Most Occurring Mining Hazards and Risks

Mining operations involve various hazards and risks that can pose a threat to worker safety. The most occurring hazards include the following:

1. Falls from Heights: Working at heights is common in mining, and falls from elevated platforms or equipment can lead to severe injuries. Safety measures such as guardrails, fall arrest systems, and training programs are essential to prevent falls [16,17].
2. Machinery Accidents: Mining machinery, such as haul trucks, loaders, and drilling equipment, can cause accidents if not operated and maintained properly. Safety protocols, equipment inspections, and operator training are vital to minimise the risk of machinery-related incidents [17].
3. Noise and Vibration: Mining operations generate elevated levels of noise and vibration, which can lead to hearing loss and musculoskeletal disorders among workers. Engineering controls, regular monitoring, and the use of hearing protection devices are important to mitigate these hazards [18].

3.1.3. Safety Regulations and Practices in the Mining Industry

1. The mining industry is subject to stringent safety regulations and practices to ensure the well-being of workers. These main regulations that are commonly used in the mining industry are the National Safety and Health Administration (OSHA) Standards: OSHA sets guidelines and regulations specific to the mining industry to address hazards, establish safe work practices, and enforce compliance [16,19].
2. Mine Safety and Health Administration (MSHA) Regulations: MSHA regulates and enforces safety standards in mining operations, including requirements for hazard assessments, training programs, and the use of safety equipment [16,20].

3.1.4. Technological Advancements in Mining Safety

Technological advancements have played a significant role in improving safety in the mining industry (Table 2). Some notable advancements include the following:

1. Proximity Detection Systems: These systems use sensors and alarms to detect the presence of personnel or equipment in the vicinity of moving machinery, reducing the risk of collisions [21].
2. Remote Monitoring and Control: Remote monitoring systems allow real-time monitoring of mining operations, enabling early detection of potential hazards and improved emergency response [22]. This includes event reporting and early warning safety systems based on the Internet of Things for underground mines [23].
3. Automated and Remote-Controlled Machinery: The use of automated and remote-controlled machinery reduces the need for workers to be physically present in hazardous areas, minimising the risk of accidents and exposure to hazards [24].
4. Dust Control Technologies: Advanced dust control technologies, such as water sprays, ventilation systems, and improved filtration, help reduce the concentration of harmful dust particles in mining environments [25,26].
5. Wearables: In the mining industry, wearable devices are being used to monitor the vital signs of miners and to detect falls [27]. For example, the TeluSense wearable device uses sensors to monitor heart rate, respiratory rate, and body temperature and can also detect falls [28].
6. AI systems linked to real-time monitoring can be used to track worker locations and environmental conditions, identify potential hazards, and prevent accidents [29,30].

Table 2. Examples of how technological advancements are being used to mitigate H&S hazards, Source: Eurostat, 2021; OSHA Europa, 2023.

Industry	Technological Advancements	Mitigated H&S Hazards	Challenges of Adopting Technological Advancements
Construction	Wearable devices, AR, robotics, and drones	Falls, exposure to hazardous substances, overexertion, machinery accidents	High cost of technology, training required for workers
Mining	Proximity detection systems, remote-controlled mining equipment, and autonomous vehicles	Falls, exposure to hazardous substances, overexertion, machinery accidents	High cost of technology, training required for workers, harsh environmental conditions
Agriculture and livestock	Precision agriculture, farm automation, and wearable devices	Falls, exposure to hazardous substances, overexertion, machinery accidents	High cost of technology, training required for workers, changing weather conditions
Transportation	Collision avoidance systems, driver monitoring systems, and fatigue detection systems	Falls, exposure to hazardous substances, overexertion, machinery accidents	High cost of technology, training required for workers, public acceptance

3.2. Agriculture and Livestock Industry

3.2.1. Safety Concerns in Agricultural Activities

Agriculture is an industry with inherent safety risks and hazards due to its diverse operations and environments. Farmers and farmworkers face various safety concerns that can result in injuries, illnesses, and even fatalities. The most relevant safety concerns are as follows:

1. Machinery-related injuries: Farm machinery, such as tractors, combines, and balers, pose significant risks if not operated and maintained properly [31].
2. Falls: Working at heights, on slippery surfaces, or in unstable environments can lead to falls and subsequent injuries. This is due to the fact that workers often need to access elevated areas, such as the roofs of barns or storage structures, silos, or agricultural

machinery. They may need to perform maintenance, inspections, or repairs in these areas. In addition, farming environments are frequently exposed to various weather conditions. Rain, snow, or the presence of liquids like water or animal waste can create slippery surfaces. Moreover, farming involves various tasks in environments that may not always be stable. For instance, uneven terrain, unstable ground due to the movement of heavy machinery, or working around large animals can create precarious conditions [32].

3. Exposure to pesticides: Farmers may come into contact with pesticides during application, handling, or storage, leading to potential health effects [33].
4. Zoonotic infections: Proximity to animals increases the risk of zoonotic diseases, which can be transmitted from animals to humans [32,33].

3.2.2. Hazards and Risks in Farming and Livestock Operations

In farming and livestock operations, several hazards and risks pose significant challenges to worker safety and health. This chapter explores key areas of concern:

1. Machinery hazards: Improper use, lack of maintenance, and inadequate guarding of machinery can lead to injuries or fatalities [31].
2. Livestock-related hazards: Working with animals carries the risk of kicks, bites, or crush injuries [5].
3. Chemical exposures: Farmers may encounter various chemicals, such as pesticides, fertilisers, and cleaning agents, which can cause acute or chronic health effects [33].
4. Musculoskeletal injuries: Farm tasks often involve repetitive movements, heavy lifting, and awkward postures, contributing to musculoskeletal disorders [6].

3.2.3. Safety Standards and Practices in Agriculture

Several safety standards and practices have been developed to address safety concerns and mitigate risks in the agriculture industry. The main standards and practices are as follows:

1. Occupational Safety and Health Administration (OSHA) regulations: OSHA sets standards and guidelines to ensure the safety and health of workers in agricultural settings [31].
2. Good Agricultural Practices (GAPs): GAPs encompass guidelines and recommendations for safe farming practices, including proper use and storage of chemicals, equipment maintenance, and worker training [32].
3. PPE: The use of PPE, such as gloves, safety glasses, and respirators, is essential for protecting workers from hazards in agriculture [31].

3.2.4. Role of Technology in Enhancing Agricultural Safety

Technology plays a crucial role in improving safety in the agriculture industry (Table 2). Advancements in agricultural technology have introduced innovative solutions to mitigate risks and improve safety:

1. Precision agriculture: Technologies such as GPS, drones, and remote sensing enable precise application of inputs, reducing exposure to chemicals and optimising resource use [32,33].
2. Automated machinery and robotics: Automation reduces the need for manual labour, minimising the risk of injuries associated with operating heavy machinery [32].
3. Sensor-based systems: Sensors can monitor environmental conditions, detect equipment malfunctions, and provide real-time feedback to farmers, enhancing safety and efficiency [34].
4. Animal handling and tracking systems: Technologies like electronic tagging and monitoring systems help track livestock health, prevent disease spread, and improve worker safety [5].
5. Drones: In the agriculture industry, drones are used to inspect crops for pests and diseases and monitor livestock. For example, the DJI Agras T30 drone can be used

to spray pesticides on crops, and it can also be used to monitor livestock for health problems [35].

3.3. Transportation Industry

3.3.1. Safety Issues in Transportation Sectors (Road, Rail, Aviation, and Maritime)

The transportation industry encompasses various sectors, including the road, rail, aviation, and maritime sectors, each with unique safety challenges. The most frequently occurring safety issues in these sectors include the following:

1. Road transportation: Road traffic accidents are a significant concern, with factors such as driver error, speeding, impaired driving, and inadequate infrastructure contributing to the risks [12].
2. Rail transportation: Rail incidents may involve derailments, collisions, or hazardous material spills, often resulting from signalling errors, track defects, or human factors [36,37].
3. Aviation: Aviation safety concerns encompass aircraft accidents, runway incursions, air traffic control errors, and pilot errors, among others [38].
4. Maritime transportation: Hazards in the maritime industry include collisions, groundings, cargo handling incidents, and crew safety risks due to harsh weather conditions or inadequate safety procedures [39].

3.3.2. Common Transportation-Related Hazards and Risks

The most common transportation-related hazards and risks can be categorised into four types, as follows:

1. Vehicle crashes: The risk of accidents, injuries, and fatalities is prevalent across all transportation sectors due to factors such as human error, mechanical failures, or adverse weather conditions [40].
2. Exposure to hazardous materials: Transporting dangerous goods, including chemicals, gases, or radioactive materials, poses risks of spills, leaks, or explosions [41].
3. Fatigue and stress: Long working hours, irregular schedules, and high-pressure environments contribute to fatigue and stress among transportation workers, affecting their performance and decision making [42].
4. Ergonomic hazards: Workers involved in transportation may face ergonomic risks from prolonged sitting, repetitive movements, and awkward postures [12].

3.3.3. Safety Regulations and Measures in the Transportation Industry

Several regulations and measures have been implemented to address safety concerns and mitigate risks in the transportation industry. The most common regulations and standards are as follows:

1. Road safety regulations: Governments establish traffic laws, speed limits, seatbelt requirements, and vehicle safety standards to promote safer road transportation [43].
2. Railway safety standards: Rail authorities enforce safety regulations for track maintenance, train operation, signalling systems, and crew training [43].
3. Aviation safety protocols: Aviation regulatory bodies mandate stringent safety standards for aircraft maintenance, pilot training, air traffic control, and airport security [44].
4. Maritime safety conventions: International maritime organisations establish safety regulations for ship design, navigation, crew training, emergency procedures, and cargo handling [44].

3.3.4. Technological Advancements for Improving Transportation Safety

Technology plays a pivotal role in enhancing safety across transportation sectors. The most relevant technological advancements that have been adopted to improve transportation safety are the following:

1. Advanced driver assistance systems (ADAS): ADAS technologies such as collision avoidance systems, lane departure warning, and adaptive cruise control enhance road vehicle safety [45].
2. Positive train control (PTC): PTC systems use GPS, digital radio, and computer-based train control to monitor and control train movements, reducing the risk of collisions and overspeed incidents [46].
3. Aviation safety technologies: Aircraft advancements include terrain awareness and warning systems, automatic dependent surveillance broadcasts, and improved weather monitoring to enhance aviation safety [46].
4. Maritime safety innovations: Technologies like electronic chart displays and information systems, automatic identification systems, and enhanced radar systems improve navigation safety in the maritime industry [39].
5. AI systems can be used to monitor driver behaviour, identify potential problems, and prevent accidents [39].

3.4. Healthcare Industry

3.4.1. Safety Challenges in Healthcare Settings (Hospitals, Clinics, Long-Term Care Facilities, among Others)

Healthcare settings face unique safety challenges due to the complexity of care delivery, diverse patient populations, and the range of services provided. The most frequently occurring safety challenges in healthcare settings include the following:

1. Patient falls: Falls are a significant concern in healthcare facilities, particularly among older adults, and can lead to injuries and prolonged hospital stays [47].
2. Healthcare-associated infections (HAIs): Infections acquired during healthcare delivery, such as surgical site infections or bloodstream infections, pose risks to patient safety.
3. Medication errors: Errors in prescribing, dispensing, or administering medication can have serious consequences for patient safety [48].
4. Workplace violence: Healthcare workers are at risk of physical and verbal assaults from patients, visitors, or even colleagues, impacting their safety and well-being [49].

3.4.2. Common Healthcare-Associated Hazards and Risks

The healthcare-associated hazards and risks can be divided into four categories, as follows:

1. Biological hazards: Exposure to bloodborne pathogens, infectious diseases, or hazardous substances poses risks to healthcare workers and patients [50].
2. Ergonomic hazards: Healthcare workers often perform physically demanding tasks, leading to musculoskeletal disorders and injuries [50].
3. Radiation hazards: Healthcare professionals working with radiation equipment, such as X-rays or radiation therapy, face risks of radiation exposure [51].
4. Psychosocial hazards: Emotional stress, burnout, and compassion fatigue are prevalent in healthcare settings, affecting the well-being of healthcare workers [52].

3.4.3. Safety Protocols and Practices in Healthcare Environments

Various safety protocols and practices have been implemented to address safety concerns and promote patient and worker safety in healthcare settings. The most important safety protocols and practices are as follows:

1. Infection control measures: Standard precautions, hand hygiene, proper sterilisation techniques, and isolation protocols are critical in preventing healthcare-associated infections [40].
2. Medication safety practices: Robust medication reconciliation, barcoding systems, and double-checking procedures help reduce medication errors in healthcare settings [53].

3. Violence prevention strategies: Implementing security measures, providing de-escalation training, and creating a culture of respect and zero-tolerance for violence can enhance workplace safety [49].
4. Ergonomic interventions: Implementing proper lifting techniques, ergonomic equipment, and workstations designed for comfort and safety can reduce the risk of musculoskeletal injuries [52].

3.4.4. Technological Advancements for Patient Safety and Staff Well-Being

Technology plays a crucial role in enhancing safety and well-being in the healthcare industry. Some used technological advancements include the following:

1. Electronic health records (EHRs): EHR systems improve patient safety by facilitating accurate and timely access to patient information, reducing medication errors, and supporting clinical decision making [54].
2. Patient monitoring systems: Advanced monitoring technologies, such as remote vital sign monitoring and wearable devices, enable real-time tracking of patients' health status, enhancing patient safety and early detection of deterioration [4].
3. Telehealth and telemedicine: Telehealth technologies provide remote access to healthcare services, improving patient access to care, reducing the risk of infections, and enhancing healthcare delivery efficiency [55].

3.4.5. Examples of Successful Safety Initiatives in Healthcare

Several healthcare organisations have implemented successful safety initiatives to enhance patient safety and improve healthcare outcomes. Some relevant examples include the following:

1. The WHO Surgical Safety Checklist: Developed by the World Health Organization, this checklist ensures essential safety steps are followed before, during, and after surgical procedures, reducing surgical complications [56].
2. Patient Safety Reporting Systems: Healthcare facilities utilise reporting systems to encourage healthcare workers to report safety incidents, near misses, and potential hazards, enabling proactive identification and mitigation of risks [57].
3. High-Reliability Organizations (HROs): Adopting HRO principles, such as fostering a culture of safety, effective communication, and continuous learning, helps healthcare organisations prevent errors and improve safety [55,58].

4. Discussion and Conclusions

4.1. Summary of the Main Findings from the Review of Various Industries

This article provides a general review of the safety status and technological development in high-risk industries. Common trends and advancements are identified by analysing multiple sectors, including construction, mining, agriculture, transportation, manufacturing, and energy. The findings highlight the critical role of technological innovations in mitigating risks, improving worker safety, and enhancing overall operational efficiency. The review emphasises the importance of knowledge transfer and collaboration between industries to foster a culture of safety and drive further advancements. Further research is needed to address the identified gaps and explore the potential of emerging technologies in enhancing safety practices across high-risk industries.

Key findings:

1. Industry-Specific Hazards and Risk Recognition: The individualised risks faced by various industries, such as cave-ins in mining and chemical exposure in agriculture, underscore the importance of tailoring safety measures to project-specific hazards. This recognition is paramount for AECO professionals to identify similar risks in construction sites and implement context-specific safety strategies that effectively address these challenges.

2. Adherence to safety regulations and best practices: While safety regulations and standards are prevalent across industries, their effectiveness can vary due to differences in implementation, enforcement, and environmental conditions. For example, a study by the International Labour Organization (ILO) found that only 50% of occupational accidents in the construction industry are covered by workers' compensation schemes. This suggests that there is a need to improve the enforcement of safety regulations and ensure that workers have access to compensation when injured on the job.
3. Technology: Technological advancements have significantly contributed to enhancing safety measures and reducing risks in various sectors, such as real-time monitoring systems and robotics automation Table 2. The claim that technological advancements significantly contribute to enhancing safety and risk reduction is substantiated by data from a variety of industries. For instance, a study by the National Institute for Occupational Safety and Health (NIOSH) found that the rate of accidents in US coal mines fell by 50% between 2000 and 2019, coinciding with the increased use of real-time monitoring systems. The oil and gas industry has also seen a reduction in accidents due to technological advancements. For example, the use of automation technologies has helped to reduce the number of injuries and fatalities in oil and gas well drilling operations. A study by OSHA found that the rate of injuries and fatalities in oil and gas well drilling operations fell by 25% between 2010 and 2019, a period that coincided with the increased use of automation technologies. The use of automation technologies in the manufacturing industry has helped to reduce the number of injuries by eliminating the need for workers to perform dangerous tasks. For instance, another OSHA report found that the rate of injuries in the manufacturing industry fell by 15% between 2010 and 2019, coinciding with the increased use of automation technologies.

The construction Industry can also benefit from technological advancements to improve safety. AECO professionals can leverage wearables, drones, and AI-based systems to foster a safer environment. For example, wearable devices can be used to monitor workers' vital signs and detect falls, while drones can be used to inspect worksites for safety hazards. AI-based systems can be used to analyse data from wearable devices and drones to identify potential hazards and predict accidents.

4.2. Implications for the Construction Industry and Potential Lessons Learned

The review of various industries and their safety status provides valuable insights and lessons that can be applied to the construction industry. While each industry has its specific safety challenges, there are important implications and potential lessons learned that can help improve safety practices in construction projects:

1. Recognising the industry-specific hazards and risks in construction: By closely examining industries with parallel challenges, such as mining's underground risks or agriculture's heavy machinery hazards [3]. The agriculture industry faces risks related to machinery accidents, falls, and exposure to chemicals [17]. Understanding these industry-specific hazards can help construction professionals identify similar risks in their projects and implement appropriate safety measures.
2. Adhering to safety regulations and implementing best practices: Safety regulations and standards play a crucial role in ensuring worker protection and environmental sustainability across industries. Construction industry stakeholders should prioritise compliance with safety regulations and adopt best practices to create a safe working environment [16]. Lessons can be learned from the transportation industry, where strict regulations and measures are in place to mitigate risks associated with road, rail, aviation, and maritime activities [7]. By mirroring the transportation sector's regulatory dedication, construction can instil a safety-centric ethos that permeates every project, from design to completion, thereby fostering a safer work environment.
3. Embracing technological advancements in construction safety: Technology has transformed safety practices in various industries. Real-time monitoring systems, for

instance, have been widely implemented in mining to track worker locations, monitor environmental conditions, and detect potential hazards [7]. Automation technologies have improved safety in the oil and gas industry by reducing human exposure to hazardous environments [9]. The construction industry can leverage these technological advancements, such as wearables, drones, and AI-based systems, to enhance safety measures and mitigate risks.

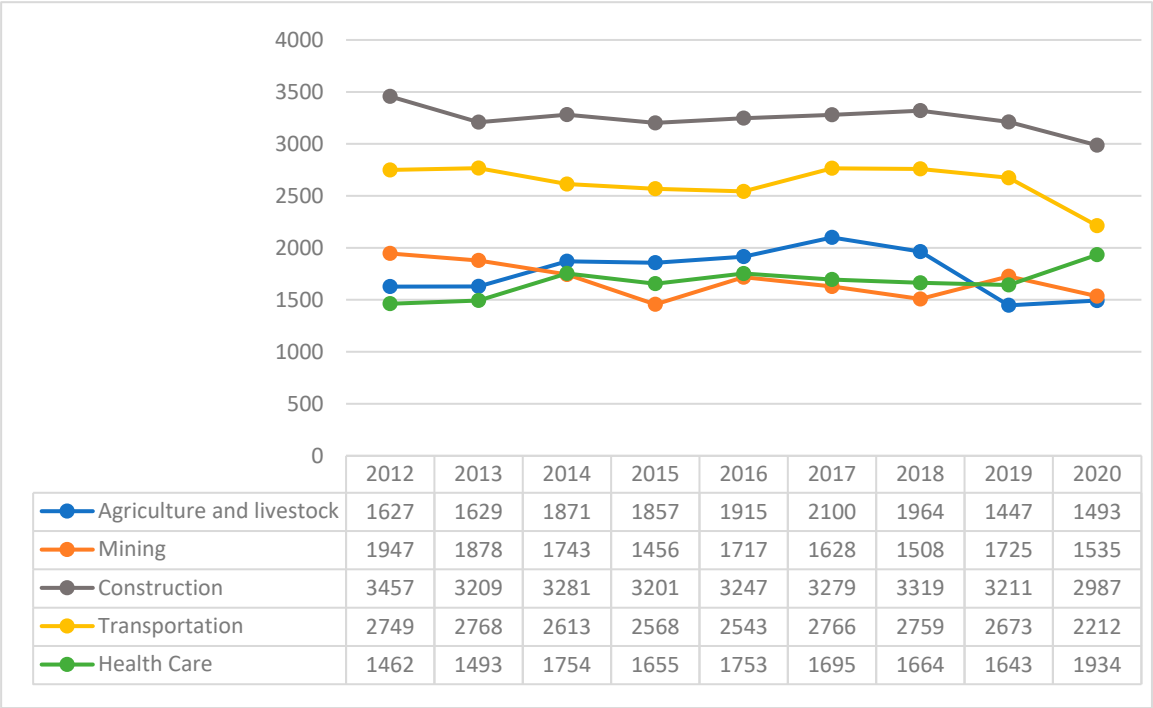
4. Promoting a safety culture: The healthcare sector's commitment to patient safety provides a valuable model for construction's pursuit of a comprehensive safety culture. By integrating safety protocols, constant training, and stringent adherence to guidelines, the construction industry can emulate the healthcare sector's success in cultivating a culture where safety is an intrinsic value. Some specific examples of how the construction industry can promote a safety culture include the following:
    - Implementing safety protocols: The construction industry should implement safety protocols for all tasks, such as fall protection and lockout/tagout procedures. This is similar to the healthcare sector, where standardised procedures are used to reduce errors.
    - Providing training: Workers should receive regular safety training on the specific risks associated with their work. This is like the transportation and aviation industry, where personnel receive extensive training on safety procedures.
    - Encouraging communication: Workers should be encouraged to communicate openly and honestly about safety concerns, such as in the healthcare sector, where workers are encouraged to report all incidents, even minor ones.
    - Creating a culture of accountability: Workers should be held accountable for following safety procedures. This is comparable to the mining industry, where workers should be held accountable for their actions.

The construction industry should focus on leadership commitment and continuous improvement. This means that senior leaders should be committed to safety and should create a culture where safety is valued. The industry should also continuously strive to improve its safety performance [59].

5. Collaboration and sharing of best practices: The review of different industries highlights the importance of collaboration and sharing of best practices in improving safety outcomes. Construction professionals can benefit from establishing partnerships and knowledge-sharing platforms with other industries, promoting cross-industry learning and innovation in safety management. For example, industry associations can be established to facilitate collaboration and knowledge sharing. Safety data can also be shared between industries to identify trends and develop preventive measures.

By considering these implications and lessons learned from various industries, the construction industry can enhance its safety practices, protect workers, and minimise risks. Continued research, collaboration, and the adoption of innovative technologies will further contribute to creating a safer construction environment. Exploring the effectiveness and impact of safety regulations and standards is a valuable opportunity to enhance safety practices in the construction industry. Based on data from Eurostat from 2012 until 2020, in some industries, such as the transportation, agriculture, mining, and construction industries, the accident rate has slightly declined over the past few years (as shown in Figure 3), which is likely due to the adoption of new technologies, standards, and regulations. The healthcare industry in 2020 showed a slight increase in the number of accidents that might be affected by the COVID-19 pandemic.

For example, the MSHA has implemented regulations on ventilation systems, gas monitoring, and emergency response protocols. These regulations have led to a significant reduction in accidents and fatalities in the mining industry [60,61].



	2012	2013	2014	2015	2016	2017	2018	2019	2020
Agriculture and livestock	1627	1629	1871	1857	1915	2100	1964	1447	1493
Mining	1947	1878	1743	1456	1717	1628	1508	1725	1535
Construction	3457	3209	3281	3201	3247	3279	3319	3211	2987
Transportation	2749	2768	2613	2568	2543	2766	2759	2673	2212
Health Care	1462	1493	1754	1655	1753	1695	1664	1643	1934

Figure 3. Non-fatal accident rates at work by economic activity, EU, 2012–2020.

The agriculture and livestock sector is another high-risk industry with a high rate of injuries. However, the agriculture sector has also made considerable progress in improving safety, in part due to the implementation of regulations like the OSHA Agricultural Operations Standard [11]. This standard requires employers to implement safety measures to protect workers from hazards such as machine accidents and chemical exposure. As a result of these regulations, the agriculture and livestock sector has seen a significant reduction in injury rates [11].

The healthcare sector is also a high-risk industry, but it has a long history of commitment to safety. The Joint Commission's National Patient Safety Goals are a set of standards that hospitals and other healthcare organisations must meet to ensure patient safety [62]. These standards cover a wide range of safety issues, including medication errors, falls, and infections. The implementation of these standards has led to significant improvements in patient safety in the healthcare sector [62].

The transportation sector is another industry that has made noteworthy progress in improving safety. The transportation sector is responsible for many accidents and fatalities each year, but implementing regulations and standards has helped reduce these numbers [63]. For example, the Federal Motor Carrier Safety Administration (FMCSA) has implemented regulations on truck driver hours of service and vehicle safety features. These regulations have helped to reduce the number of truck accidents and fatalities [64].

The energy sector is diverse and includes industries such as oil and gas, nuclear power, and renewable energy. The energy sector is also a high-risk sector, but it has a strong commitment to safety. The Nuclear Regulatory Commission (NRC) is responsible for regulating the nuclear power industry, and it has implemented stringent standards for safety. These standards have helped to ensure the safety of nuclear power plants [65].

By actively examining and adopting effective safety regulations and standards from these industries, the construction sector can make substantial strides in ensuring the well-being of its workforce and minimising avoidable accidents. The construction industry can learn from the success of other industries by implementing regulations and standards that target specific hazards, establish stringent safety protocols, and emphasise risk management and emergency response. By taking these steps, the construction industry can create a safer

work environment for all [66]. Investigating emerging technologies and their potential applications in enhancing safety measures within the construction industry is a critical endeavour that can yield transformative results.

For instance, the mining sector has seen substantial advancements in real-time monitoring systems that track worker locations and environmental conditions, significantly improving hazard identification and response times [22]. These systems can be used in construction to track the location of workers and equipment, as well as environmental conditions such as air quality and noise levels. This information can be used to identify potential hazards and take steps to mitigate them.

The healthcare sector has also made significant progress in using technology to improve safety. For example, AI-based predictive analytics is being used to prevent medical errors [29,30]. This technology can be used in construction to analyse data on accidents and injuries to identify patterns and trends. This information can then be used to develop targeted safety interventions.

The energy sector has also adopted several innovative safety technologies. For example, robotics is being used to inspect hazardous areas such as nuclear reactors [67]. These robots can be used in construction to inspect difficult-to-reach areas or areas that are too dangerous for humans to enter.

The transportation industry has also made use of fatigue detection technologies to reduce accidents [42]. These technologies can be adapted to construction to monitor worker fatigue and prevent accidents caused by drowsiness.

These are just a few examples of emerging technologies that have the potential to improve safety in the construction industry. By closely examining and applying these technologies, the construction industry can unlock innovative solutions that significantly improve safety practices, reduce accidents, and establish a future where construction sites are safer and more efficient.

By adopting these technologies, the construction industry can make significant progress in reducing accidents and injuries.

The following are some specific examples of how emerging technologies can be applied to the construction industry:

- Real-time monitoring systems can be used to track the location of workers and equipment, as well as environmental conditions such as air quality and noise levels. This information can be used to identify potential hazards and take steps to mitigate them. For example, a system could be used to track the location of workers in a confined space and sound an alarm if they stray too close to a hazardous area. Another example is intelligent and vision-based fire detection systems. These systems are created as a convolutional neural network which can be adapted to any environment [68].
- AI-based predictive analytics can be used to analyse data on accidents and injuries to identify patterns and trends. This information can then be used to develop targeted safety interventions. For example, an AI system could be used to identify workers who are at increased risk of injury and provide them with additional training or safety equipment.
- Robotics can be used to perform dangerous or repetitive tasks, such as welding or demolition. This can help to reduce the risk of accidents and injuries to workers. For example, robots could be used to demolish structurally unsound buildings, a task that humans currently perform.
- Fatigue detection technologies can be used to monitor worker alertness and prevent drowsy driving. This can help to reduce the risk of accidents caused by fatigue. For example, a wearable device could be used to track workers' heart rate and eye movement to identify signs of fatigue.

Future research in the construction industry could focus on implementing AI-based predictive analytics systems to anticipate and prevent accidents. Moreover, exploring the potential of BIM for enhancing safety planning and risk management within construction projects could be a valuable path for research. Investigating how a culture of safety can be

embedded into the operations of small and medium-sized construction businesses, which often face unique challenges, is another vital area of future research. It is important to note that the adoption of emerging technologies will not eliminate all safety risks in the construction industry. However, these technologies can play a significant role in reducing the number and severity of accidents. By carefully evaluating the potential benefits and risks of emerging technologies, the construction industry can make informed decisions about how to use these technologies best to improve safety.

Future studies should investigate the challenges related to the adoption of technological advancements and safety regulations in the construction industry. Studies should aim to provide insights into overcoming barriers such as high technology costs, training requirements, and adapting to changing environmental conditions. Furthermore, future studies should focus on developing tools or methodologies to identify and assess industry-specific hazards in the construction sector. This may involve creating hazard recognition checklists, conducting in-depth hazard analysis studies, and utilising data analytics to recognise and mitigate risks proactively.

Author Contributions: Conceptualization, A.S. (Adeeb Sidani) and J.P.M.; methodology, A.S. (Adeeb Sidani).; formal analysis, A.S. (Adeeb Sidani); investigation, A.S. (Adeeb Sidani); resources, A.S. (Alfredo Soeiro) and J.P.M.; data curation, A.S. (Adeeb Sidani); writing—original draft preparation, A.S. (Adeeb Sidani); writing—review and editing, A.S. (Adeeb Sidani), J.P.M. and A.S. (Alfredo Soeiro).; supervision, J.P.M. and A.S. (Alfredo Soeiro). All authors have read and agreed to the published version of the manuscript.

Funding: This work was financially supported by: Base Funding—UIDB/04708/2020 of the CONSTRUCT—Instituto de I&D em Estruturas e Construções—funded by national funds through the FCT/MCTES (PIDDAC).

Data Availability Statement: The data presented in this study are openly available in Accidents at work statistics, EuroStat at https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Accidents_at_work_statistics.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Chen, H.; Li, H.; Goh, Y.M. A review of construction safety climate: Definitions, factors, relationship with safety behavior and research agenda. *Saf. Sci.* **2021**, *142*, 105391. [CrossRef]
2. Sidani, A.; Martins, J.P.; Soeiro, A. BIM approaches for enhanced health and safety status in construction—Protocol fora systematic review. *Int. J. Occu. Environ. Saf.* **2022**, *6*, 1–8. [CrossRef]
3. Ismail, S.N.; Ramli, A.; Aziz, H.A. Influencing factors on safety culture in mining industry: A systematic literature review approach. *Resour. Policy* **2021**, *74*, 102250. [CrossRef]
4. McGrath, S.; Taenzer, A.H.; Karon, N.; Blike, G. Surveillance monitoring management for general care units: Strategy, design, and implementation. *Jt. Commun. J. Qual. Patient Saf.* **2016**, *42*, 293–302. [CrossRef]
5. Svendsen, K.; Aas, O.; Hilt, B. Non-fatal Occupational Injuries in Norwegian Farmers. *Saf. Health Work* **2014**, *5*, 147–151. [CrossRef] [PubMed]
6. Bongiovanni, R.; Lowenberg-Deboer, J. Precision agriculture and sustainability. *Precis. Agric.* **2004**, *5*, 359–387. [CrossRef]
7. Ahmed, S.; Hossain, M.A.; Ray, S.K.; Bhuiyan, M.M.I.; Sabuj, S.R. A study on road accident prediction and contributing factors using explainable machine learning models: Analysis and performance. *Trans Res. Interdisci. Perspect.* **2023**, *19*, 100814. [CrossRef]
8. Arana-Landín, G.; Laskurain-Iturbe, I.; Iturrate, M.; Landeta-Manzano, B. Assessing the influence of industry 4.0 technologies on occupational health and safety. *Heliyon* **2023**, *9*, e13720. [CrossRef]
9. Guzman, J.; Recoco, G.A.; Pandi, A.W.; Padrones, J.M.; Ignacio, J.J. Evaluating workplace safety in the oil and gas industry during the COVID-19 pandemic using occupational health and safety Vulnerability Measure and partial least square Structural Equation Modelling. *Clean. Eng. Technol.* **2022**, *6*, 100378. [CrossRef]
10. Eurostat. Statistics Explained—Accidents at Work Statistics. *Eurostat Statistics Explained* 2021; pp. 1–7. Available online: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Accidents_at_work_-_statistics_by_economic_activity#Developments_over_time (accessed on 15 October 2023).
11. CDC. Healthcare Workers | NIOSH | CDC. CDC. Available online: https://www.cdc.gov/niosh/topics/healthcare/ (accessed on 15 October 2023).

12. European Agency for Safety & Health at Work—Information, Statistics, Legislation and Risk Assessment Tools. Available online: https://osha.europa.eu/en (accessed on 15 October 2023).
13. Mark, C.; Gauna, M. Preventing roof fall fatalities during pillar recovery: A ground control success story. *Int. J. Min. Sci. Technol.* **2017**, *27*, 107–113. [CrossRef]
14. Zhu, Y.; You, G. Monitoring System for Coal Mine Safety Based on Wireless Sensor Network. In Proceedings of the 2019 Cross Strait Quad-Regional Radio Science and Wireless Technology Conference (CSQRWC), Taiyuan, China, 18–21 July 2019. [CrossRef]
15. Bureau of Labor Statistics, National Census of Fatal Occupational Injuries in 2010 (Preliminary Results). Bureau of Labor Statistics. 2017; pp. 1–13. Available online: https://www.bls.gov/news.release/pdf/cfoi.pdf (accessed on 15 March 2023).
16. Laurence, D. Safety rules and regulations on mine sites—The problem and a solution. *J. Saf. Res.* **2005**, *36*, 39–50. [CrossRef] [PubMed]
17. Ruff, T.; Coleman, P.; Martini, L. Machine-related injuries in the US mining industry and priorities for safety research. *Int. J. Inj. Control. Saf. Promot.* **2010**, *18*, 11–20. [CrossRef]
18. Fu, W.; Luo, Z.; Wang, J.; Cao, C.R.; Shu, C.M. Experimental study of the influence of coal mine noise on miners. *J. Loss Prev. Process Ind.* **2022**, *80*, 104926. [CrossRef]
19. U.S. Department of Labor. OSHA Regulation—3021-12R 2019—Workers Rights—Construction Documents and Templates. 2019. Available online: https://www.osha.gov/sites/default/files/publications/osha3021.pdf (accessed on 4 February 2023).
20. Mine Safety and Health Administration. *Federal Regulatory Guide*; CQ Press: Washington, DC, USA, 2020; pp. 883–886. [CrossRef]
21. Navon, R.; Goldschmidt, E.; Shpatnisky, Y. A concept proving prototype of automated earthmoving control. *Autom. Constr.* **2004**, *13*, 225–239. [CrossRef]
22. Groves, W.A.; Kecojevic, V.J.; Komljenovic, D. Analysis of fatalities and injuries involving mining equipment. *J. Saf. Res.* **2007**, *38*, 461–470. [CrossRef]
23. Jo, B.W.; Khan, R.M.A. An event reporting and early-warning safety system based on the internet of things for underground coal mines: A case study. *Appl. Sci.* **2017**, *7*, 925. [CrossRef]
24. Zhou, Y.; Li, Y.; Chen, Y. Remote Real-Time Monitoring System for Mine Slope Based on Cloud Computing. *Water* **2022**, *14*, 714. [CrossRef]
25. Nie, W.; Guo, C.; Zhang, S.; Peng, H.; Xu, C.; Ma, Q.; Yuan, M.; Zhou, W.; Guo, L.; Cheng, L. Optimisation of spraying dust reduction technology of continuous miner machine and the dust environment in a tunnel, based on computational fluid dynamics (CFD) technology. *Powder Technol.* **2022**, *398*, 117044. [CrossRef]
26. Richardson, C.; Rutherford, S.; Agranovski, I. Particulate emission rates for open surfaces in Australian open cut black coal mines. *J. Environ. Manag.* **2019**, *232*, 537–544. [CrossRef] [PubMed]
27. Kim, S.M.; Choi, Y.; Suh, J. Applications of the open-source hardware Arduino platform in the mining industry: A review. *Appl. Sci.* **2020**, *10*, 5018. [CrossRef]
28. Svertoka, E.; Saafi, S.; Rusu-Casandra, A.; Burget, R.; Marghescu, I.; Hosek, J.; Ometov, A. Wearables for industrial work safety: A survey. *Sensors* **2021**, *21*, 3844. [CrossRef]
29. Cavur, M.; Demir, E. RSSI-based hybrid algorithm for real-time tracking in underground mining by using RFID technology. *Phys. Commun.* **2022**, *55*, 101863. [CrossRef]
30. Hyder, Z.; Siau, K.; Nah, F. Artificial intelligence, machine learning, and autonomous technologies in mining industry. *J. Database Manag.* **2022**, *30*, 67–79. [CrossRef]
31. Heldman, D.R.; Moraru, C.I. *Encyclopedia of Agricultural, Food, and Biological Engineering*; Print Version; CRC Press: Boca Raton, FL, USA, 2010. [CrossRef]
32. Thorp, K. Precision agriculture. In *Encyclopedia of Earth Sciences Series*; Elsevier: Amsterdam, The Netherlands, 2023; pp. 515–517. [CrossRef]
33. Tessema, R.A.; Nagy, K.; Ádám, B. Occupational and environmental pesticide exposure and associated health risks among pesticide applicators and non-applicator residents in rural Ethiopia. *Front. Public Heal.* **2022**, *10*, 1017189. [CrossRef] [PubMed]
34. Bui, X.N.; Lee, C.W.; Nguyen, H.; Bui, H.B.; Long, N.Q.; Le, Q.T.; Nguyen, V.D.; Nguyen, N.B.; Moayedi, H. Estimating PM10 concentration from drilling operations in open-pit mines using an assembly of SVR and PSO. *Appl. Sci.* **2019**, *9*, 2806. [CrossRef]
35. Ayamga, M.; Akaba, S.; Nyaaba, A.A. Multifaceted applicability of drones: A review. *Technol. Forecast. Soc. Chang.* **2021**, *167*, 120677. [CrossRef]
36. U. S. DOT. Role of Human Factors in Rail Accidents. Available online: https://www.transportation.gov/testimony/role-human-factors-rail-accidents (accessed on 15 October 2023).
37. Responsibilities | US Department of Transportation. Available online: https://www.transportation.gov/priorities/safety (accessed on 15 October 2023).
38. Safety Management System (SMS) and Voluntary Safety Programs | Federal Aviation Administration. Available online: https://www.faa.gov/licenses_certificates/airline_certification/air_carrier/cert_volun_safety_program (accessed on 10 June 2023).
39. Cao, Y.; Wang, X.; Yang, Z.; Wang, J.; Wang, H.; Liu, Z. Research in marine accidents: A bibliometric analysis, systematic review and future directions. *Ocean. Eng.* **2023**, *284*, 115048. [CrossRef]

40. World Health Organization. Global Report on Infection Prevention and Control. 2022. Available online: https://www.who.int/news/item/06-05-2022-who-launches-first-ever-global-report-on-infection-prevention-and-control (accessed on 15 October 2023).
41. Guo, J.; Luo, C. Risk assessment of hazardous materials transportation: A review of research progress in the last thirty years. *J. Traffic Trans. Eng. (Eng. Ed.)* **2022**, *9*, 571–590. [CrossRef]
42. Horberry, T.; Hartley, L.; Krueger, G.; Mabbott, N. Fatigue Detection Technologies for Drivers: A Review of Existing Operator-Centred Systems. In *IEE Conference Publication, Proceedings of the 2001 People in Control. The Second International Conference on Human Interfaces in Control Rooms, Cockpits and Command Centres, Manchester, UK, 19–21 June 2001*; Institution of Engineering and Technology: Stevenage, UK, 2001; pp. 321–326. [CrossRef]
43. U. S. D. of Transportation. Pipeline and hazardous materials safety administration. *Fed. Regist.* **2009**, *74*, 62503–62506. [CrossRef]
44. Pernice, D. Tourism: Fact Sheets on the European Union—European Parliament. 2022; pp. 1–7. Available online: https://www.europarl.europa.eu/factsheets/en/sheet/134/aviation-safety (accessed on 15 October 2023).
45. Masello, L.; Castignani, G.; Sheehan, B.; Murphy, F.; McDonnell, K. On the road safety benefits of advanced driver assistance systems in different driving contexts. *Trans. Res. Interdisci. Perspect.* **2022**, *15*, 100670. [CrossRef]
46. Frittelli, J. Positive train control (PTC): Overview and policy issues. In *U.S. Transit, Transportation and Infrastructure: Considerations and Developments*;2013; Volume 3, pp. 119–140. Available online: https://www.everycrsreport.com/reports/R42637.html (accessed on 15 October 2023).
47. Oliver, D.; Healey, F.; Haines, T. Preventing falls and fall-related injuries in Hospitals. *Clin. Geriatr. Med.* **2010**, *26*, 645–692. [CrossRef] [PubMed]
48. Partin, B. Preventing medication errors: An iom report. *Nurse Pract.* **2006**, *31*, 8. [CrossRef] [PubMed]
49. Liu, J.; Gan, Y.; Jiang, H.; Li, L.; Dwyer, R.; Lu, K.; Yan, S.; Sampson, O.; Xu, H.; Wang, C.; et al. Prevalence of workplace violence against healthcare workers: A systematic review and meta-analysis. *Occup. Environ. Med.* **2019**, *76*, 927–937. [CrossRef] [PubMed]
50. Lucas, J.B. The National Institute for Occupational Safety and Health. *Contact Dermat.* **2023**, *3*, 321–326. [CrossRef] [PubMed]
51. Goula, A.; Chatzis, A.; Stamouli, M.A.; Kelesi, M.; Kaba, E.; Brilakis, E. Assessment of health professionals' attitudes on radiation protection measures. *Int. J. Environ. Res. Public Health* **2021**, *18*, 13380. [CrossRef]
52. Magnavita, N.; Heponiemi, T. Violence towards health care workers in a Public Health Care Facility in Italy: A repeated cross-sectional study. *BMC Health Serv. Res.* **2012**, *12*, 1–9. [CrossRef]
53. Ciapponi, A.; Nievas, S.E.F.; Seijo, M.; Rodríguez, M.B.; Vietto, V.; García-Perdomo, H.A.; Virgilio, S.; Fajreldines, A.V.; Tost, J.; Rose, C.J.; et al. Reducing medication errors for adults in hospital settings. In *Cochrane Database of Systematic Reviews*; John Wiley and Sons, Inc. and the Cochrane Library: Hoboken, NJ, USA, 2021. [CrossRef]
54. Blumenthal, D.; Tavenner, M. The 'Meaningful Use' Regulation for Electronic Health Records. *N. Engl. J. Med.* **2010**, *363*, 501–504. [CrossRef]
55. Bashshur, R.L.; Howell, J.D.; Krupinski, E.A.; Harms, K.M.; Bashshur, N.; Doarn, C.R. The Empirical Foundations of Telemedicine Interventions in Primary Care. *Telemed. J. E. Health* **2016**, *22*, 342–375. [CrossRef]
56. WHO. WHO Guidelines for Safe Surgery 2009—Safe Surgery Saves Lives. WHO/IER/PSP/2008.08-1E. *Second Glob. Patient Saf. Chall* **2013**, *6*, 133. Available online: https://www.who.int/publications/i/item/9789241598552 (accessed on 15 October 2023).
57. Shoemaker-Hunt, S.; Hall, K.; Hoffman, L. Advancing Patient Safety: Reviews From the Agency for Healthcare Research and Quality's Making Healthcare Safer III Report. *J. Patient Saf.* **2020**, *16* (Suppl. S1), S1. [CrossRef]
58. Chassin, M.R.; Loeb, J.M. High-Reliability Health Care: Getting There from Here. *Milbank Q.* **2013**, *91*, 459. [CrossRef] [PubMed]
59. Occupational Safety and Health Branch Labour Department. Code of Practice on Safety Safety Management. 2022; pp. 1–125. Available online: http://www.labour.gov.hk/eng/public/os/manage.pdf (accessed on 25 January 2018).
60. Gernand, J.M. Evaluating the effectiveness of mine safety enforcement actions in forecasting the lost-days rate at specific worksites. *ASCE-ASME J. Risk Uncertain. Eng. Syst. Part B Mech. Eng.* **2016**, *2*, 041002. [CrossRef]
61. Jha, A.; Verburg, A.; Tukkaraja, P. Internet of Things–Based Command Center to Improve Emergency Response in Underground Mines. *Saf. Health Work* **2022**, *13*, 40–50. [CrossRef] [PubMed]
62. JCI. Quality Management and Patient Safety. JCI. Available online: https://www.jointcommissioninternational.org/what-we-offer/advisory-services/quality-management-and-patient-safety/?utm_source=Google&utm_medium=cpcjci&utm_campaign=jcic_gaqualitymgmt&gclid=Cj0KCQjwm66pBhDQARIsALIR2zAPJxkY34TjmZTkOAf9I4FPiHiHxkkggLKZky1oq (accessed on 15 October 2023).
63. Azami-Aghdash, S.; Gorji, H.; Gharaee, H.; Moosavi, A.; Sadeghi-Bazargani, H. Role of health sector in road traffic injuries prevention: A public health approach. *Int. J. Prev. Med.* **2021**, *12*, 150. [CrossRef] [PubMed]
64. Federal Motor Carrier Safety Administration. Revised Hours-of-Service Rule to Help Ensure Truck Drivers Get Adequate Rest. Available online: https://www.fmcsa.dot.gov/newsroom/revised-hours-service-rule-help-ensure-truck-drivers-get-adequate-rest (accessed on 15 October 2023).
65. Morrow, S.L.; Koves, G.K.; Barnes, V.E. Exploring the relationship between safety culture and safety performance in U.S. nuclear power operations. *Saf. Sci.* **2014**, *69*, 37–47. [CrossRef]
66. Liu, X.; Xue, Z.; Ding, Z.; Chen, S. Current Status and Future Directions of Construction Safety Climate: Visual Analysis Based on WOS Database. *Sustainability* **2023**, *15*, 3911. [CrossRef]

67. CLiang, J.; Cheng, M.H. Trends in Robotics Research in Occupational Safety and Health: A Scientometric Analysis and Review. *Int. J. Environ. Res. Public Health* **2023**, *20*, 5904. [CrossRef]
68. Bu, F.; Gharajeh, M.S. Intelligent and vision-based fire detection systems: A survey. *Image Vis. Comput.* **2019**, *91*, 103803. [CrossRef]