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UNDERSTANDING HOW AI IS USED IN HSE REGULATED SECTORS

Introduction

The Health and Safety Executive (HSE) aimed to increase understanding of the use of Artificial Intelligence (AI) applications in industry by:

Documenting real-world AI use cases in HSE regulated sectors
Identifying potential occupational health and safety impacts associated with the use cases

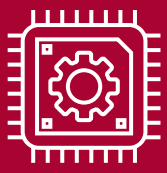
The information was gathered internally utilising experience from HSE colleagues and through an external anonymous industry survey.

The research identified approximately 250 use cases of AI being developed and deployed in industries which HSE regulates, which could impact on health and safety. The information from the industrial survey was self-reported, and the research didn't evaluate whether the AI technologies cited, or their implications, were appropriate in the applications.

Industry sectors where AI use cases were identified

Key areas of AI use identified

HSE identified four key areas of AI being used in the sectors which it regulates, where it could impact health and safety. AI is rapidly evolving, this highlights some key applications and is not an exhaustive list, some applications overlap these areas.



Maintenance Systems

AI used in maintenance systems through advanced inspection, failure monitoring, and decision support

Health and Safety Management

AI used in safety management systems for risk assessment, incident analysis, and training material generation

Control of Equipment and Process Plant

AI used to control autonomous vehicles, robotic systems, machinery, industrial processes and process data analytics

Occupational Monitoring

AI and computer vision used for safety, workplace and worker monitoring

Examples of AI use in maintenance systems

Drone Inspections

Drones using computer vision to inspect difficult to access locations, and in hazardous environments. For example, at height on bridges and cranes and in confined spaces.

Predictive Maintenance

AI used to analyse data from industrial equipment, including sensors and maintenance records, to recommend maintenance frequencies and actions, used in a range of industries.

Component Failure

AI systems used to analyse inspection images, or constant video monitoring for critical parts, to identify signs of component failure in plant and equipment. For example, during heavy goods vehicle inspections or to monitor for early signs of parts failure on fairground rides.

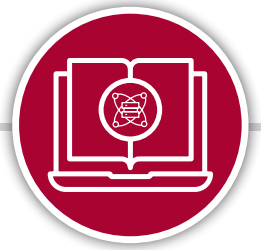
Examples of AI use in health and safety management

Accident Reports

Large language models analyse historical accident reports to identify hazard trends, risk factors, and create heat maps of site incidents.

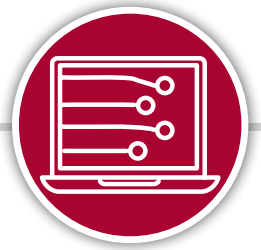
Risk Assessment

Generative AI systems used to create risk assessments and identify controls, based on safety documentation and visual analysis. For example, to generate hazard and operability studies and hazardous area classification.



Training

AI video generation creates health and safety induction and incident response training materials.



Operational Documents

Large language models used to draft safety policies and procedures and provide live answers to health and safety queries, based on internal health and safety documentation.

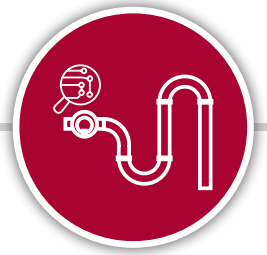
Examples of AI use in control of equipment and process plant

Vehicle and Equipment Control

Computer vision and sensors control equipment and autonomous vehicle movements, including quarry vehicles and farm equipment. For example, to prevent bin lifts on refuse collection vehicles operating when workers are in the danger zone.

Automated Operations

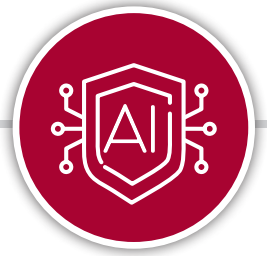
Autonomous systems using a combination of robotics and algorithmic route planning. For example, AI-driven mobile robots and forklifts to manage stacking and collecting goods in automated warehouses.



Process Optimisation

AI models used to analyse and optimise process plant and system processes. For example, to dynamically set high and low limits for fill level or monitor for overpressure.

Examples of AI use in occupational monitoring



Safety Monitoring

Computer vision monitors whether workers follow safety procedures and wear protective equipment correctly. For example, monitoring worker and vehicle movements and providing warnings if a pedestrian and vehicle are too close.

Workplace Monitoring

AI monitors site conditions and converts real-time video footage into searchable text to enable workplace activity analysis. For example, detecting hazards like spills and leaks and if maintenance is occurring on a pipeline, it will alert workers to highlight the pipeline should not be operated.

Worker Monitoring

AI system monitors worker health data and behavioural information, in combination with process data. For example, to identify fatigue indicators, and exposure to vibration and sound.

Health and safety risks as identified by respondents

Human Factors

- Over-dependence on AI safety systems could reduce worker attention, weakening the overall safety culture
- Deskilling of the workforce in areas where work is performed by AI, which leads workers to lose essential knowledge
- AI monitoring through algorithmic management could increase worker stress
- Frequent system alerts could cause ‘warning fatigue’, leading operators to miss critical safety notifications

Health and Safety

- AI could generate inaccurate safety assessments, resulting in appropriate controls not being implemented
- AI systems operating without human oversight could create dangerous situations
- Systems could fail to alert operators to real hazards or trigger false alarms, leading to either equipment failures or wasted downtime
- Operating outside of design limits can lead to unpredictable outcomes
- Unsafe ways of working in human/machine interactions could lead to physical injury

Technical

- Security breaches of AI systems could cause loss of control, risking worker safety
- Flawed or biased data could lead to unreliable safety decisions and missed hazards
- Data privacy risks where personal data is collected, including from worker monitoring and incident data
- Complex AI decisions could be hard to explain, making failures difficult to understand and prevent
- Systems could fail in new situations if training data does not cover full range of scenarios

Assurance techniques as identified by respondents

Processes, practices, and standards to ensure that AI systems are developed, deployed, and operated in a safe, secure and robust manner.

- **Trials in controlled environments**
- **Performance checked against humans in training phase**
- **Use of diverse and representative training datasets to reduce bias and increase fairness**
- **Performance compared to other algorithms to iterate the best design**
- **Robust testing**
- **Technology review when procuring AI software solutions**
- **Review publications from AI Safety Forums, the Alan Turing Institute, industry standards and emerging AI ethics frameworks**
- **Verification of system predictions through sampling**
- **Systems which involve personal data are subject to rigorous data protection and security measures**

Control measures as identified by respondents

Technical and procedural mechanisms to manage, guide, and restrict the behaviour and operation of AI systems and help prevent and mitigate risks associated with AI.

- **Encrypted training and processed data to prevent hacking of system**
- **AI used in control layer in conjunction with parallel traditional safety system**
- **Continual assessment of model performance post-deployment**
- **Human review and approval for high risk or safety decisions**
- **Autonomous vehicles fail safe stopping in the case of an error**
- **Human free zones for autonomous vehicle operation**
- **Induction, training and competency checks for staff to ensure the system will be used correctly**
- **Regular system audits and maintenance to help prevent malfunctions**
- **AI includes links to sources with its responses, so the user can check its accuracy**

Challenges in implementing AI as identified by respondents

Technical

- Preprocessing data to ensure it is clean, relevant, properly labelled, effectively stored, and aligned with the intended purpose takes time. Insufficient attention to data entry requirements can lead to inaccurate results
- Integrating AI systems with legacy platforms and workflows presents compatibility issues
- Ensuring AI algorithms are not biased can be difficult to do and this could lead to incorrect decision-making, such as prioritising certain safety risks over others
- The effort involved in initial setup and customisation of AI to achieve the desired functionality can slow development
- Being aware that generative AI can produce incorrect results and the need for content to be checked

Human Factors

- Employees may initially distrust AI systems, especially if they feel the technology is replacing human oversight or creates privacy issues
- Lack of trained individuals to work with AI, there is a long learning curve

Business

- Cost of installation and limitations of free software, associated with AI development and use
- Companies being too cautious or overly optimistic and thinking AI can do more than it is capable of
- Poor internet connectivity when using online AI tools
- Protecting company data

Respondents' 3-year plan for AI implementation

Health and Safety Management

- Integrate AI into real-time safety and incident monitoring, using advanced computer vision, health monitoring and sensors to detect hazards and unsafe behaviours instantly
- Enhance AI-driven risk assessment by using more comprehensive data sources, including environmental factors and worker health metrics
- Shift from basic data analysis to AI-driven predictive models that identify risks and prevent incidents
- Developing AI-powered training programs tailored to individual needs and behaviours to improve safety awareness
- Develop interactive audit tools

Maintenance Systems

- Monitoring operational equipment to remove workers from an area, to reduce exposure to dust, noise and vibration

Control of Equipment and Process Plant

- Fully integrated driverless machines and autonomous robotics

Occupational Monitoring

- AI tracking the occupancy rates of a building, in real-time
- Advanced occupational monitoring through worker exposure data

What's next?

The increased understanding of how AI is being used, will help HSE to consider risks and opportunities of AI use in industrial settings and increase HSE's ability to regulate AI use. This will contribute to HSE's wider work on developing its regulatory approach to AI.

HSE will continue establishing relationships with industry and academic stakeholders, to share knowledge and learning on AI use cases and understand the impact on health and safety.

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