



Overview of research and practices in relation to new monitoring systems for improving worker safety and health

EU-OSHA high-level workshop
Bilbao, 28-29 June 2023



Answering
tomorrow's
challenges
today

Field research on the design, development and implementation of new forms of OSH monitoring systems

- 10 in-depth case studies with companies designing monitoring systems or using such systems at the workplace
- Variety of company locations: France, Germany, Ireland, UK, USA
- Variety of technologies used in monitoring systems: IoT, smart PPE, wearables, video analysis, AI, SaaS analytics platforms
- Multiple economic sectors of system application
- Methodology: individual interviews, group interviews, contextualisation interviews, surveys, field visits

Case study #1

Preventing hand-arm vibration (HAV)

Reactec



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Problem statement

Hand-arm vibration (HAV) can cause vibration white-finger, a permanent and painful numbness and tingling in the hands and arms [1]

According to EU-OSHA, 1 out of 3 European workers is exposed to vibration [2]

[1] <https://www.hse.gov.uk/mvr/topics/vibration.htm#:~:text=Case%20study-,Introduction,may%20cause%20carpel%20tunnel%20syndrome>.

[2] <https://osha.europa.eu/en/publications/report-workplace-exposure-vibration-europe-expert-review>

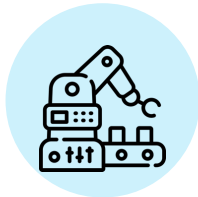
Sectors & risks



Construction



Mining



Manufacturing



**Motor
vehicle repair**



**Roads and railways
maintenance**

Equipment-related risks

- hand-held equipment: concrete breakers, bolting machines, sanders, polishers, compactors

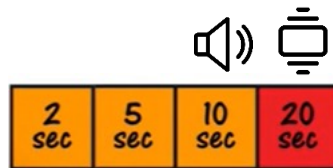
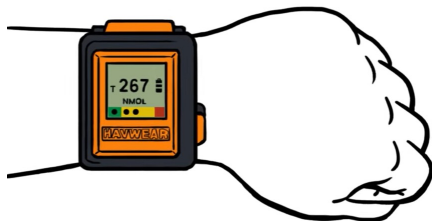
Task-related risks

- Drilling, blasting, operating sanders, operating polishers

Icon made by [Freepik](#) (construction, mining, manufacturing roads and railways maintenance) from [flaticon.com](#)

What does the solution look like?

Wearable providing workers with real-time information regarding their exposure to vibration & sending to them sound and vibration alerts when their exposure is high.



Using the smart digital system 5 steps

Collect



Wear



Mount



Return



Manage



Technologies



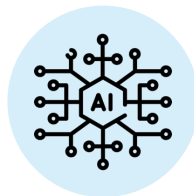
Internet of Things

Transferring vibration data from the wearable to the cloud



Bluetooth

Transferring data and enabling real-time assessment of risks



Artificial Intelligence

Analysing the data to produce reports



Cloud-based analytics

Reporting and managing users, tools, and plants

Icon made by [wanicon](#) (IoT), [Freepik](#) (Bluetooth, Artificial Intelligence) and [smashingstocks](#) (cloud-based analytics) from [flaticon.com](#)

Features

1. Using sensed exposure points vs tool exposure points
2. Notifications to OSH managers when vibration thresholds are exceeded*
3. Automated paperless and GDPR compliant reports available 24/7 including individual worker exposure & tool usage reports
4. New capabilities: measuring distance (COVID-19)

* Set based on UK's HSE exposure point system

Case study #2

Reacting to emergencies / protecting lone workers

TRAXxs



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Case study 2: Reacting to emergencies / protecting lone workers

Problem statement

Workers in sectors with high OSH risks are subject to risks that can be critical for their lives

In the EU, almost 600,000 accidents at work occurred in 2019 due to slipping, stumbling and falling / fall of persons of which 520 were fatal [1]

[1] Eurostat database - Accidents at work by sex, age, severity, NACE Rev. 2 activity and deviation

Case study 2: Reacting to emergencies / protecting lone workers

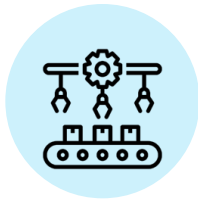
Sectors & risks



Construction



Mining



Manufacturing



Energy

Work environment-related risks

- Slipping, stumbling and falling (from height)
- Accidents calling for workers to evacuate the workplace
- Hostile behaviours

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Case study 2: Reacting to emergencies / protecting lone workers

What does the solution look like?

Wearable insoles functioning without smartphones or additional accessories



Case study 2: Reacting to emergencies / protecting lone workers

Technologies



SIM Card with 2G/4G M2M Connectivity (IoT)

Transferring workers' data from the wearable to the cloud



Cloud-based platform

Sending app notifications, SMS or emails to safety managers



Long-range Bluetooth

Covering dead areas where 2G/4G network is unavailable



Multi-satellite receivers (Outdoor)

Tracking workers' location in case of emergencies

Icon made by [wanicon](#) (IoT), [smashingstocks](#) (Cloud-based platform) and [Freepik](#) (Bluetooth, Multi-satellite receivers) from [flaticon.com](#)

Case study 2: Reacting to emergencies / protecting lone workers

Features

1. Fall/loss of vertical position detection
2. Invisible voluntary alert through having a worker tap his right foot against his left foot three times
3. Safety supervisor/manager may send an evacuation order in the form of a long vibration to all workers on the team
4. Sole respects ISO, CEM, CE and (soon) ATEX insole and electronics guidelines

* Set based on UK's HSE exposure point system

Case study #3

Monitoring hazardous gases in high OSH risk sectors

Draeger



Icons from left to right made by [katakuro](#) and [Smashicons](#) and [Eucalyp](#) from flaticon.com

Problem statement

Gases (flammable, toxic, asphyxiant) can cause critical and often fatal risks for workers in high OSH risk sectors

In the US, carbon monoxide (CO) inhalation led to most workplace fatalities by chemical or chemical product between 2011-2017 [1]

[1] U.S. Bureau of Labor Statistics. For more information, see: <https://www.bls.gov/opub/ted/2019/fatal-chemical-inhalations-in-the-workplace-up-in-2017.htm>. More recent statistics are not available.

Case study 3: Monitoring hazardous gases

Sectors



**Catalyst
handling**



Petrochemicals



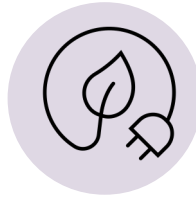
**Industrial
cleaning**



Sewerage



Water treatment



Green sectors (hydrogen, batteries etc.)

Icon made by [Smashicons](#) (catalyst handling) [Eucalyp](#) (petrochemicals), [Leremy](#) (industrial cleaning, sewerage), [mynamepong](#) (water treatment) from [flaticon.com](#)

Case study 3: Monitoring hazardous gases

Risks



Flammable

Fire/explosion risks

Methane, Butane,
Propane



Toxic

Poisoning risks

Carbon Monoxide,
Hydrogen, Chlorine



Asphyxiant

Suffocation risks

Oxygen deficiency.
Oxygen can be
consumed or displaced
by another gas

Icon made by [iconmas](#) (flammable) [Freepik](#) (toxic) and [AomAm](#) from [flaticon.com](#)

What does the solution look like?

Small, portable device, using infrared tech with various monitoring possibilities

Case study 3: Monitoring hazardous gases

Safe gas entry

Gas entry from two sides

360° visible alarm

Crocodile clip

Secure attachment

Sensors

Up to four different sensors

Robust design

Water and dust resistant in acc. With IP 67

Large display

All values at a glance



Case study 3: Monitoring hazardous gases

Technologies



Infrared sensors

Are new types of sensors monitoring hazardous gases



Cloud-based SaaS

Enabling asset management of gas detection fleets and geo-located live monitoring of gas-readings

Icon made by [Freepik](#) from [flaticon.com](#)

Features

1. Hosting multiple sensors measuring several gas channels
2. Combining infrared & electrochemical sensors for inert-space entry
3. Providing real-time monitoring of gas readings
4. Using Microsoft as a partner to ensure the SaaS platform is secure
5. EN 50271 certified (relevant EN standard for firmware safety/security for mobile gas detectors)

Case study #4

Using voice-AI to detect emotions, stress and other vocal biomarkers

Audeering



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Case study 4: Using voice-AI to detect emotions, stress & other vocal biomarkers

Problem statement

In the European Union, work-related stress (WRS) is the most common work-related health problem, after back pain, affecting 28% of EU workers [1]

[1] <https://osha.europa.eu/en/publications/factsheet-22-work-related-stress>.

Case study 4: Using voice-AI to detect emotions, stress & other vocal biomarkers

Risks & sectors



Maritime



**Services sector
e.g. call centers
handling
complaints**



**Healthcare and
well-being**

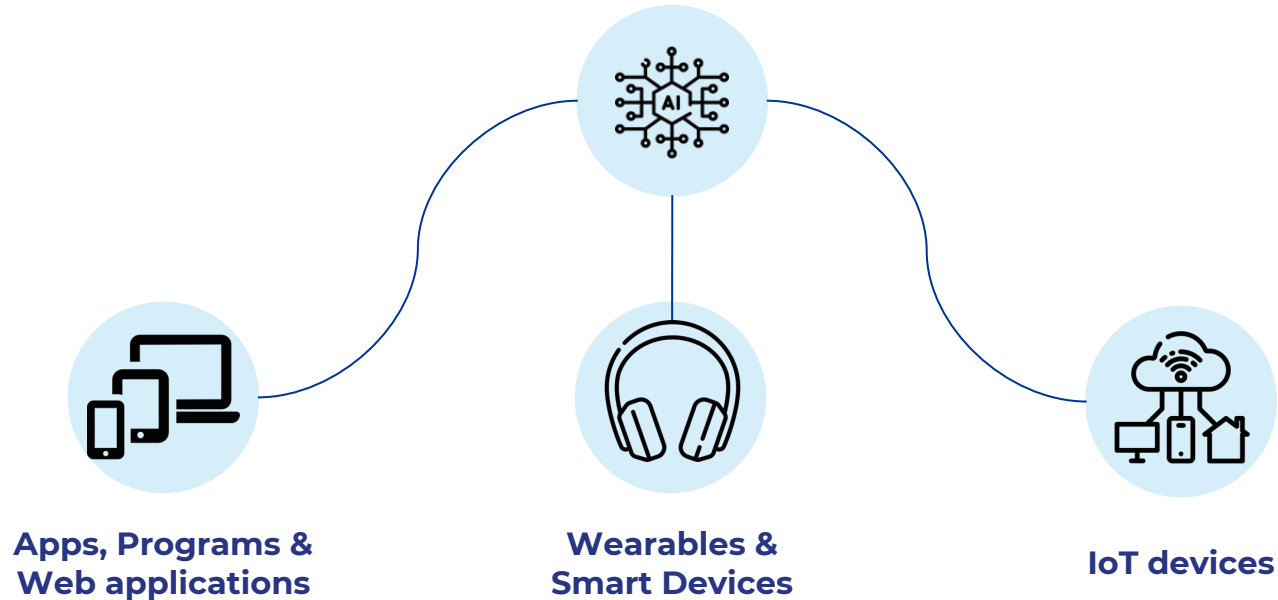
Task or work environment-related risks

- Handling complaints
- Psychosocial risks (poor work design, organisation and management, bullying / violence at work)

Icon made by [Inna Mikheeva](#) (maritime) and [Freepik](#) (services) from [flaticon.com](#)

Case study 4: Using voice-AI to detect emotions, stress & other vocal biomarkers

devAlce® integrates audio analysis into software and hardware



Case study 4: Using voice-AI to detect emotions, stress & other vocal biomarkers

Features

Using audio, text or both, the software solution can detect:

Emotion classes



Neutral



Happy



Angry



Sad

Emotion dimensions



Activation



Valence



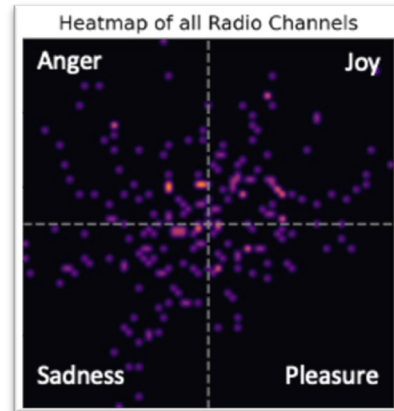
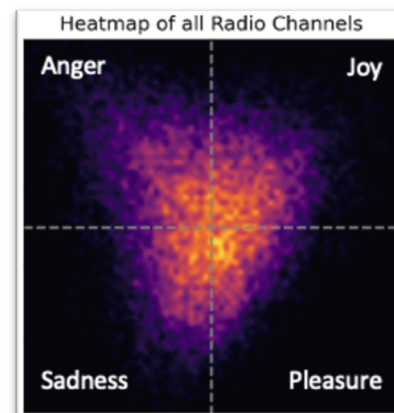
Dominance

Case study 4: Using voice-AI to detect emotions, stress & other vocal biomarkers

Features

Setup on oil tanker

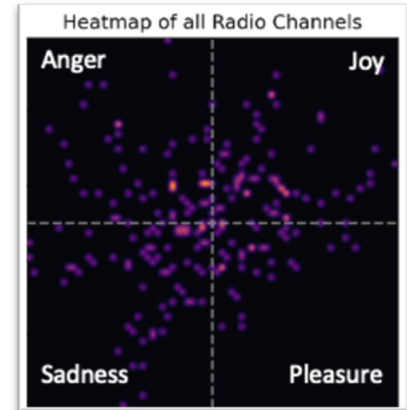
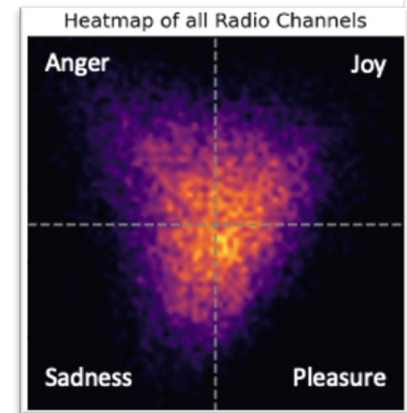
- Voyage-data recordings from ship's bridge and radio channels
- Heatmap: dimensional emotional expression over several days
 - Brighter colours signify greater intensity of emotions
 - More variance and higher intensity during loading phases (top)
 - Calmer open water periods (bottom)



Case study 4: Using voice-AI to detect emotions, stress & other vocal biomarkers

Features

- Data protection
 - Summary of all speech events → No distinction between speakers
- Active recording solution
 - Surveys and individual speech recordings of each user
 - Self-rated stress levels
 - --> Verify the emotion predictions of the VDR-based system



Case study 4: Using voice-AI to detect emotions, stress & other vocal biomarkers

Opportunities and challenges

Opportunities

- Using voice-AI based systems to detect emotions or stress is novel and can have multiple applications in the services and in other sectors
- Using voice-AI systems can also take place at an organisational level, where the voice does not link to a specific user

Challenges

- Blurred line between performance measurement and OSH
- Product has to operate on-premise (connectivity limited in maritime setting)
--> usage of the offline SDK of devAlce®

Case study #5

Real-time health and safety data analysis

Makusafe



Icon made by [Freepik](#) from [flaticon.com](#)

Problem statement

Safety professionals often focus on understanding what happened in the past. However, technology can be used proactively to collect the information needed to prevent an injury from happening before it is too late.

Case study 5: Real-time health and safety data analysis

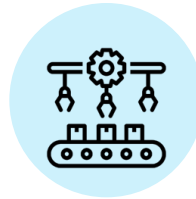
Risks & sectors



Construction



Heavy industries



Manufacturing



Consumer goods, packaging

Task or work environment-related risks

- Hazards related to human motion, proximity, location
- Avoiding musculoskeletal disorders

Icon made by [Inna Mikheeva](#) (maritime) and [Freepik](#) (services) from [flaticon.com](#)

Case study 5: Real-time health and safety data analysis

What does the solution look like?

Wearable devices with multiple sensors combined with data analytics

Slips/Trips/Falls

Hazardous Motion

Air Quality

Repetitive Motion

Voice Memo



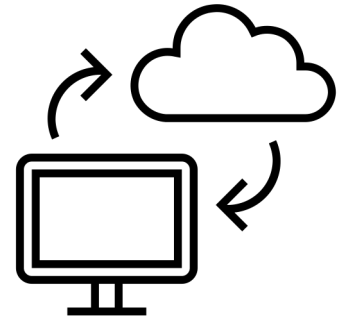
Noise Levels

Humidity

Light Levels

Air Temperature

Indicator Location



Case study 5: Real-time health and safety data analysis

Technologies



Kiosk (base station)

Workers checkout
devices using
unique IDs



Wearable device

Multi-sensor
wearable inserted
into armband



Connectivity

Bluetooth / Wi-Fi +
kiosk onsite,
smartphone offsite



Cloud-based platform

SaaS platform
providing AI
analytics and
reporting dashboard
for OSH
professionals

Icon made by [wanicon](#) (IoT), [smashingstocks](#) (Cloud-based platform) and [Freepik](#) (Bluetooth, Multi-satellite receivers) from [flaticon.com](#)

Features

1. Collecting information about the environment rather than the worker
2. Monitoring indicators of hazards: slips/trips/falls, MSD's, strain/exertion concerns, sound exposure, air quality, etc.
3. Voice memo recording
4. Real-time notifications and intelligence using AI/ML models
5. Data-driven insights for reporting and analysis

Case study #6

Preventing risks in the mining sector

Wenco International Mining Systems



Icon made by [Freepik](#) from [flaticon.com](#)

Problem statement

Operator fatigue contributes to 65% safety incidents at mines each year [1]

[1] <https://fatiguescience.com/blog/digging-into-fatigue-in-mining/>

Risks & sectors



Mining

Task-related risks

- “Fatigue” that contributes to accidents in the mining industry refers to cognitive fatigue rather than physical fatigue from demanding physical work

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What does the solution look like?

A band which can be worn on its own or inside any type of headwear



Case study 6: Preventing risks in the mining sector

Technologies



Wearable

Band utilising EEG



Bluetooth

Alerts provided to
app via Bluetooth

Icon made [Freepik](#) (Bluetooth) from [flaticon.com](#)

Features

1. Real-time fatigue monitoring by measuring the electrical activity of the brain (electroencephalography)
2. Alertness scores, early warnings and fatigue alarms are delivered via a smartphone app
3. Assists workers in managing fatigue, identifying the risk of microsleep
4. Proactive fatigue detection and microsleep prediction rather than reacting to the state of worker alertness

Case study #7

Autonomous drone systems in railroad applications

Easy Aerial

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Case study 7: Autonomous drone systems in railroad applications

Risks & sectors



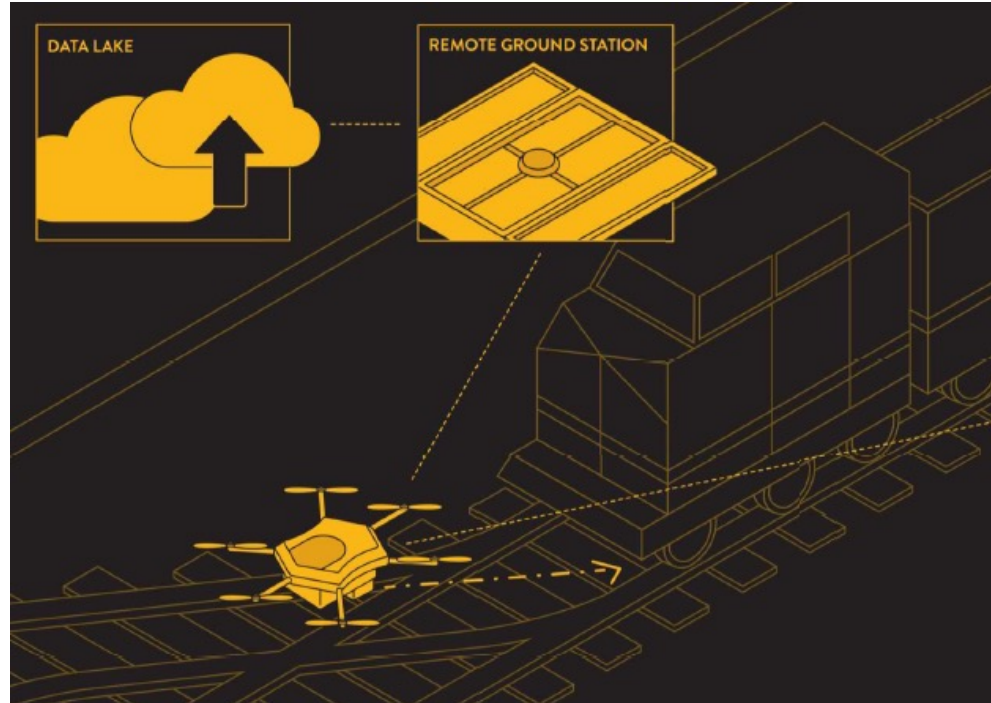
Railroad

Task-related risks

- Inspection systems – autonomous solutions that provide inspection services of mechanical rolling stock, tracks, critical infrastructure
- Protection systems – autonomous solutions that protect workers or trains by providing surveillance, warning and communication to prevent accidents

Case study 7: Autonomous drone systems in railroad applications

What does the solution look like?



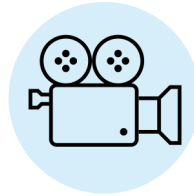
Case study 7: Autonomous drone systems in railroad applications

Technologies



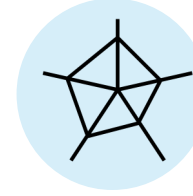
Autonomous UAV

High-mobility in all weather conditions



AI video analysis

On-board analysis of video data



Lidar, RFID scanning

Various possible payloads add capability for customization

Opportunities - OSH

- Preventing risks by improving the understanding of work conditions, specific tasks, environmental factors and taking remedial actions, e.g. training, behavioural change, changing equipment
- Reacting to risks and events such as slipping, stumbling and falling, hostile behaviour etc.; sending alerts to workers and managers
- Reducing the time of rescue operations through locating workers and events
- Facilitating risk identification, reporting, analysis, planning
- Empowering workers through increased awareness and making people feel safer

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Opportunities - technology

- Real-time monitoring of environment in ways that have not been possible until very recently with precise, connected sensors, AI-assisted audio and video analysis, autonomous devices
- Ease of use of devices that are integrated or compatible with existing items, e.g. PPE, shoes, helmets
- Flexibility and comprehensiveness of purpose-made wearable devices that integrate multiple sensors and functions
- Person-centred rather than device or vehicle-centred monitoring systems
- Mobility of devices over long distances and difficult to access or hazardous locations, reducing workers' exposure to risks by enabling remote or autonomous operation

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Challenges - perceptions

- Concerns about privacy and data handling, misconceptions about system functionality, lack of trust towards technology
- 'Big brother' issue - blurred line between performance measurement and OSH monitoring
- 'Stolen job' issue – potential misuse of technology in tasks, automation and changing workplace

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Challenges - technology

- High costs of solution and system development, costs of implementation
- Competition as an economic challenge vs innovation driver
- 'Vanishing point' issue - device ergonomics and ease of use, automation of tasks and processes as constantly evolving areas
- 'Drones fall' issue – risks associated with technology failure; continuous connectivity required for system operation and real-time data analysis

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Thank you for your attention

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Publications

- EU-OSHA (2022). Smart digital monitoring systems for OSH: workplace resources for design, implementation and use
- EU-OSHA (2022). Smart digital monitoring systems for OSH: opportunities and challenges
- EU-OSHA (forthcoming). Smart digital monitoring systems for OSH: real-world applications