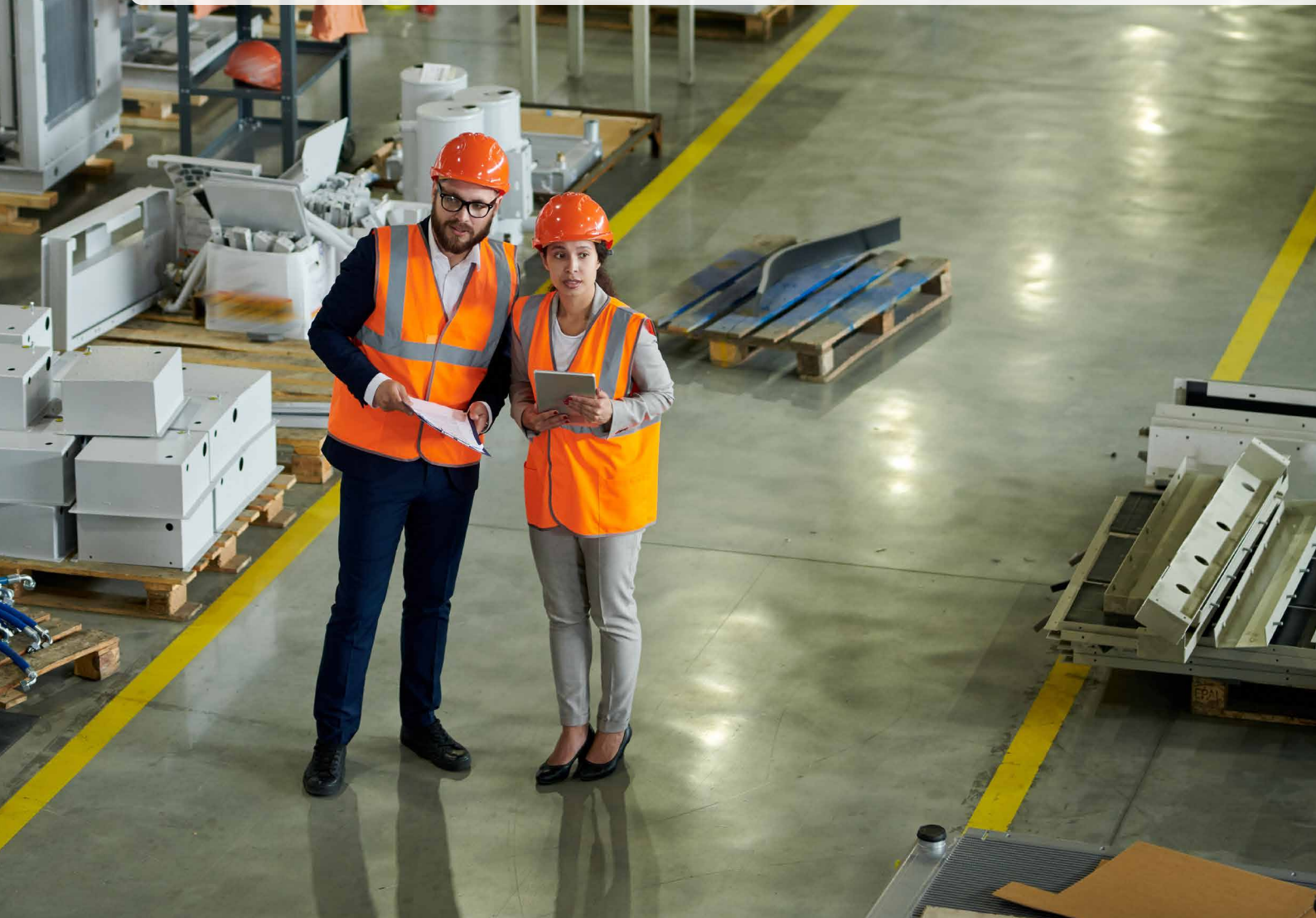# RAND EUROPE

The role of evidence in occupational safety and health

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Summary

Using evidence in occupational safety and health (OSH) decision making may help reduce rates of occupational incidents and diseases. However, the role evidence currently plays within OSH is unclear. This report describes a study exploring the role of evidence in OSH decision making. It also considers what evidence is produced, shared and used, and by whom.

We developed two conceptual models based on literature from a Rapid Evidence Assessment (REA) that included 28 articles and stakeholder engagement (via secondary analysis of existing interview data, a global survey and primary interviews). The first illustrates the actors and agencies involved in evidence production, sharing and use and their interrelationships. The second demonstrates the processes involved in decision making at the local (e.g. organisation/business) and systems level and the role evidence plays in these processes. Our research suggests that legal, regulatory, business and cultural factors influence OSH-related decision making, and are often prioritised over OSH evidence.

This study's findings suggest the need for more effective translation of evidence for lay audiences alongside more effective tools and techniques for sharing knowledge about OSH evidence and practices at a local and systems level. Promoting a positive safety culture (e.g. where employees appreciate the value of safety practices rather than viewing them as an inconvenience) is also important for using evidence in OSH, particularly at a local level. This is because individual attitudes, values, perceptions and behaviours heavily influence the use of evidence in practice. At a systems level, methods need to be developed to map the evidence ecosystems for specific countries, sectors and topics of interest, as the models developed in this work are generic and may differ based on these factors. Finally, our findings suggest a substantial time gap between identifying a problem and using evidence to address it, possibly calling for increased system capacity for rapid evidence assessment and response to issues.

Executive summary

Introduction

Occupational accidents, illnesses and fatalities are prevalent globally; between 2000 and 2017, an estimated 1.9 million [1] to 2.78 million [2] global deaths were attributable to occupational accidents or diseases. The past decade has seen work-related accident and fatality rates plateau in many high-income countries [2-7]. However, safety outcomes and disparities within and between countries remain prominent issues [1, 2, 8, 9]. Enhancing working conditions and making workplaces safer is necessary to decrease the number of fatalities, injuries and cases of occupational diseases, and to promote and safeguard psychological welfare. One way to make working environments safer is by using evidence to inform guidelines, regulations, practices and decision making. However, some suggest that occupational safety and health (OSH) underutilises systematic, scientific evidence and over-relies on expert-based recommendations [10, 11]. It is currently unclear what evidence types are used to help make work environments safer, who uses such evidence and for what purpose. In the absence of existing evidence, it may be beneficial to produce new evidence for use within organisations and governments. However, it is unclear which agencies are involved in producing, translating and sharing evidence with end users. It is also unclear how OSH decisions are informed and what role evidence plays in this process.

Research questions

This work aimed to answer the following research questions (RQs):

- RQ1: What types of evidence exist in OSH?

- RQ2: Who is using the evidence in OSH and what for?

- RQ3: How are OSH decisions informed and what role does evidence play in this process?

- RQ4: Which agencies are involved in producing, translating and sharing evidence in OSH?

Research approach

The research undertaken was divided into the following activities to answer the four research questions:

1. **A Rapid Evidence Assessment (REA):** We conducted searches of PubMed and the citation indexes via Web of Science and performed a series of targeted grey literature searches of Google and ten key organisations' websites. We extracted and

synthesised data from the 28 articles that met the inclusion criteria.

2. **Stakeholder engagement activities:** First, we analysed existing data from 240 interviews conducted between 2018 and 2020 with OSH leads and Human Resources Directors from national and international organisations. Second, we conducted an online survey of OSH stakeholders from 25 May 2022 to 22 June 2022, capturing answers from 132 participants. Third, we interviewed an additional 13 individuals involved in OSH (researchers, practitioners, regulators/policymakers and membership organisation representatives).

3. **Development of conceptual models:** Using data collected from the REA and stakeholder engagement activities, we developed two conceptual models: one mapped the different actors and agencies involved in OSH decision making (structural model, Figure 5), and the other highlighted the processes involved in OSH and the role of evidence at an operational and systems level (process model, Figure 7).

4. **Analysis and synthesis:** Lastly, guided by our conceptual models, we analysed and synthesised findings from the REA and stakeholder engagement activities to answer the four key research questions.

Findings

Our findings highlighted that no single definition of 'evidence' existed in the OSH space. The literature and stakeholders we consulted drew upon various information and research sources for decision making. The OSH evidence ecosystem contains multiple actors interacting in what we describe as the *lifecycle of evidence*, which refers to the production, synthesis, sharing and use of evidence at an operational and systems level. Although

we distinguish between these categories for clarity, they are interdependent processes in practice.

The actors involved in this ecosystem include:

The academic and research community (mainly evidence production and sharing).

Government agencies, regulatory bodies and policymakers (evidence production, sharing and use).

Intermediaries such as professional bodies, consultants and OSH professionals (mainly evidence sharing).

Organisations/businesses (evidence production, sharing – mostly internally – and use).

One of the primary uses of evidence is to inform decision making. We developed a conceptual model to illustrate the two levels at which evidence is used to inform decision making: (i) a local level (i.e. within an organisation/business) and (ii) a systems level. At a local level, we based the lifecycle of evidence on a continuous-improvement cycle (also known as a 'plan-do-study-act' or 'Deming' cycle) [12]. At a systems level, we based the cycle on the International Labour Organisation's (ILO) OSH-management system [13], which incorporates policies, aims, organisation, implementation, evaluation and improvement. Each stage commonly uses different types of evidence.

Several factors influence decisions and evidence-use in the decision-making process. Broadly grouped and presented by stakeholder groups, these factors include (in ascending priority): the legal basis and regulations, the business case (e.g. finances, staffing), culture and finally, evidence (e.g. existence,

accessibility and relevance). An organisation's size can also impact these factors (i.e. larger companies are likely to have greater resources and more specialist staff than smaller companies), as can the country (affecting regulations, expectations and culture).

Discussion and recommendations

Our REA and stakeholder engagement findings highlight a complex evidence ecosystem involving multiple actors, agencies and influences on the production, synthesis, sharing and use of evidence within OSH. Based on this work's findings, we present five recommendations for future work:

- **For evidence sharers:** greater investment is required in knowledge translation. To maximise its impact, workplace-safety evidence must be tailored toward its intended audiences, who are often not academic researchers (e.g. workers, policymakers and organisational leaders/ decision makers). As a starting point, academic literature must be translated into easy-to-digest formats such as infographics, videos and manuals for non-OSH-specialist audiences. Many organisations – particularly small-and-medium-sized enterprises (SMEs) in developing countries – need further support utilising academic research evidence in decision making and practice. Networks and communities supporting evidence dissemination, mutual learning, critical thinking and literacy are likely beneficial. A single point of reference for OSH evidence globally may be beneficial and help overcome issues relating to identifying and accessing relevant evidence in a timely manner.

- **For workplaces:** a workplace's safety culture (comprising psychological, behavioural and situational aspects [14])

is a key influence on safety outcomes, and is greatly influenced by organisational leaders' and decision makers' values and expertise. While there may be a perception that evidence-based practice is time-consuming and/or costly, organisational leaders should be educated about the benefits a safer work environment can offer their organisation (e.g. increased quality and profitability). The promotion of a positive safety culture among all workers is likely to be beneficial.

- **For researchers:**

  » Further research is required to bridge the knowledge-to-action gap in how evidence is used (or not) to implement specific change. This may begin with evaluations to understand the use and effects of shared/translated evidence in practice, including long-term follow-ups.

  » Cost/benefit analyses of evidence-based practice are required to provide empirical evidence addressing perceptions that evidence-based practice is costly. The results may stimulate cultural changes, encouraging organisations to utilise evidence they may have previously hesitated over.

  » Collecting data on organisation sizes would be beneficial when conducting future research about evidence utilisation in OSH, as we found this to be a key influence. In addition, greater efforts to include representation from low-and-middle-income countries (LMICs) are needed, which may require additional resources and increasing capacity and capabilities in LMICs.

  » There is often a delay between the emergence of safety issues and the provision of new evidence that helps

address them. Therefore, system capacity must be in place to minimise the time between problems arising and the availability of evidence to respond, whether through the production of new evidence and/or the synthesis of existing evidence. It may also be beneficial to conduct horizon scanning for future potential issues for the rapid mobilisation of evidence when needed. Moreover, it may be worth considering a body/council of representatives from LMICs that could champion and facilitate LMIC research inclusion in a timely manner.

» Our research highlighted significant variability in the available evidence and how it is accessed and implemented across countries and sectors. It may be beneficial to map evidence ecosystems for specific countries, sectors and topics of interest. Accurate mapping exercises could help identify OSH issues, highlighting areas that would benefit from further research or tailored interventions.

Table of contents

Figures, tables and boxes

Abbreviations

HICs	High-Income Countries
HMICs	High-and-Middle-Income Countries
HSE	Health and Safety Executive
LICs	Low-Income Countries
ILO	International Labour Organisation
LMICs	Low-and-Middle-Income Countries
NGO	Non-Governmental Organisation
OSH	Occupational Safety and Health
REA	Rapid Evidence Assessment
RQ	Research Question
SMEs	Small-and-Medium-sized Enterprises
UEA	University of East Anglia
WP	Work Package

Acknowledgements

1 Introduction

An estimated 1.9 million [1] to 2.78 million [2] global deaths were attributable to occupational accidents or diseases between 2000 and 2017. The past decade has seen work-related-accident and fatality rates plateau in many high-income countries [2-7]. However, safety outcomes and disparities in outcomes between countries and within countries remain prominent issues [1, 2, 8, 9]. In a recent global poll of workers (n=150,000) across 142 countries, 19% reported that they had been seriously injured at work [15]. As well as the personal impact on the worker, occupational accidents and diseases have societal and economic impacts. Consequences include reliance on welfare and healthcare systems, insurance claims to cover medical expenses and economic issues arising from lost productivity, which may impact a country's economic growth [16-23]. Therefore, there is a need to reduce work-related fatalities, injuries and diseases, requiring new tools and techniques to ensure working environments continue becoming safer.

Evidence can help improve work-environment safety by informing guidelines, regulations, practice and decision making [11]. Evidence can be defined as 'The available body of facts or information indicating whether a belief or proposition is true or valid' [24]. However, evidence is underutilised in occupational safety and health (OSH), and recommendations for improving workplace safety are often informed by individual opinion (which may include individual OSH experts) rather than direct consultation of more rigorous evidence sources [10, 11]. Therefore, it is vital to understand the types and role of evidence in OSH and identify possible opportunities to improve its positive impact on safety outcomes.

It is currently unclear what evidence types exist in OSH, who uses them and for what purposes. In the absence of existing evidence, it may be beneficial to produce new evidence for organisations, workplaces and governments. However, it is unclear which agencies are involved in producing, translating and sharing evidence. It is also unclear how OSH decisions are informed and what role evidence plays in this process. Therefore, this study aimed to explore and identify globally: (i) what types of evidence are produced, shared and used, and by whom, and (ii) how OSH decisions are informed and the role evidence plays in this process.

2 Research approach

This section describes our study's research approach. We considered expert input from the funders (LRF and NSC) alongside input from an independent expert panel.

2.1. Research questions

The project endeavoured to answer four research questions (RQs) to achieve its aims:

- RQ1: What types of evidence exist in OSH?

- RQ2: Who is using the evidence in OSH and what for?

- RQ3: How are OSH decisions informed and what role does evidence play in this process?

- RQ4: Which agencies are involved in producing, translating and sharing evidence in OSH?

The project undertook four main activities to answer these RQs: (i) a rapid evidence assessment (REA), (ii) stakeholder engagement, (iii) conceptual-model development and (iv) synthesis and reporting. Figure 1 (below) outlines the methods used in each activity.

Figure 1. Overview of approach

Activity	Rapid evidence assessment	Stakeholder engagement	Conceptual models	Synthesis and reporting
Tasks	• Evidence scoping • Database searches • Screening of results • Data extraction • Targeted search of grey literature • Analysis and interpretation	• Finalisation of survey questions and interview protocol • Conduct survey and interviews • Analysis and interpretation	• Initial conceptual model development • Collate expert views and further iterate	• Synthesis of findings • Reporting • Dissemination
Output	Preliminary findings and finalised list of stakeholders	Findings from stakeholder insight	Fully developed conceptual model	Final report and communications narratives

Quality assurance and engagement with expert advisors

2.2. Rapid Evidence Assessment

Overview of REA methods

Our literature review approach followed the principles of an REA [25]. It aimed to develop an understanding of the current role of evidence in the OSH field rather than directly assessing or comparing the effectiveness of particular approaches to OSH evidence generation, dissemination or use.

We ran searches of academic literature in PubMed on 10 January 2022 and via Web of Science (Science Citation Index Expanded (SCI-EXPANDED)), Social Sciences Citation Index (SSCI) and the Emerging Sources Citation Index (ESCI) on 19 January 2022. We also conducted searches of grey literature via Google (16 searches between 9 and 10 February 2022) and targeted searches (1 and 2 March 2022) of ten key organisations' websites deemed likely to produce or post information relevant to the topic of interest. One review team member screened articles for inclusion (SS, JD, or GM screened academic papers; SS or SB screened grey literature) using pre-defined criteria (Table 1). Any uncertainties were resolved through discussion between reviewers.

For two reasons, we excluded articles focused on the effectiveness of specific OSH interventions or intervention types. First, the high volume of corresponding articles precluded their inclusion in this review's scope. Second, the particular nature of such articles did not directly address this review's research questions about the evidence types produced, shared and used in OSH and by whom. For example, one overview of studies identified through academic searches [11] included 25 systematic reviews on the effectiveness of behavioural, relational and mixed interventions in preventing occupational injuries and diseases. Similarly, we excluded specific examples of OSH evidence generation, studies relating to occupational medicine (the branch of medicine concerned with the maintenance of health in the workplace) or workplace health promotion, and those focused solely on identifying or classifying indicators for the measurement of OSH outcomes.

We included publications if the topic was relevant to the OSH research landscape or the generation, dissemination, need for, or practical use of evidence, including those focused on identifying priorities for future research based on need. We excluded publications on occupational medicine, intervention effectiveness or specific evidence-generation examples. As our REA included various sources, no formal quality assessment was conducted. Therefore, we did not exclude articles based on quality. Three reviewers (GM, JD and SS) used an Excel template to extract data from the included sources.

Table 1. REA inclusion and exclusion criteria

	Include	Exclude
Topic focus	Journal articles and grey literature sources focused on: • The **topic** of the generation, dissemination, need for, or practical use of evidence in the field of occupational safety and health (OSH) • The OSH **research landscape**, including those focused on identifying priorities for future research based on need	Sources reporting on: • The **effectiveness** of a particular intervention or intervention type (unless focused on the nature of the evidence base or identifying a need for evidence) • **Examples** of evidence generation or identification of knowledge gaps in specific fields or populations that could inform interventions (e.g. a survey of service workers in north-eastern Malaysia on knowledge, attitude and practice concerning leptospirosis prevention) • Studies relating to **occupational medicine** (the branch of medicine concerned with the maintenance of health in the workplace) or **workplace health promotion** • Solely the **identification or classification of indicators** for the measurement of OSH outcomes
Publication date	Review articles published since 2012 Original articles and grey literature sources published since 2017	Review articles published before 2012 Original articles and grey literature sources published before 2017
Source type	Articles and reports reporting on research studies of any design Opinion pieces, commentaries and editorials	Research protocols
Language	Written in English	Written in a language other than English

Overview of studies included in the REA

We identified 4,985 records from electronic database searches after removing duplicates. Of these, 28 publications met the inclusion criteria for data extraction and synthesis; 23 were academic journal articles, and 5 were grey literature reports. The journal articles included review articles (n=8), primary research studies (n=9), commentaries/concept papers (n=4), and guidance/recommendation papers (n=2). All articles were published between 2012 and 2022.

Caveats

The REA's focused nature means some potentially important articles and pertinent information may not have been included, as we purposefully sampled the selection. Similarly, we may have missed some potentially significant websites, documents, or relevant information by confining grey literature searches to specific dates/websites and the first 50 hits on Google. Furthermore, we only included articles/documents written in English, thus excluding those in other languages. Lastly, only one

reviewer screened records, whereas double screening may have identified disagreements between reviewers and resulted in the inclusion of additional articles. However, we double-screened a sample of articles as part of the initial piloting of the screening process and criteria, which demonstrated good agreement between reviewers. Furthermore, reviewers erred towards inclusion during screening and resolved any uncertainties through discussion.

2.3. Stakeholder engagement

2.3.1. Secondary interview analysis

A unique source of added value for this study was a set of interviews conducted between 2018 and 2020 with OSH leads and Human Resources Directors from national and international organisations as part of another study (see below). These interviews offer a wealth of information not typically accessible, manageable, or affordable within our project's timescales.

The original research

The data were from a University of East Anglia (UEA) and RAND Europe ESRC-funded project on understanding the successful implementation of well-being initiatives in the UK. The project aimed to identify factors in successfully introducing health and well-being practices in organisations to foster increased productivity levels, staff engagement, health and well-being, focusing on a broad conception of well-being rather than on OSH specifically.

A total of 240 qualitative semi-structured interviews were conducted with leaders, well-being practitioners and employees across eight organisations between January 2020 and July 2021. Participating organisations included a range of industries and both large (construction, finance, pharmaceutical, facilities management) and small (education, information services, web development, media

production) organisations. The interviews assessed each company's well-being and performance approach, any related initiatives/ programmes, any changes to their well-being and performance strategy/action, and the extent of employee engagement and dialogue.

The re-analysis

The re-analysis was undertaken in four stages: familiarisation, text searching, coding and analysis. Firstly, the researcher familiarised themselves with the data, particularly on how practitioners discuss evidence mobilisation, giving them a list of search words to highlight potentially relevant data. Secondly, they conducted a text search across 240 transcripts in NVivo (Version 12) [26] to identify exact matches and stemmed words and return each word in its broad (full paragraph) context. They identified a total of 3,782 references of possible relevance. Each identified excerpt was then coded to one of the following general codes: 'what is evidence?', 'evidence production', 'evidence use', 'evidence dissemination/sharing', 'evidence gaps', 'miscellaneous', or 'none' (i.e. if the word was not relevant to OSH/well-being evidence). From this re-coding, the researcher could provide answers to the questions posed.

Caveats

While issues in evidence production and (usually internal) use came up in response to questions during these initial interviews, they did not explicitly focus on safety or the role of evidence. Therefore, in-depth probing into data sources and perceptions of validity were rare. In addition, since the study participants were self-selected, they may not represent the views and experiences of the whole population.

2.3.2. Survey

Overview of the survey methods

The research team surveyed OSH stakeholders, researchers and policymakers, as well as

workers within all sectors worldwide. The survey aimed to better understand the key sources and producers of evidence in OSH, the primary users of each evidence type and how they use it. The REA findings informed the survey design, alongside input from the Lloyd's Register Foundation (LRF) and the expert panel. The survey covered the following topics: (i) information about the respondent (e.g. professional role/ sector), (ii) involvement with organisational OSH-related decision making and (iii) experience with evidence production, sharing and use. The survey was hosted online via SmartSurvey [27] and disseminated via social media, email, OSH member organisations, RAND Europe and LRF contacts and the expert-panel members' networks. The survey was open from 25 May to 22 June 2022. All participants provided informed consent. Those who did not consent to participate were automatically redirected to end the survey and thus were ineligible for participation.
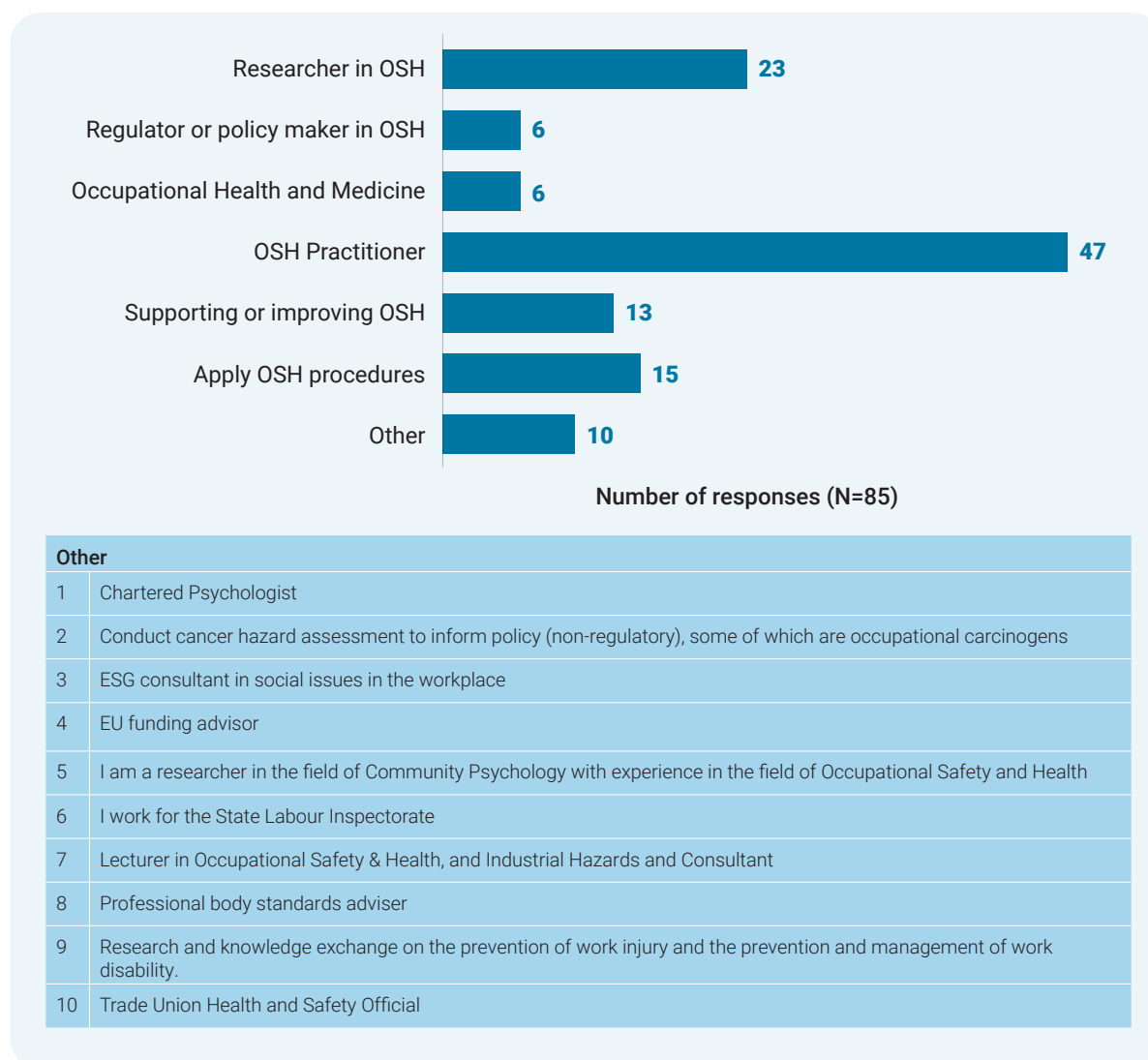
Survey analysis

Responses from 132 participants were downloaded in a raw data file from SmartSurvey and organised/cleaned by the research team for analysis. Only participants who answered at least one question (other than the consent questions) were included in the analysis, resulting in a final dataset of 85 participants. The remaining 47 participants did not answer any questions beyond the consent questions and were thus excluded from the analysis. Descriptive analyses were conducted in the R statistical software package [28], including the counts and percentages of respondents that selected each response option. Missing data were excluded from the analysis for each question. Missing data may have been because participants were routed to relevant questions only or because some did not answer all questions. The findings state the total number of respondents for each question.

Description of survey respondents

The survey was completed by respondents from 29 countries worldwide, with participants most frequently based in the UK (28%, n=24) or New Zealand (27%, n=23). Other countries included the USA (n=6), Spain (n=2), India (n=2), Greece (n=2), Finland (n=2), Canada (n=2), Australia (n=2), Uganda (n=1), Sweden (n=1), South Korea (n=1), South Africa (n=1), Saudi Arabia (n=1), the Philippines (n=1), the Netherlands (n=1), Malta (n=1), Malaysia (n=1), Macedonia (n=1), Lithuania (n=1), Kosovo (n=1), Italy (n=1), Estonia (n=1), Egypt (n=1), Croatia (n=1), Botswana (n=1), Belgium (n=1), Algeria (n=1) and Afghanistan (n=1). Overall, this represents 76 respondents from high-income countries (HICs) and 9 from lower-and-middle-income countries (LMICs).

Participants operated in 34 different sectors, of which the most common were health and social care (32%, n=27), manufacturing (29%, n=25) and construction (28%, n=24). Most respondents were OSH practitioners (55%, n=47) and about a quarter were OSH researchers (27%, n=23) (Figure 2). When asked about the primary objective of their OSH work, almost two-thirds (64%, n=52) reported involvement in implementing or supporting practice changes (e.g. introducing risk management measures, environmental changes, or efforts to change employee behaviour), about half (48%, n=39) in making or informing changes in workplace policies and just over one-third (37%, n=30) in increasing academic knowledge about OSH. Figure 2 shows the breakdown of all answers (note that the totals exceed 85 as participants could select multiple options).

Figure 2. Survey respondents' professional roles within occupational safety and health

Role	Number of responses
Researcher in OSH	23
Regulator or policy maker in OSH	6
Occupational Health and Medicine	6
OSH Practitioner	47
Supporting or improving OSH	13
Apply OSH procedures	15
Other	10

Number of responses (N=85)

Other	
1	Chartered Psychologist
2	Conduct cancer hazard assessment to inform policy (non-regulatory), some of which are occupational carcinogens
3	ESG consultant in social issues in the workplace
4	EU funding advisor
5	I am a researcher in the field of Community Psychology with experience in the field of Occupational Safety and Health
6	I work for the State Labour Inspectorate
7	Lecturer in Occupational Safety & Health, and Industrial Hazards and Consultant
8	Professional body standards adviser
9	Research and knowledge exchange on the prevention of work injury and the prevention and management of work disability.
10	Trade Union Health and Safety Official

Caveats

The limited sample size across multiple sectors, professional roles and geographies precluded sub-group analysis and means the survey results are not generalisable across the population. The survey was distributed across membership networks, with respondents likely highly engaged in OSH. Thus, respondents may not represent all types of workers.

2.3.3. Primary interviews

Overview of methods

An interview guide was developed based on the research questions outlined in section 2.1. The guide was influenced by the policy cycle framework [29] (primarily focused on defining, organising, implementing, evaluating and sustaining) and the International Labour Organisation (ILO) management system for

the OSH framework [13] (see Box 1). Questions were asked about the individual's occupational context and the definition and role of evidence within the organisation's decision making.

Interview analysis

All survey respondents were asked if they would like to participate in an interview. Of the twenty respondents who indicated they were willing to participate, all were invited to an interview. In addition, one potential interviewee who LRF highlighted was also invited to interview. Of these 21 invitations, 13 respondents were interviewed via Microsoft Teams (four researchers, five practitioners, two researcher-practitioners, one regulator/policymaker and one OSH membership organisation worker). All participants were from HICs. All participants gave informed consent. Interviews lasted an average of 39 mins (range: 28–49 mins) and were transcribed using the Microsoft Teams in-built transcription service with the interviewee's permission. The interviewers then wrote bullet point notes under each question using the transcriptions and notes taken during the interview, using these summaries to synthesise data across data-collection methods.

Throughout this report's findings section, we refer to data from primary interviews by the interview number (e.g. [INT01]) and data from secondary interviews as '[secondary interviews]' – only referencing a specific secondary interview if presented as a direct quote.

Caveats

Highly motivated and potentially better-informed individuals may have been more likely to volunteer to be interviewed, meaning their use of evidence for decision making may not fully represent all organisations or individuals. Moreover, there were no practitioners from SMEs, which may utilise evidence differently than larger organisations. In addition, all volunteer participants were from HICs. Therefore, many represented views likely reflect HIC-specific experiences less relevant to LMICs.

2.4. Conceptual models

We developed two conceptual models: one highlighting the processes involved in OSH and the operational and systemic role of evidence (process model), and another mapping the different actors and agencies involved in OSH decision making (structural model). We created both conceptual models iteratively using a combination of information gathered from the REA, secondary interview analysis, survey and primary interviews. The team developed an initial model for the process model based on a plan-do-study-act improvement cycle [12] and ILO model [13]. For the structural model, we listed actors and agencies mentioned in the REA, secondary interviews and survey, and mapped their anticipated relationships. The interviews provided further evidence of relationships and/or actors/agencies involved in OSH-related decision making.

2.5. Synthesis and reporting

To answer the four key research questions, the team analysed the findings from the REA, secondary interviews, survey and primary interviews, and synthesised them with the conceptual models.

3 Findings

This section describes the synthesised findings from the REA, secondary interview analysis, survey and primary interviews organised by the four main research questions. We describe the existing evidence types (RQ1), followed by the actors and agencies involved in producing, sharing, translating and using evidence (RQ2 and RQ4). Lastly, we discuss how decisions are informed and the role of evidence in this process (RQ3), including the decision-making process and its influences.

3.1. What types of evidence exist? (RQ1)

To identify existing evidence types, we must first understand how evidence is defined in OSH. Although none of the articles included in the REA explicitly defined 'evidence', many provided examples. Some stakeholders from the primary interviews also offered definitions. Suggested definitions included that 'evidence is something that has a solid body of research and practice' [INT12], that it is 'observable and repeatable, [...] and independent' [INT08], and that 'evidence is, in a sense, information about the consequences of different choices' [INT01]. One stakeholder involved in research provided a comprehensive definition:

> 'My definition of evidence, I feel, follows the original definition of evidence-based medicine from David Sackett in the

early 90s or the late 80s. [...] So that definition suggests that evidence-based medicine was the clinician's expertise, the best available research, and the values of the patient. So, if we adapt that to occupational health and safety, we think of the expertise of the practitioners, the occupational health and safety practitioners, the best available research, [...] and then I think it should also take into account the values and experiences of the end user or the worker. [...] So evidence can come from those sources in my opinion.' [INT04]

While other stakeholders could not define evidence, all could provide examples of what they considered evidence. Examples of 'evidence' from the REA and interviews include:

- **Academic expert opinion** [30] [INT01, INT02, INT04, INT07, INT09, INT10, INT13]

- **Accident/incident reports** [30-37] [INT01, INT03, INT06, INT07, INT11, INT12, INT13]

- **Audit and inspection reports** [38, 39] [INT06, INT13]

- **Benchmarking reports** [30, 37, 39] [INT06, INT07]

- **Big data and safety analytics** [32, 40] [INT04]

- **Biomarker data** [41]

- **Cultural assessments** [40]

- **Guidelines produced by the government** [34, 42, 43] [INT06, INT07, INT12]

- **Incident cause analysis method investigations** [INT03] [40]

- **'Knowledge network' analyses or safety analytics readiness assessments** for initial processing and modelling of safety performance [32, 40]

- **Legislation** [31] [INT05, INT09]

- **News/media (including social media) / publicly available information on major OSH incidents** [31, 44] [INT06]

- **OSH statistics** (e.g. accident and near miss data) [32-36, 40, 42] [INT05, INT06, INT07, INT11, INT13]

- **Performance metrics and monitoring and audit data** [33, 35, 37, 39, 40, 45, 46] [INT07, INT13]

- **Photographs relating to incidents** [INT03]

- **Policies and procedures** [37, 39, 47] [INT06, INT10]

- **Practitioners' expertise** [INT01, INT02, INT04, INT13] [30, 31], although this is highly dependent on their qualifications and experience [INT09]

- **Process/outcome evaluations of OSH interventions** [48] [INT02, INT04, INT11]

- **Publications from professional bodies and employee associations** [INT07, INT12]

- **Regulations and regulatory standards** [34, 38, 45, 49] [INT06, INT11]

- **Research findings** (e.g. peer-reviewed papers in academic journals) [INT02, INT04, INT06, INT07, INT09, INT10, INT12] [30, 31, 41, 42, 44, 47-56]

- **Tacit knowledge / worker experiences** [31, 33, 34, 46] [INT01]

- **Tools based on scientific evidence** (e.g. exposure limits, evidence-based guidelines) [51, 55]

- **Workforce consultation** (e.g. surveys and interviews) [INT01, INT03, INT04, INT07, INT08, INT10, INT12] ([13]cited in [46]) [33, 46].

Survey respondents from both academic and non-academic backgrounds considered evidence to be high-quality when it had been peer-reviewed (n=54, 78%) or had its quality formally assessed (n=43, 62%). However, one study in the REA reported that under half of the respondents in a survey of OSH knowledge users in Canada felt they had the skills to critically appraise the methodological quality and reliability of research; many were self-directed when finding and assessing evidence for their jobs [49]. Interviewees perceived evidence as higher quality than practitioner experience or anecdotal information when produced using rigorous research methods or peer-reviewed [INT01, INT02, INT08, INT10, INT11]. Nonetheless, practitioner experiences were still seen as potentially valuable ('sometimes listening to people who have lived through these issues in workplaces can be […] helpful' [INT01]). However, many urged caution to avoid 'hearsay' [INT03], which they did not deem to be evidence. The most prominent factor reported when considering the quality of evidence was its source (n=69, 87%), with interviewees mentioning that it must be from a reputable, trustworthy and 'reliable' [INT11] source to be considered better quality.

The following section (Section 3.2) discusses the actors and agencies involved in producing and sharing different evidence types. The REA identified various channels of evidence communication, and the survey asked respondents to select which ones they use for sharing evidence (Figure 3). The most popular channel was face-to-face (data from survey). We found no clear typology of what

was considered an evidence type versus a communication channel, perhaps because this differs depending on the actors and agencies involved and potential overlaps between them. For example, the REA and interviews identified 'guidelines' as an evidence type according to the perspective of the workers who use them. However, they may also be considered a communication channel by the guideline's authors, who used other evidence types to

create them. One interviewee distinguished between internally and externally produced evidence types [INT06]. Another interviewee mentioned 'reactive' and 'proactive' evidence [INT13], e.g. evidence collected in response to an incident versus evidence routinely collected before an incident occurs. This highlights the complexity and ambiguity surrounding definitions of evidence in OSH, with evidence meaning different things to different audiences.

Figure 3. Channels used for evidence sharing

Number of responses (N=60)
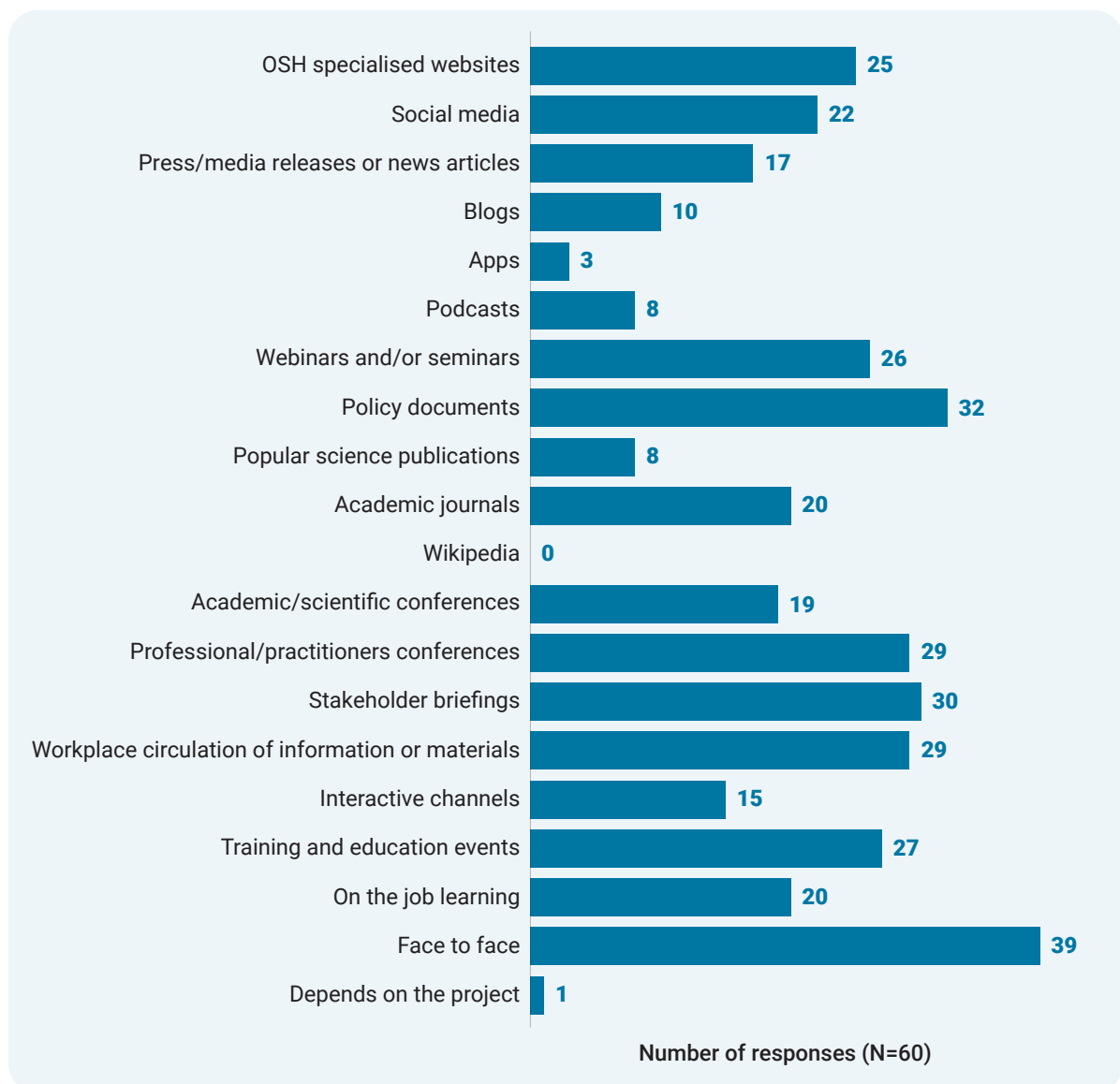
3.2. Actors and agencies involved in producing, sharing, translating and using evidence (RQ2 & RQ4)

3.2.1. The lifecycle of evidence

We developed a structural model to describe the OSH-related evidence ecosystem based on synthesised data from the REA, primary and secondary interviews and surveys. This ecosystem contains multiple actors interacting with each other in what we call the *lifecycle of evidence*, referring to the production, sharing and use of evidence:

- **Evidence production:** usually refers to generating novel information, e.g. conducting a research study to test an intervention's effectiveness, or collecting and analysing primary data, such as incident reports.

- **Evidence synthesis and sharing:** any process of evidence dissemination, including delivering training, writing a manual, printing a poster, or publishing a journal article. Sharing also includes knowledge transfer and translation processes, i.e. actions that communicate evidence in ways that are attuned to the end-users' needs. Common translation types include re-writing academic findings into local lay language or presenting data as visual infographics.

- **Evidence-use:** the different ways evidence can be implemented at an operational or systems level, e.g. to inform decision making (explored further in section 3.2.).

Although reported as distinct categories for clarity, note that production, sharing and use are interdependent processes.

3.2.2. The structure of the evidence ecosystem

Multiple actors are involved in the evidence lifecycle; while some participate in only one lifecycle phase, others engage in multiple stages. Our survey found that 76% of respondents (n=54) were involved in all lifecycle aspects: evidence production, sharing and use. The dynamic interplay between actors and their involvement with the evidence lifecycle involves multiple components, forces and processes, as illustrated in Figure 4.

Figure 4 illustrates the main actors and their interrelationships in a typical evidence ecosystem. We have grouped the actors into four broad categories, summarised here and discussed in more detail in the following paragraphs. They are as follows:

- At the base of the ecosystem (in blue) are the **organisations/workplaces** where workers perform their job. The ecosystem's main objective is to support the workers' safety and prevent their physical or emotional harm. Organisations can be involved in producing, sharing and using evidence, but the degree of involvement varies greatly depending on size, resources available, sector and organisation type.

- At the top of the ecosystem (in yellow) are **governments and regulatory bodies**, which set national regulations, policies and guidelines. There is high variability between countries. Alongside differences in the amount of evidence used to establish national policies are differences in how regulated OSH is at the state level, as highlighted by one interviewee [INT02]. In countries with many detailed regulations, organisations rely more on government guidance in their OSH decision
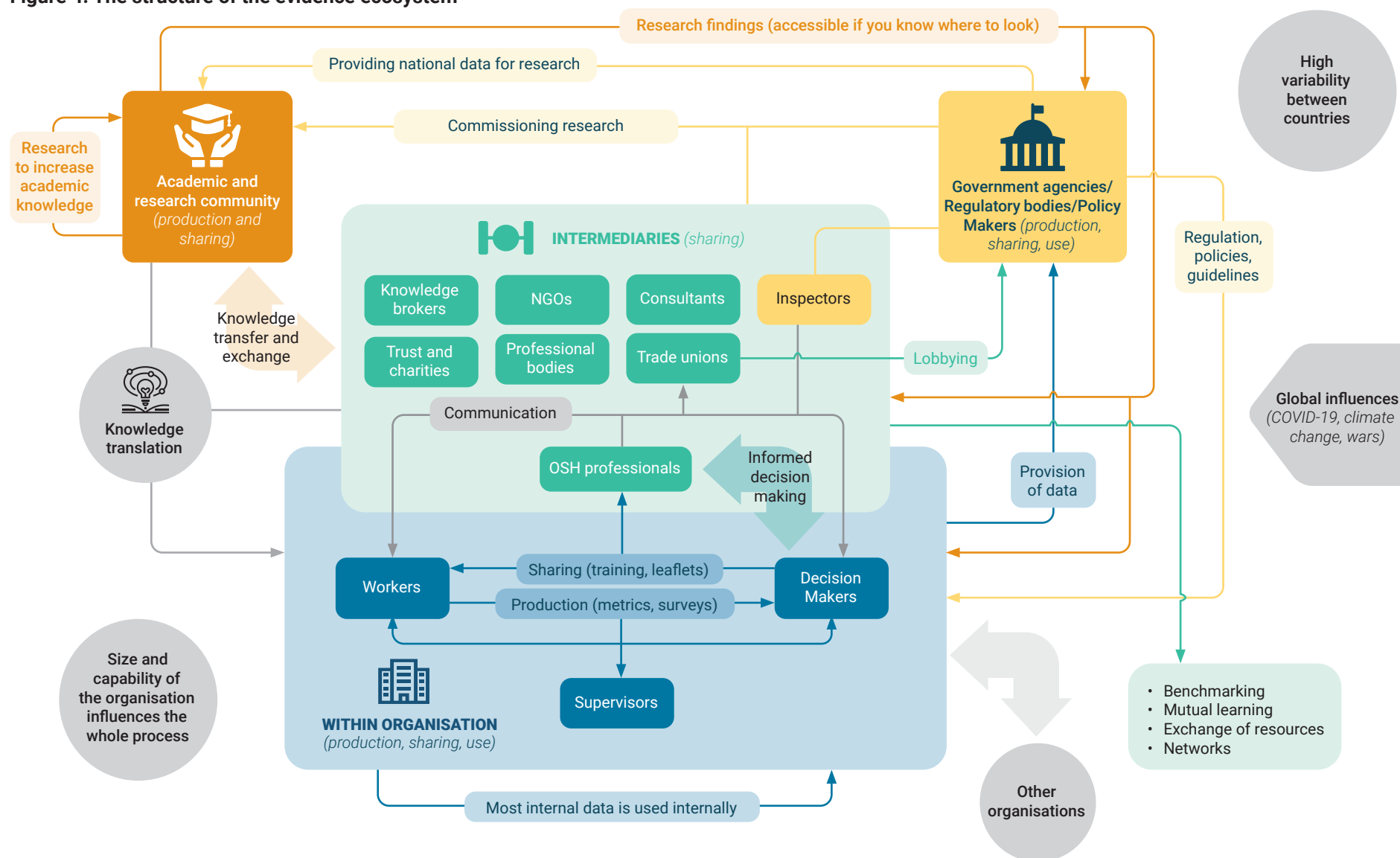
making. Conversely, in countries where OSH regulations are less developed or prominent, the organisations have a greater responsibility for independently using evidence in decision making.

- The **academic and research community** (in orange) is mainly involved in conducting research and disseminating evidence through journal articles and reports.

- Finally, **intermediary bodies** (in green) include professional bodies, charities and trade unions that support organisations in their OSH needs, e.g. by facilitating access or translating research findings into more user-friendly formats, such as educational training or infographics.

Each group of actors plays an important role in the OSH evidence ecosystem. However, different actors have varying involvement levels in each part of the ecosystem. For instance, organisations and governments may use evidence for organisational and systems-level decision making. In contrast, the research community and intermediary bodies are more likely to produce and disseminate evidence than use it for decision making, as discussed in the following section (Section 3.2).

The structural model (Figure 4) provides a generic example of the main actors and interactions within the evidence ecosystem. While not based on one country, the model is informed by interviews with respondents from predominantly high-and-middle-income countries (HMICs), meaning it may not represent low-income countries (LICs). We suggest that similar elements and relationships may be found in most countries, although they are likely constituted differently, reflecting local structures, actors and contexts. Future research could focus on mapping the ecosystem of countries, sectors or regions. As shown on the right-hand side of Figure 4, global contextual factors such as COVID-19, economic/trade flows and climate change influence the whole ecosystem. Although these factors have certainly influenced the OSH space and will continue to do so, their analysis is outside this study's scope.

Figure 4. The structure of the evidence ecosystem

Research findings (accessible if you know where to look)

Providing national data for research

Commissioning research

Research to increase academic knowledge

Academic and research community *(production and sharing)*

INTERMEDIARIES *(sharing)*

Government agencies/ Regulatory bodies/Policy Makers *(production, sharing, use)*

High variability between countries

Knowledge brokers

NGOs

Consultants

Inspectors

Regulation, policies, guidelines

Trust and charities

Professional bodies

Trade unions

Lobbying

Knowledge transfer and exchange

Knowledge translation

Communication

Global influences *(COVID-19, climate change, wars)*

OSH professionals

Informed decision making

Provision of data

Sharing (training, leaflets)

Workers

Production (metrics, surveys)

Decision Makers

Size and capability of the organisation influences the whole process

Supervisors

WITHIN ORGANISATION *(production, sharing, use)*

- Benchmarking
- Mutual learning
- Exchange of resources
- Networks

Most internal data is used internally

Other organisations

The following subsections detail how these actors interact, how they contribute to producing and sharing the evidence lifecycle and the channels through which they share evidence. Section 3.3 will then focus on the use of evidence for decision making.

3.2.3. Organisations/workplaces

Evidence production within organisations/ workplaces

Organisations create multiple data and evidence types depending on their size and sector. The most common evidence type produced is based on the analysis of performance metrics (n=38, 67% of survey respondents) and audit data (n=32, 56% of survey respondents) on safety performance and systems [37, 40, 45, 46] [secondary analysis]. Other evidence types include cultural assessment findings [40], process/ outcome evaluations of OSH interventions [48], big data and safety analytics (using data captured in sources such as Industry 4.0, the Internet of Things and the open web) [32, 40], incident investigation findings [40], data on biomarkers from biological monitoring of workers (including biomarkers of exposure and biomarkers of effect) [41] and findings on the state of existing knowledge and systems (e.g. 'knowledge network' analyses or safety analytics readiness assessments on for initial processing and modelling of safety performance) [32, 40]. Additional evidence types include the creation of tacit safety knowledge (gained through experience) within the workforce and its conversion to explicit forms of knowledge [33, 46] and the collection of 'real world' insights to directly inform decision making. Examples include stakeholder workshops, steering committees, focus groups, surveys [48, 54] (n=41, 84% of survey respondents) and pilot studies [48].

Organisation/workplace evidence sharing

Internally produced evidence can be shared within an organisation/workplace and/or externally with other organisations/workplaces.

Sharing internal evidence within organisations or workplaces

According to the survey and secondary interviews, organisations rarely share internally produced evidence externally. However, there are some exceptions. For example, organisational data are reported to regulators and added to national safety databases in some countries [INT06]. Otherwise, internally produced evidence is mainly shared internally to inform that organisation's decision making [INT02]. Common ways to analyse internal data include creating predictive models [32, 40] and dashboards/apps for leaders to access real-time data [25, 31].

Organisations internally share evidence in multiple ways. Examples include educational channels, such as training sessions and taught courses [secondary interviews] [INT01, INT02, INT03, INT06, INT07, INT08, INT13] [31, 33, 34, 38-40, 42, 46, 49, 56, 57] (n=31, 52% of survey respondents are involved in such activities), and printed materials such as posters and manuals [INT02] [56, 57]. These are provided by the workplace or obtainable through intermediary bodies, as exemplified in a secondary interview referring to COVID-19 workplace safety guidelines:

> 'The majority [of the COVID guidance] is led by [external provider], so, for example, our lead doctor has done conference calls to health and safety leads, the senior team, so they have been giving them the information and going through statistical data, recommendations, government guidelines. So, the majority has come from [external provider], but there have been points where stuff like posters and

briefings independent contractors have done that for their workers.' [Secondary interviews: Construction 14B]

Organisations also internally share evidence on safety practices through conversations, on-the-job examples, socialising and networking [INT01, INT04, INT07, INT10] [42, 46, 49, 54, 56, 57].

Sharing internal evidence outside of organisations/workplaces

Organisations can share internal data via benchmarking exercises,[1] which compare one organisation's safety performance to other organisations' performances [37, 39] (n=33, 67% of survey respondents). Outputs from benchmarking exercises are shared in various formats, including benchmarking reports [31], newsletters, web forums, e-databases and/or electronic documents [26]. As one interviewee mentioned, regulators can also conduct benchmarking when inspecting organisations:

> 'We [inspectors] might go out and, you know, look at, you know, how are we gonna have a problem in this sector? We might do a pilot. A number of pilot inspections, what we call benchmarking visits, and we can look at the standards of control and compliance within that sector. But we do two different things really, we do national targeting towards high-risk sectors, so industry sectors where we know we've got high incidences of ill health or accidents […] But we also look locally looking at companies with poor enforcement records and looking at companies that have had accidents as well so, you know, we can do the national interventions based on sectors, but we can also do local

interventions based on local intelligence about companies.' [INT06]

Benchmarking is only one way that organisations interact with one another; they also share resources via networks and alliances [42, 46, 49, 54, 56, 57] [secondary interviews], although these are often facilitated by intermediary bodies [41, 42, 44, 56, 57] [INT08]. Such resource exchanges are particularly beneficial for smaller enterprises, which often struggle to access evidence. It is not uncommon for larger organisations to share resources with smaller ones, e.g. manuals and Standard Operating Procedures [46, 57] [INT08, INT10].

3.2.4. Governments and regulatory bodies

Evidence production within government and regulatory bodies

Governments and regulatory bodies may collect and gather national-level data through censuses, household surveys, administrative records and safety databases [31, 34, 36-38, 40, 44]. There is high inter-country variability in the types and quantities of collected data. In the UK, the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR) mandate organisations to report injuries and fatalities occurring in the workplace [37]. However, there may be instances where incidents are underreported, or safety data is not collected. As one interviewee highlighted, 'Not many countries tend to report those figures or some, or sometimes you, you just see, you know, like the tip of the iceberg because, due to underreporting practices from governments and businesses' [INT05]. Another way governments are involved in producing evidence is by commissioning research to inform policy [INT06].

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1   The European Agency for Safety and Health at Work (EU-OSHA) defines benchmarking as 'a planned process by which an organisation compares its health and safety processes and performance with others to learn how to reduce accidents and ill health, improve compliance with health and safety law and/or cut compliance costs' [37].

Evidence sharing by government and regulatory bodies

The degree to which regulatory bodies are involved in disseminating evidence-based advice and guidance varies internationally [INT02, INT03, INT05, INT06, INT08, INT09]. In the UK, the Health and Safety Executive (HSE) takes a proactive approach, providing advice that is easy to access, understand and implement for a wide range of audiences; the HSE website is the main portal for health and safety guidance [31, 38]. However, even if the evidence is available on governmental websites, organisations may not always know where to look, as one interview highlighted:

> 'We [regulatory agency] are trying to target and target the companies where we're likely to find problems and you know, it's often the case where these might be SMEs, small-and-medium-sized enterprises that you may not have much competence in-house and may not come to the [agency] website for their information. They might look elsewhere. They might look to trade associations or trade publications or their suppliers for information on the processes that they operate and the risks that they have and how to control those risks. They might look to social media, but they're not often coming to [agency] website. [...] some very basic problems could be avoided by [looking at the website]' [INT06]

3.2.5. Academic and research community

Evidence production in the academic and research community

The academic and research community is predominantly involved in producing evidence via research findings [31, 33, 37, 42, 44, 48-53], typically as key actors conducting research or evidence gathering [37, 52] [INT01, INT04, IN05, IN10, INT12] or being a research participant [31, 33, 49]. Of the 23 participants in our survey who were OSH researchers (27%), 11 conducted primary research (e.g. randomised controlled trials, qualitative research), 14 conducted secondary research (e.g. analysis of existing data, literature reviews), 7 conducted citizen science (performing or managing research-related tasks such as observation, measurement, or analysis as part of a personal or professional network) and 1 conducted horizon scanning (a method for exploring potential futures to better understand uncertainty).

Evidence sharing by the academic and research community

Research findings are at the intersection between evidence production and sharing: research is conducted to produce new information that can be shared by writing and publishing journal articles [42, 44, 48-50, 53], technical or research reports [42, 48, 50] or chapters in edited books [42, 50]. Academics may also be involved in steering groups or advisory boards [42] [INT01, INT05, INT10]. Research outputs are usually available to anyone who knows how to find them, with some restrictions (such as access fees). The main barrier to sharing research findings highlighted by interviewees relates to the language and style of academic writing, which can sometimes be difficult for end users to understand and translate into action [INT04, INT10, INT12]:

> 'Researchers are used and trained to publish, to write things according to the scientific method, right, and in a language which is extremely specific, which might not be understood by non-academia' [INT10]

Therefore, translating research findings into more accessible language for broader audiences in the OSH field may help optimise their practical use [34, 49] [54] and inform the development of evidence-based guidelines or other tools/educational materials [34, 41-43, 47,

50, 53]. Knowledge broker groups may complete this work, e.g. the Institute for Work and Health (IWH) in Canada [54] or the practice-based research network for occupational safety and health (PBRN-OSH) in Sweden [42].

> 'Making sure that the information is communicated in a very clear way, because again, you know we do have a bit of an issue in the social sciences, I think with impenetrable language sometimes.' [INT12]

As was evident in the literature and interviews, academic researchers in OSH are often involved in the knowledge transfer and exchange process [54, 56], supporting end users to understand relevant evidence and implement it in practice. Furthermore, what Van Eerd and Saunders (2017) [54] described as integrated knowledge transfer and exchange is a mutual learning exercise between OSH researchers and knowledge users. Thanks to their 'on-the-ground' experience, knowledge users such as OSH professionals, stakeholders and workers can help researchers identify research priorities by identifying gaps and evidence needs. Knowledge users can also help researchers adapt the language of their research to make it more accessible for end users. Conversely, researchers can help OSH professionals better understand research outputs and critically appraise the quality and trustworthiness of available evidence:

> 'The research process, as itself an exchange, it's not just sort of the researchers working away on their own, and then at the end they come up with something and they tell, you know, the stakeholders 'this is what we found'. Rather it's a process of dialogue. [...] we already talked a bit about how the importance of, in any particular research project, engaging stakeholders, if possible, at multiple times over the course of the project, like early on as you develop the specific research questions as well as midway course check

as well as towards the end when you have findings and so on.' [INT01]

3.2.6. Intermediary bodies

Intermediary bodies are involved in supporting organisations in meeting their OSH needs by providing evidence translation, networking, resource sharing and signposting [41, 44, 56, 57]. Some intermediary bodies are involved in evidence production, e.g. collecting and analysing data or participating in research. However, intermediary bodies' main contribution is in evidence sharing:

> 'I would say that the biggest influence by far is through intermediaries, and that can be worker representatives, as well as employer representatives and organisations that provide professional services to workplaces around occupational health and safety. As well as, of course, government policymakers.' [INT01]

Many intermediary bodies and researchers are dedicated to ensuring workers receive safety information in a useful and understandable format [34, 41-43, 47, 50, 53, 54] [secondary interviews] [INT08]. One interviewee [INT01] discussed the importance of tailoring safety training to the attendees' capabilities, possibly integrating literacy and numeracy education into safety training in some cases. For example, an inability to efficiently calculate the maximum load onto a machine can constitute an occupational risk in many professional roles. Indeed, another interview reported the case of a fishing trawler that sank off the coast of New Zealand because the crew exceeded the maximum cargo by more than 20 tonnes [interviewee number not presented for anonymity].

Types of intermediary bodies

NGOs, professional bodies and charities
Intermediary organisations such as non-governmental organisations (NGOs),

professional bodies and charities serve as communication channels between the government, organisations and individuals [57] [INT03, INT04, INT08]. Their role can vary from translating information into local languages to working with the government to improve regulations. They utilise multiple channels to share evidence, including websites, conferences, e-mail, magazines, newsletters, technical journals and through the provision of workplace safety and health training and educational materials, such as fact sheets, brochures and safety manuals [56, 57].

Knowledge brokers

Knowledge brokers are individuals or organisations that connect evidence producers with end users [56] [INT01, INT02, INT04, INT08, INT10]. They are involved in disseminating and translating evidence and creating networks that bring people together by building relationships and sharing ideas and evidence to help stakeholders 'do their jobs better' [56].

Trade unions and workers' representatives

The role and influence of trade unions vary greatly by country [55]. In countries like the UK, 'there's a requirement for employers to talk to trade union employees and safety representatives regarding occupational health and safety arrangements' [INT07]. In other countries, trade unions might not be present or not cover all sectors or workers. For example, one interviewee highlighted that precarious workers rarely have representation [INT12].

If present, trade unions act as an intermediary between workers and government and between employers and employees. Trade unions can lobby for improvements and better regulations in the interaction between workers and government, providing representation and circulating communications to and from the workers. Tensions can arise in employer-employee communication and trade unions can support organisational improvement [31].

Inspectors

The roles of inspectors, governments and intermediary bodies also vary between countries [36]. In some countries, inspectors are part of governmental agencies, e.g. the HSE in the UK, the Argentinian Work Risks Authority (Superintendencia de Riesgos de Trabajo), Safe Work Australia and the Irish Health and Safety Authority [36]. Such agencies use evidence from audits and inspections to check that risk management controls are implemented, properly resourced and reviewed in line with regulatory requirements [35, 38, 42]. Inspectors investigate safety risks and concerns by visiting workplaces, talking to employees, managers and trade unions and looking at performance metrics, national data and benchmarking outputs [INT06]. They can provide information, guidance and signposting to support organisations in meeting safety standards. Depending on the country, they might also have the power to halt work, fine managers and even close businesses [INT06]. Inspectors have a critical role in the evidence ecosystem, but government interventions in the workplace are not as prevalent in some countries.

Insurance companies

Insurance companies gather and collect records and data on safety performance which can be used by other intermediary bodies, governments and researchers [36, 40] [secondary interviews]. In some countries, insurance companies also fund intermediary bodies to introduce programmes and interventions designed to reduce insurance claims [INT01, INT08]. As one interviewee noted, insurance companies' involvement in these cases can prompt intermediary bodies to prove their interventions' effectiveness:

'Because we're funded by the national insurer, for a lot of our programmes, we're actually required by them to prove that we've had an impact. So, they call it the return on investment. So, at the end of the

day, they're an insurance company, and for every dollar they give us, we have to provide evidence that we've provided at least $1.80 in terms of claims reduction back to them.' [INT08]

Evidence sharing by intermediary bodies

Knowledge translation

One of the main contributions of intermediary bodies is connecting organisations with evidence in a knowledge transfer and exchange process [42, 54]. Often going beyond straightforward signposting, this process may entail translation (into other languages or from academic to lay language), re-writing or re-shaping information so that the evidence's language and format are more understandable for end users [34, 49, 54]. Knowledge translation plays a vital role in the evidence ecosystem because research outputs are often presented in difficult forms for end users to engage with and implement [INT10, INT12]. The process entails transforming evidence into evidence-based guidelines or other tools/educational materials, such as infographics [34, 41-43, 47, 50, 53]. The argument for evidence translation is that evidence must be tailored to end-users' needs and capabilities to be effective:

> 'Sometimes we're trying to have like more novel practices because we also know that different generations require different approaches. So you know, when it comes to producing like videos or podcasts or different sources of content, you know, like data visualisation as well, infographics, those kind of things because I mean it's still difficult that when we produce like a consultation response of like 10 to 12 pages, quite technical and niche you know like even like OSH members or members of the public might not be able to go through that' [INT05]

Networking

Intermediary bodies are also involved in creating organisation and stakeholder networks that share evidence [37, 39, 42, 46, 49, 54, 56, 57] [INT08], of which there are multiple types. Examples include (i) peer networks and communities of practice, which involve an exchange of knowledge amongst evidence users and collaboration to improve practice [49, 54, 56]; support networks for SMEs [46, 57] [INT08]; (ii) alliances between regulatory agencies and a range of other organisations (such as the OSHA Alliance Program), which bring together regulatory agencies with unions, trade and professional organisations, faith-and-community-based organisations, businesses and educational institutions to 'leverage resources and expertise to help raise awareness of OSHA's rulemaking and enforcement initiatives, promote both outreach and communication, and foster education and training efforts' [42]; and (iii) practice-based research networks, e.g. the Swedish PBRN-OSH program designed to bridge the gap between OSH research and practice [24]. One interviewee working for a charity also mentioned how their charity collaborates with existing workers' associations to disseminate information [INT08]:

> 'We also work with a lot of the associations that the small companies are members of, say for example, in [country] we might have registered master builders or certified electricians or master plumbers, for example and we'll work with those organisations to try and get the messages to their members. So that's a good strategy for us; rather than trying to invite them to our own channels, we actually link up with the people who already have channels.' [INT08]

3.3. How are decisions informed and what role does evidence play in this process? (RQ3)

3.3.1. Roles within organisations/ workplaces that impact decision making

Decision makers and senior management

Many organisations include people responsible for the workers' safety. This report refers to such individuals as 'decision makers', but who they are will vary depending on the organisation. In most cases, the organisation's senior members are ultimately responsible for OSH, as evident in survey answers (Figure 5) that refer to owners, leaders, CEOs or any senior management [37, 39, 46, 48]. These actors are often responsible for sharing and communicating evidence and using it to make decisions.

Figure 5. Who are the OSH decision makers within organisations?

Perceived decision making power:

- Main decision makers
- Key influencers
- Not involved/there is no one in this role
- I don't know

Supervisors

A few interviewees highlighted supervisors as key influencers in determining the safety culture[2] and are consequential for an organisation's safety performance [INT02, INT09] [secondary interviews] [30]. One interviewee discussed the importance of investing in leadership training for supervisors, explaining that while they might have technical skills, 'they're not given the sort of management skills that you'd expect around leadership, pastoral care, planning, dealing with conflict, all those good things that actually make them good leaders' [INT08]. Arguably, better OSH leadership would improve overall performance and safety. Another interviewee – an OSH practitioner – discussed the importance of involving supervisors and frontline workers in writing operational processes and manuals since they have the necessary on-the-job knowledge and experience:

> 'So, in the ideal world, I'd actually get frontline people and supervisors to write the operational processes. So, if that's done, it tells me that the frontline own the processes and I'll reflect the dynamic operation of the business. If the procedures are written at head office and sent to the business sent to the operating units and that tells me I have a problem and it's one of the things I correct.' [INT02]

Bridging the gap between decision makers and workers, these actors are often involved in producing, sharing and using evidence within OSH.

Other employees/staff in general

Worker/employee engagement is an important contributor to an organisation's safety culture [31, 36, 37, 41, 42, 44, 46, 48, 54, 55] [secondary interviews]. As Figure 5 shows, 62% of survey respondents considered employees to be key influencers of OSH-related decisions. Staff engagement can come from conducting or attending safety training and providing reports on safety incidents [secondary interviews] [35, 40, 45, 46] [INT03, INT07, INT13]. Organisations also commonly gather employees' opinions via surveys, interviews, forums or focus groups [secondary interviews] [48, 54] [INT08, INT09, INT10]. Often, organisations conduct staff surveys to gather employee feedback on specific issues, with some organisations repeating the same questionnaire annually to track changes over time [secondary interviews]. As quoted above, staff engagement can also involve co-producing standard operating procedures and manuals [INT02]. Therefore, workers are often involved in producing and using evidence (e.g. following evidence-based guidelines or manuals) but may not be aware that these are *informed* by evidence.

OSH professionals, practitioners and consultants

Although OSH professionals, practitioners and consultants often share and use evidence [39, 40, 49], they are not always part of workplace implementation. Depending on the size and resources allocated to safety, some organisations will employ full-time OSH experts to support OSH management and decision making. Others might not have the resources to assign staff to OSH [46] [INT04, INT07, INT08]. Some organisations might also hire external consultants for the same purpose, as one interviewee mentioned:

> 'The size of the organisation I think is the biggest factor [...] Some organisations that are small, there would be a person

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2   'Safety culture' encompasses psychological aspects (i.e. how people feel), behavioural aspects (i.e. what people do) and situational aspects (i.e. 'what the organisation has') [14, 58].

who, let's say, wears multiple hats and may be the decision maker, but may also be somebody who is working in that field. What we've seen over time is that workers don't often have the opportunity to take that much decision-making latitude in their workplaces. So, we do tend to see that it's occupational health and safety professionals if they have a designation. Consultants from outside the workplace fit into that as well. And we've been increasingly targeting those as independent decision makers, so to speak.' [INT04]

If present, an OSH professional has the important role of advising and supporting the decision makers by running risk assessments, seeking up-to-date evidence and operationalising evidence to support its implementation.

> 'I never produce evidence to the business from outside research. That's my job [as a practitioner] to take it, interpret, and put it in a business. At times, if there's an interesting paper around something similar to what we're doing, then I'd

share that. It's kind of more for me to be updated and to keep up to date on what's happening and then distil that learning that I get into the business that way.' [INT02]

The presence of OSH professionals can save decision makers valuable time and help them make informed decisions, which is particularly important when the decision makers are not OSH experts [INT02, INT03, INT04]. OSH professionals, practitioners and consultants can also be considered an intermediary body if they are external to an organisation and brought in to help with its OSH aspects.

3.2.3. Process of decision making

It is useful to consider the processes involved in using evidence for OSH, particularly in distinguishing between operational and systems-level OSH and the roles different evidence types play. To illustrate this, the research team developed a process model (Figure 6). The model incorporates three main components: (i) a local improvement cycle, (ii) a system-level cycle and (iii) the different evidence types involved.

Figure 6. A process model of the relationships between evidence, occupational safety and health systems and local improvement
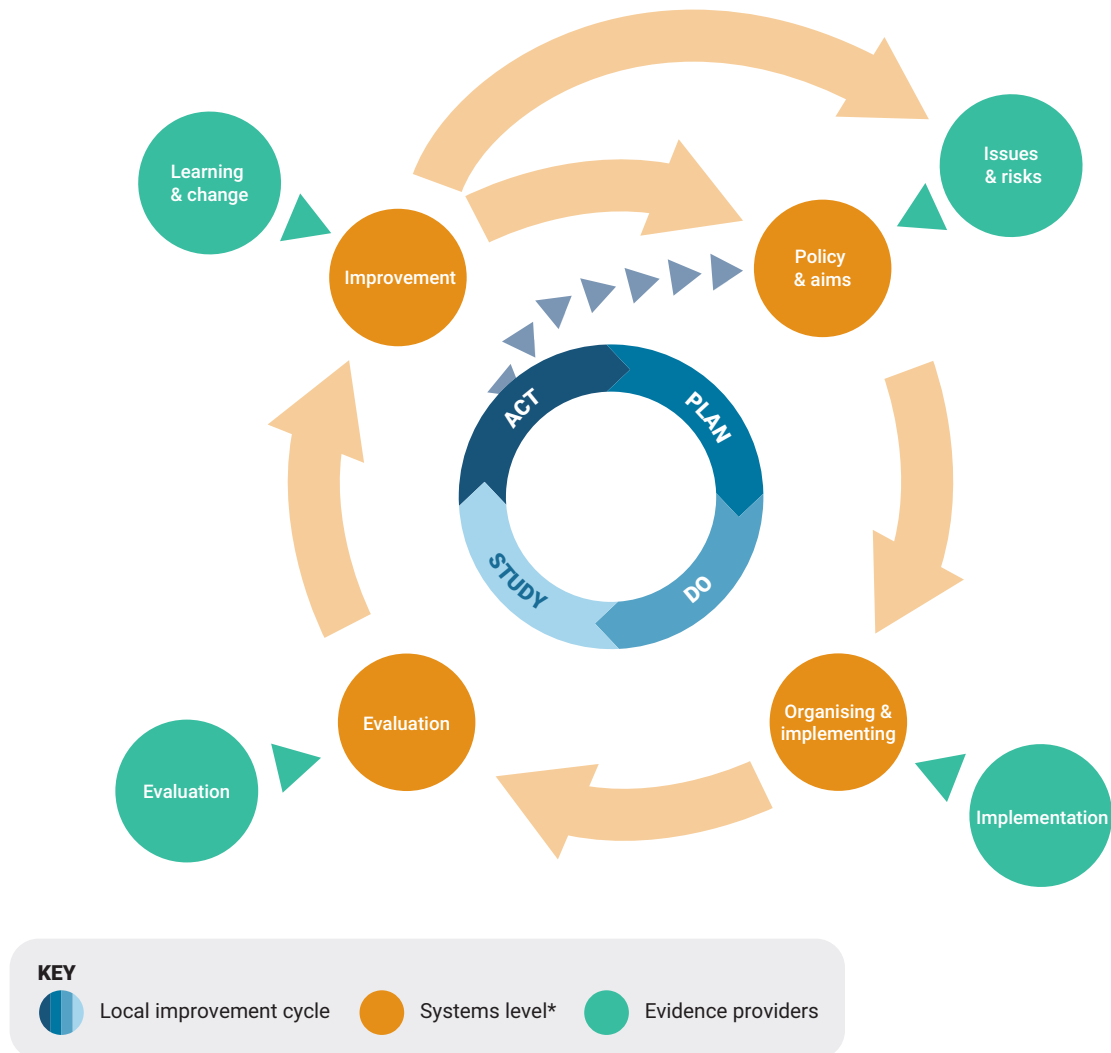
*Adapted from the ILO OSH management system

The innermost cycle (shades of blue) represents a local improvement cycle, also known as the plan-do-study-act or Deming cycle [12]. This cycle describes a widely used model for operational improvement, involving four stages: (i) **planning** how to address an issue, (ii) **doing** through implementing changes (ideally in a pilot format), (iii) **studying** the action's impact and effects and (iv) **acting** to widely implement the solution (adapted based on study stage).

The middle cycle (in orange) represents the system level. It is based on the ILO's management system for OSH [13] (Box 1) and adapted to merge the organising and implementing stages to highlight commonalities with the local improvement cycle. This illustrates an overall process of identifying issues for policy and regulation, putting strategies in place to address them, evaluating them and adapting them through ongoing improvement mechanisms.

Box 1. Steps in the International Labour Organisation model of OSH management system approach [13]

- **Policy writing**: determining requirements for sufficient resources; defining management commitment; stating OSH targets

- **Organising**: determining organisational structure, responsibility and accountability, communication, documentation and definition of competencies and training requirements

- **Planning and implementation**: initial review of OSH performance, developing and implementing approaches to hazard identification and risk management, setting goals and objectives to drive OSH performance and measure progress, and arrangements for contingencies and emergencies

- **Evaluation**: measuring and assessing OSH management system performance, determining reporting processes, and investigating accidents and incidents; internal and external audit processes

- **Action for improvement**: corrective and preventive actions and arrangements to ensure continual system improvement – taking into account all data acquired under each element of the system and comparisons with other organisations.

The outer cycle (in green) illustrates the contribution of different evidence types at various stages of these cycles. During planning (of the operational cycle) or setting policy (at the system level), evidence about issues and risks is likely to be particularly relevant. In contrast, in the doing and implementing stages, evidence about processes of implementation and change will be pertinent.

This model represents an abstraction of the complex, interacting and dynamic systems through which OSH-related action is taken. The different levels of this model interact with the improvement and OSH-management processes, generating data and evidence for each other and evidence producers. However, these different stages may not occur in a clear sequence or manifest at all (e.g. decisions taken but not implemented, or implementation that is not evaluated). The model intends to draw out the different contributions of evidence related to different action stages when they occur, as described in more detail below.

3.3.3. How evidence is used at the local improvement-cycle level for decision making

At a local level, evidence is used in a plan-do-study-act improvement cycle. Interviewees commonly report that trigger events – often an incident or inspection – act as catalysts, highlighting a problem requiring an OSH decision [INT01, INT03, INT06, INT11, INT13]. In response, senior managers and/or OSH professionals often create action plans to address the problem and future risk, which may include changes to procedures/policies, training and practice [INT01, INT02, INT03, INT11, INT13]. In theory, these action plans are then implemented. However, companies rarely formally check that their action plans are implemented correctly or have achieved a positive impact [INT04, INT11, INT13]. If checked at all, it is likely via informal conversations about 'how things are going' [INT07]. In contrast, academic researchers and those required to demonstrate value for money are better at formally evaluating interventions [INT01, INT02, INT08]. In both instances,

however, decisions are often only checked in the short term [INT01, INT11, INT13] – unless a repeat inspection is required [INT06]. Most local-level evidence came from interviews rather than from articles included in the REA, whereas the REA articles more frequently discussed the broader systems level.

3.3.4. How evidence is used at the systems level for decision making

At the systems level, evidence is used in four main ways: (i) policy and aims, (ii) organising and implementing, (iii) evaluation and (iv) improvement (see Box 1 above), as detailed below.

Policy and aims

Our study identified three main ways evidence is used for policy:

i.   Informing workplace policy (including changes to overarching organisational OSH policy and more specific policies, such as those relating to training) [36, 39, 49] [INT02, INT07] and national policy development [36, 38, 44, 55] [31] [INT06]

ii. Informing resource allocation for OSH management [32, 35, 39]

iii. For strategic and operational decision making by corporate partners to inform financial and supply-chain decisions [35] [INT02].

Overall, 61% of survey respondents stated that they use OSH evidence to inform policy development (36 of 59). The main evidence types used to inform policy include (i) benchmarking reports, e.g. standardised evidence-based research products, including colour-coded scores, based on validated measures relating to organisational policy and practices (developed by researchers with input from OHS practitioners and workplace parties) [39]), (ii) expert input (e.g. experts attending board meetings, academic collaborations)

[30], (iii) workforce consultation findings ([13] cited in [46]), (iv) evidence from collaborative information exchanges/policy networks and workshops [44], (v) government OSH statistics [36], (vi) news or publicly available information on major OSH incidents [31] and (vii) research findings [30, 41, 44, 47, 54]. While the use of research findings to inform the development of organisational OSH policies is inconsistent [49], research findings and government OSH statistics are often used to inform the development of national OSH policy and legislation [36, 38, 44, 55]. MacEachen et al. (2016) note that while policy development is typically driven by 'standard processes involving research and expert knowledge', it can also reflect other factors, such as shock effects relating to major accidents [31].
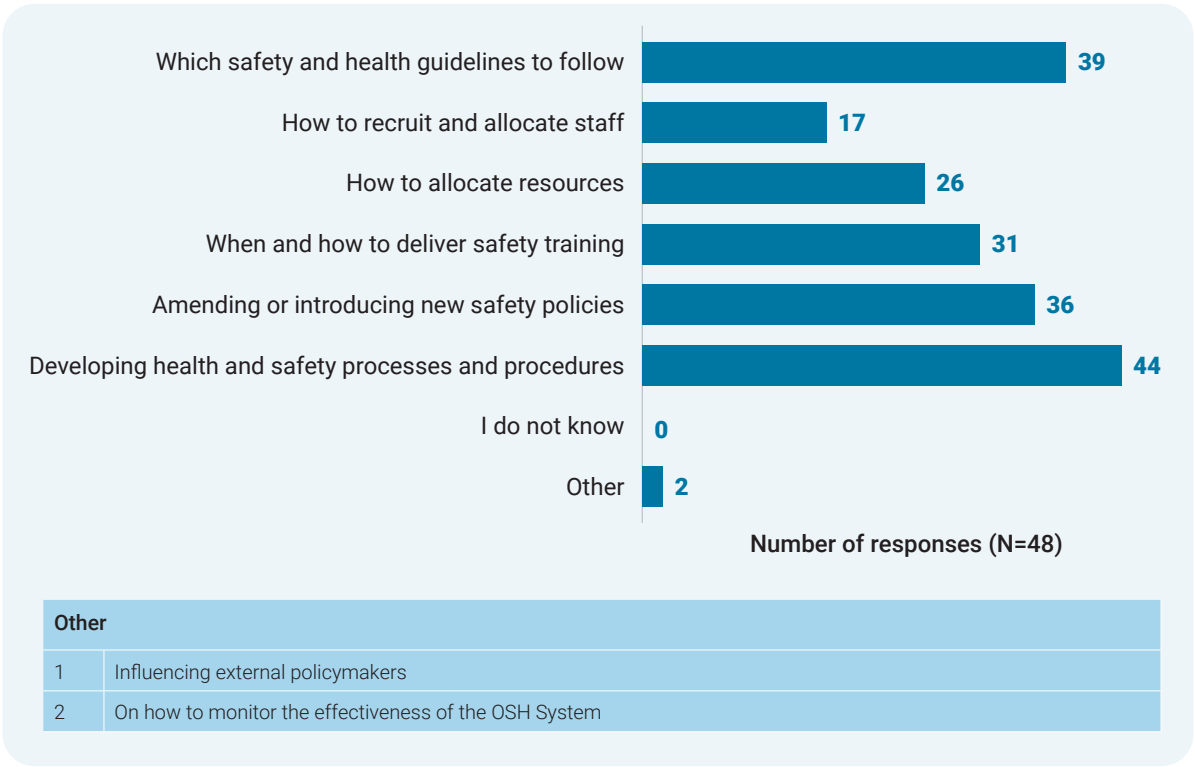
Organising and implementing

Our study identified seven main ways evidence is used for the organising stage of OSH management:

i.   Informing improvement of recording and monitoring practices (e.g. tracking injuries and lost work time) [39] [INT02, INT08]

ii. Supporting communication (e.g. facilitating discussions with leadership and members of health and safety committees and raising awareness across the whole organisation) [39]

iii. Developing a safety culture [49] [INT08]

iv. Informing training development and provision [33, 49] [INT03]

v.   Informing recruitment strategies to prioritise safety [40]

vi. Informing regulatory approaches and intervention strategies [38]

vii. Identifying priority focus areas and planning preventive measures [36] [INT01, INT04].

Three-quarters of survey respondents (44 out of 59) stated that they use OSH evidence to inform the development of organisational processes supporting OSH (e.g. for recording, monitoring and recruitment). The main evidence types used include research findings (peer-reviewed journal articles, non-peer-reviewed sources, electronic databases, 'credible' websites, material shared through peer networks) [49] [38], benchmarking reports [39], internal consultation findings (e.g. training-needs assessment findings) [33, 46], tacit knowledge and worker experiences [33, 46] and

data from regulator-led stakeholder workshops [38]. The survey results suggest that the three most frequent decision types that respondents made concerned (i) developing health and safety processes and procedures (n=44, 92%), (ii) determining which safety and health guidelines to follow (n=39, 81%) and (iii) amending and introducing new policies (n=36, 75%) (Figure 7). Senior organisation members generally make these decisions, though sometimes with professional OSH expertise and employee consultation.

Figure 7. Types of OSH decisions taken by decision makers

Other	
1	Influencing external policymakers
2	On how to monitor the effectiveness of the OSH System

Our study identified 12 ways evidence is used for implementation:

i.   Understanding baseline OSH performance and confirming areas for improvement (e.g. what needs to be changed and how by assessing workplace safety and security) [36] [INT3]

ii.   Using benchmarking to compare performance across organisations to better understand areas for improvement [39] [INT06]

iii. Understanding current knowledge-management / safety-analytics capabilities (e.g. to accommodate more advanced analytics) and informing system development [32]

iv.   Predicting future OSH performance and identifying risks and priorities [32, 40] [INT2, INT08]

v.   Identifying the hazards and health consequences of environmental and occupational exposures [35, 36, 49, 53] (e.g. building a business 'risk profile' [35])

vi.   Formulating plans to prevent or reduce OSH risk [32, 36] [INT07] (e.g. redesigning workplaces or changing operational/safety equipment or PPE [38, 47])

vii. Assessing the feasibility of different intervention strategies before taking action [49]

viii. Managing workers' exposure to hazards [55]

ix.   Informing changes in organisational processes and procedures [39, 45] [INT02]

x.   Identifying vulnerable worker groups and targeting efforts [36]

xi.   Developing occupational exposure limits [53, 55]

xii. OSH regulation development [31] [INT07].

Eighty-five per cent (50 out of 59) of our survey respondents stated that they use OSH evidence to inform the planning and implementation of OSH management systems, strategies, or interventions (e.g. identifying risks and priorities for improvement and formulating plans to reduce risk). Evidence types used for planning and implementation include (i) research findings [31, 53] (e.g. on OSH intervention effectiveness [48], implementation processes [48], biomarkers [41], exposure to hazards [55]), (ii) tools based on scientific evidence (e.g. occupational exposure limits [55], evidence-based guidelines [51]), (iii) government OSH statistics [36, 40], (iv) benchmarking reports [39], (v) big data and safety analytics [32, 40] (however, Ezerins et al. 2022 note that use of big data by organisations is 'the exception not the rule' [32]), findings from internal assessments of knowledge-management / system-readiness (e.g. 'knowledge network analysis' [40] and safety analytics readiness assessment [32]), (vi) expert guidance [31] and (vii) information on worker experiences [31].

Using scientific evidence/expertise in developing regulation can be an indirect process involving consultation between regulatory agencies and interest groups. Employers' federations tend to draw on specialists' and academics' technical and scientific expertise, while trade unions place greater value on workers' experiences. Power structures, relations and different actors' interests can influence how much scientific evidence is prioritised [31].

Evaluation

Our study identified 14 ways evidence is used in evaluation in OSH:

i.   Directly evaluating OSH management systems [30, 35]

ii. Indirectly evaluating OSH management systems via organisational culture (e.g. validated safety climate survey results) [35] [INT08]

iii. Assurance of OSH management systems to establish compliance with regulation and legislation (e.g. audits and inspections) [35, 38, 42] [41] [INT06]

iv. Justifying actions already taken [39] [secondary interview analysis]

v. Understanding the factors influencing the successful implementation of specific OSH interventions [48]

vi. Determining the success/effectiveness of specific OSH interventions [48] [41] [INT01, INT02, INT04, INT08]

vii. Monitoring employee competence and assessing the impact of training (e.g. regulation/guideline awareness and compliance or changes in knowledge/ practice) [38, 42] [INT01]

viii. Estimating the consequences of occupational accidents (e.g. lost work days, income or production) [36], which can affect compensation contingent on safety performance [40], pay [38] and company profitability [38]

ix. Identifying priority areas of focus and planning preventive measures [36]

x. Identifying vulnerable worker groups and targeting efforts [36]

xi. Developing occupational exposure limits [53, 55]

xii. Developing OSH regulation [31]

xiii. Evaluating the impacts of policies, systems and programmes implemented at the national and international level [36]

xiv. Estimating the consequences of occupational accidents and evaluating progress towards achieving international goals and targets (e.g. sustainable development goals and targets) [36].

Seventy-one per cent (42 out of 59) of survey respondents stated that they use OSH evidence to evaluate systems, strategies, or interventions (e.g. assessing their effectiveness or exploring factors influencing successful implementation). Evidence types commonly used for evaluation include internal OSH performance monitoring data [35], audit findings [46] [33] [35], internal workforce survey findings (e.g. organisational climate surveys) [35], benchmarking reports on a range of indicators [39], data from biological monitoring of workers/exposure assessments [41], findings based on data collected to evaluate specific OSH interventions (e.g. results from process/implementation evaluations and outcome evaluations) [48] and national OSH statistics [36].

Improvement

Our study identified two main ways evidence is used to inform continual improvement:

i. Informing corrective action plans to ensure continual improvement of organisational processes, procedures and practices in OSH [39, 40, 43, 45] [INT02, INT08, INT13]

ii. Enabling performance comparisons between organisations to inform learning and improvement (e.g. inter-organisational discussions and comparisons within the same sector [30, 38-40] or across different industries [30]).

The majority of survey respondents (83%, n=49) stated that they use OSH evidence to ensure continual improvement. The main evidence types used include implementation research findings [48], audit findings [39, 45, 46] and benchmarking reports [39].

3.3.5. Influences on the use of evidence for decision making at an organisational level

Stakeholder interviews and REA findings highlighted that the decision-making context is as important – and in some cases more important – as its evidence basis [INT10, INT12] [42]. Multiple stakeholders mentioned legalities and regulations as a starting point for decision making, closely followed by the business case (e.g. economics, logistics and staff) [55] [INT04, INT08, INT11]. A few stakeholders mentioned that some individuals and organisations might consider a morals/values [INT12] or cultural/social [INT10] base. The final consideration is evidence (Figure 8).

Figure 8. Indication of the priorities related to the decision-making process and the role that evidence plays
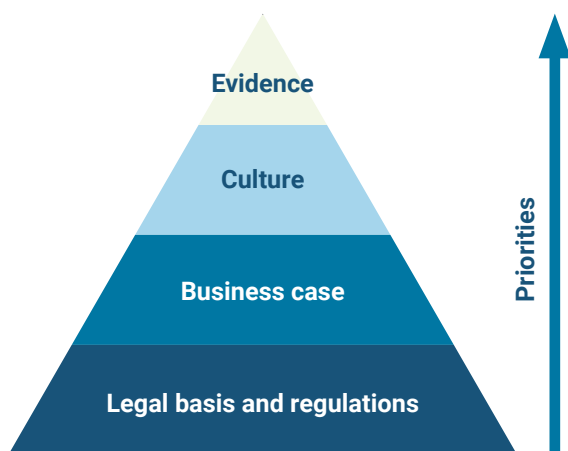
Legal basis and regulations

Regulation considerably influences OSH decision making [38] [INT13]. However, there is sometimes a lack of guidance documents

[47] or non-conclusive evidence [41] to help decision makers. The survey findings showed that legislation and regulation were most frequently used in decision making (n=38, 84%) compared to various evidence types.

There is considerable variability between countries regarding OSH regulations [INT02, INT03, INT05, INT08, INT09]. In countries like the United States and those within the European Union, the government specifies highly detailed OSH regulations, while in other countries like Australia, the organisation is responsible for writing guidelines and manuals [INT02]. Much of this information was based on interview data, and as none of the interviewees represented LMICs we cannot comment on their OSH regulations.

Business case

Many of the challenges interviewees mentioned regarded insufficient resources, including finances and staff expertise, to utilise evidence in OSH decisions [46, 48, 55] [secondary interviews] [INT04, INT06, INT11, INT12, INT13]. The REA findings suggested that subscription fees may limit access to some evidence [50] and that no single data source can fulfil all data needs. Therefore, data from multiple sources must be used [36], increasing the potential cost of accessing evidence. While respondents in the primary interviews generally regarded access to evidence as a potential problem [INT04, INT06, INT09], views on this were more mixed in the survey (Figure 9), and some of the interviewees themselves had no difficulties accessing OSH evidence [INT02, INT03, INT11].

Figure 9. "The available evidence on OSH...
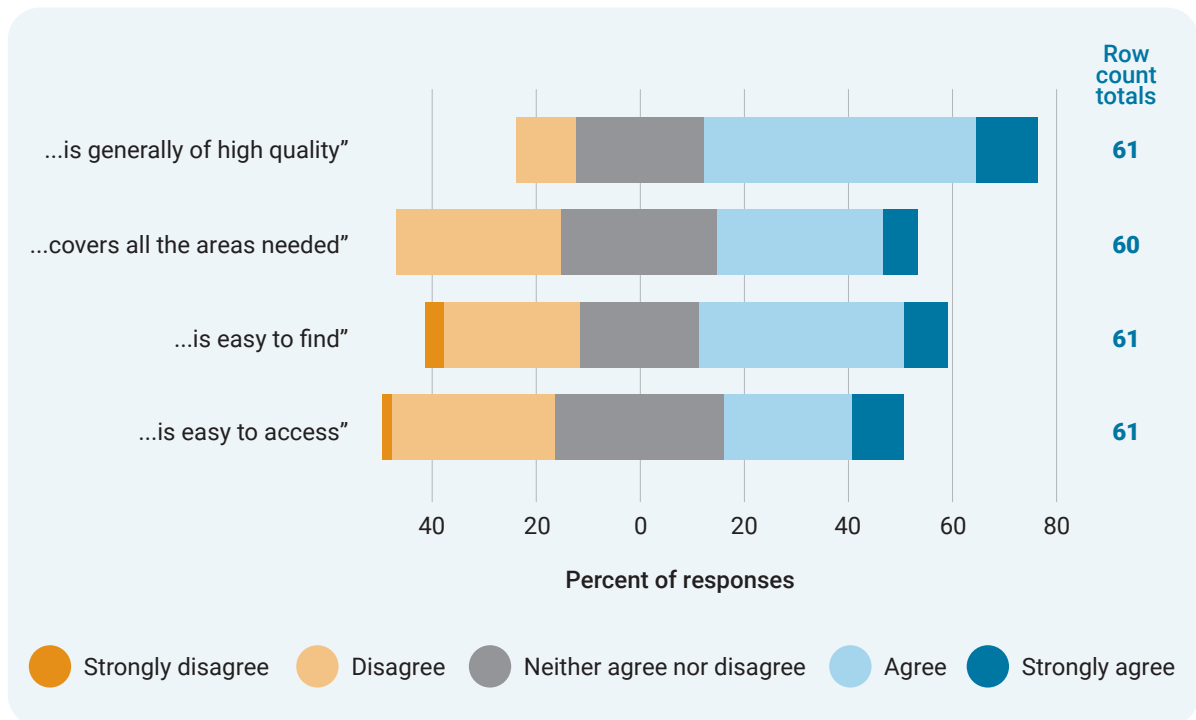
Secondary interviews highlighted that whilst evidence production highlights issues that need tackling, limited resources mean that only a proportion (the most urgent/ high priority) can be addressed:

'So, we have ten areas we look into, and they are measured every single year. In theory, there's kind of 20 in our list that we look at, but we only focus on ten of them. And the higher up the list, or the higher the risk, that's what we're looking for. It's really, we put a lot of our time in the top five, the top ten still get a look in, and then anything under that we don't divide so much of our time into it because it means that it's really low kind of risk to our business. So, things like diabetes came off our list last year because when we were looking at the GP stats and our local employment stats in terms of our age, diabetics weren't high within our company.... But our top risks are musculoskeletal, that we kind

of measure the reactive spend on that in terms of private medical insurance, how much time is spent at the GP. So, we measure those sort of stats now, and MSK year on year has always been one of our biggest spends on reactive...' [Secondary interviews: 1A, Finance Company]

Having specialist OSH staff or staff with some OSH expertise within organisations also influences the use of evidence. Where evidence is available and shows the need for improvements, managers may not always have the knowledge or expertise to make them before taking action [39] [47] [secondary interviews]. As one interviewee remarked, 'I think it's a rarity for them to have had real exposure to health and safety so. We've got a problem with directors. We've got a problem with managers' [INT09]. Where evidence *is* used, it is sometimes outdated because of insufficient time to keep up-to-date with the latest research and best-practice, or because

of the long lag time between research and practice [INT03, INT04, INT09, INT10]: 'research as being more lagging than leading' [INT04] [42].

Some interviewees felt that OSH often focuses on the wrong data types, e.g. incident and frequency rates, which lack the predictive quality some people attribute to them and can be 'wildly distorted' [INT08]. Safety climate was perceived to be a better measure for understanding safety by two OSH experts [INT02, INT08]. Furthermore, end users cannot always interpret research findings and extrapolate actionable suggestions from them unless the information has been translated into a more user-friendly format [INT01, INT04, INT09]:

> 'There's also barriers to reading academic papers and being able to take the actionable messages from them. So we've heard that, you know, academic papers don't suit very well. They're interesting to read sometimes, but they don't give us the answer they're looking for. I think that is a barrier in terms of the ability to use evidence directly from the literature, which is why we do those translations. We try to provide plain language summaries and other ways when we integrate; when we actually work with stakeholders [...] we hope to enable them to be better at using the information from research studies' [INT04]

An organisation's size can magnify such influences [46], as larger organisations are more likely than SMEs to have the resources and staff expertise to utilise evidence in decision making [INT04, INT06, INT08, INT09]. As one interviewee commented, 'Smaller companies are also the ones that don't have the necessary investment, health and safety management systems - they don't have resources.' [INT08]

Culture

OSH evidence-use varies across industry sectors because of differing industry standards, cultures and sub-cultures [34, 38]. Some industries perceive evidence-based approaches as a way to enhance credibility [49], whereas others find working to guidelines time-consuming [42, 55]. Individuals or small teams involved in the task also have the most influence [45], meaning that individuals with an interest in evidence-based practice are the driving force for its implementation [42] [INT12, INT13]. However, the opposite is also true: if individuals or small teams are uninterested in evidence-based practice and decision making, it can be difficult to change routines in everyday practice [42] [INT13].

Power structures, relationships and different actors' interests also influence OSH decision making [31, 38]. For instance, one study suggests that hierarchical social structures and objective-based management inhibit the implementation of a cohesive safety culture in construction firms [34]. In addition, employee and employer interests may conflict, e.g. employer concerns relate to cost, competition and job loss, while unions prioritise accident statistics and avoidance of harm [31]. As highlighted in the interviews, decision makers' may be skewed towards a perception that safety comes at a financial cost [INT02, INT04, INT09]. This perceived trade-off between profitability and safety may be misplaced, as experts believe that the same processes that make an organisation safer will typically make it more efficient. A classic example is regular equipment maintenance, which is essential for operating machinery safely while also optimising the equipment's longevity and efficiency:

> 'There is still a perception, and I can't tell you anything about how widespread the perception is, that putting in health and safety costs money, it slows you

down. You just can't get the goods out of the door. You can't get the building constructed. Whatever it is. When the evidence is to the contrary. […] Research evidence mostly shows how implementation of health and safety adds to the bottom line. It makes the business more profitable.' [INT09]

The values embodied in perceptions of safety and how organisations discuss it may influence safety outcomes. Duryan et al. (2020) highlight the importance of cultivating a positive safety culture to encourage the transfer of lessons learnt (from good practices, incidents, near misses and failures) between projects, from projects to programmes and across supply chains [34].

Evidence

It was recognised in the literature and by one interviewee that in some instances, the data/evidence is either unavailable or too poorly recorded to be instructive [35] [INT03]. The literature also mentioned that data/evidence might not be comparable across countries/sectors/industries or over time [36]. However, interviewees noted that people too often seek sector-specific information despite transferable learning opportunities from other sectors [INT04, INT11]:

> 'What seems to be the biggest focus when we talk to stakeholders is, was this research conducted in my occupation or sector? That's the first question. […] So they wanna know whether it's applicable immediately to their context, that is one of the first questions, one of the first perceived barriers, and when we talk about the results as being decontextualised and that it seems to hold within a number of different sectors that eases that barrier, but only a little, it still helps a lot more if the research was done in their sector.' [INT04]

Two interviewees noted that individual organisations can struggle to find what they need and can practically implement [INT07, INT13]: 'Evidence is usually quite thin on the ground […] It's sometimes exceptional to find something that's directly related to what you want' [INT07]. It was also apparent from interviews that countries look at evidence from other countries and/or international contexts to help inform the development of country-specific evidence, with the UK's HSE often referred to as 'the gold standard' [INT03]. Whilst helpful, this requires staff with OSH and/or legal knowledge who can understand English to translate these into lay and country-specific languages [INT11]. One interviewee noted that while there is a considerable quantity of evidence from all over the world, it is not available in one place, challenging an organisation's capacity and resources for finding, integrating and understanding it all. They concluded, 'So I think you could almost spend all your time looking at loads of stuff that people produce and then getting a bit tied up in knots' [INT13]. As mentioned in section 3.1, some people may find it challenging to assess the quality and reliability of research evidence [49]; people may over-rely on the credibility of the evidence's source to judge its quality rather than evaluate the evidence itself.

Two articles in the REA concluded that OSH research was generally not well integrated into practice [52] and that evidence is not always used [39]. The authors mention several possible reasons for this, including established knowledge of the organisation's health and safety performance, a fast-paced work environment where anything beyond immediate deadlines falls to the wayside, or the risk of alienating employees who are practice leaders [39]. In addition, organisations may not want to draw attention to the fact that they are not performing well – or senior management may simply decide not to share the evidence

[39]. In addition, non-specific statements in policy and guidance documents such as 'so far as is reasonably practicable' leave room for interpretation, creating implementation, inspection and enforcement issues [31]. Those who produce and share evidence may 'hope' [INT11] that people will use it, but resource and budget restrictions make it challenging to follow uptake unless it is regulated [INT12].

4 Discussion and recommendations

In partnership with NSC, LRF commissioned RAND Europe to explore the role of evidence in OSH. To investigate this area, we conducted an REA, a survey, a secondary analysis of existing interview data and primary interviews. Data collected from these work packages informed the design of two conceptual models: (i) a structural model describing the actors and agencies and (ii) a processes model describing OSH decision-making processes and the role evidence plays in them.

One of the most striking findings of this work was that there was no single definition of 'evidence'. In practice, evidence was described as a wide variety of information and research, including information internal and external to organisations. In addition, OSH evidence is produced and shared in various ways and involves multiple stakeholders. These extend beyond academic research and publication of peer-reviewed journal articles to include varied approaches to internal evidence production in organisations and an extensive array of output types, communication channels and networks. Much of the evidence organisations produce internally is rarely shared outside the organisation.

Figure 4 illustrates the complex evidence ecosystem through which evidence is produced, shared and used, and the actors and agencies involved. However, this represents an 'ideal' version, as our investigation showed that using evidence to inform decision making is less clear in practice and often greatly underutilised at both a local/organisational level and systems level.

Several factors influence the ecosystem that produces, shares and uses OSH evidence. We found significant variations between countries, e.g. differences in the extent to which OSH is nationally regulated in each country, with some having well-established regulations and guidelines while others are less developed. However, since our work was primarily informed by experiences in HIMCs, more research is needed on LICs. We also found differences between sectors and organisations within the same countries and sectors.

At an organisational level, utilising evidence for OSH decision making is heavily influenced by an individual's abilities to access, understand and incorporate evidence in practice. Our research shows that while there is often at least some relevant evidence available, decision makers might not know how to access it or distinguish between reliable and unreliable types, and/or may not have the time, capability, knowledge and/or resources to understand it. Research evidence is particularly underutilised at an organisational level.

An organisation's size may also impact its capacity to use evidence for OSH decision making. On the one hand, larger organisations may be more able to hire personnel dedicated

to OSH. Extra-large organisations may even have entire divisions dedicated to internal evidence translation and dissemination, such as producing manuals and protocols and providing decision makers with the relevant evidence to make an informed decision. On the other hand, smaller organisations are less likely to have the resources or knowledge base necessary to understand and implement evidence into practice; thus, those making OSH-related decisions may have insufficient time to gather and interpret up-to-date information. Small organisations often rely on external support to make informed safety decisions from national regulations, inspections or professional bodies.

Another determining factor is the organisation's safety culture, which is strongly influenced by the senior management and workers' values and capability.

4.1. Recommendations

Based on this work's findings, we present the following five recommendations for future work:

- **For evidence sharers:** greater investment in knowledge translation is required. For optimal impact, workplace-safety evidence must be tailored towards the intended audiences – often not academic researchers but workers, policymakers, organisational leaders and decision makers. As a starting point, academic literature must be translated into easy-to-digest formats such as infographics, videos and manuals for non-OSH-specialist audiences. Many organisations, especially SMEs and organisations in developing countries, need further support utilising academic research evidence in their decision making and practice. Networks and communities that support evidence dissemination, mutual learning, critical

thinking and literacy are likely to be beneficial. A single point of reference for OSH evidence globally may be beneficial and help overcome issues relating to identifying and accessing relevant evidence in a timely manner.

- **For workplaces:** a workplace's safety culture (comprising psychological, behavioural and situational aspects [14]) is a key influence on safety outcomes and is greatly influenced by organisational leaders' and decision makers' values and expertise. While there may be a perception that evidence-based practice is time-consuming and/or costly, organisational leaders should be educated about the benefits that a safer work environment can offer their organisations (e.g. increased quality and profitability). The promotion of a positive safety culture among all workers is likely to be beneficial.

- **For researchers:**

  » Further research is required to bridge the knowledge-to-action gap in how evidence is used (or not) to implement specific change. This may begin with evaluations to understand how shared/translated evidence has been used in practice and its effects, including long-term follow-ups.

  » Further research is required to analyse the cost/benefit of evidence-based practice to provide empirical evidence for organisations that could address perceptions that evidence-based practice is costly. This may potentially lead to cultural changes and encourage organisations to utilise evidence where previously they may have been hesitant.

  » When conducting future research about utilising evidence in OSH, it would be beneficial for data regarding

organisation sizes to be collected, as we found this to be a key influence. In addition, greater efforts toward representation from LMICs are needed, which may require additional resources and increased capacity and capabilities in LMICs.

» There is often a delay between the emergence of safety issues and the provision of novel evidence to address them. Therefore, system capacity must be in place to minimise the time between issues arising and the availability of evidence to respond, whether through the production of new evidence and/or the synthesis of existing evidence. It may also be beneficial to conduct horizon scanning for future potential issues for the rapid mobilisation of evidence when needed. It may be worth considering a body/council of representatives from LMICs that could champion and facilitate LMIC research inclusion in a timely manner.

» Our research highlighted considerable variation in the available evidence and how it is accessed and implemented across countries and sectors. It may be beneficial to map evidence ecosystems for specific countries, sectors and topics of interest. Accurate mapping exercises could help identify OSH issues, highlighting areas that would benefit from further research or require tailored interventions.

5 Conclusion

This study aimed to identify which types of evidence are being produced, shared and used, and by whom, and to explore how decisions are made and informed in OSH and the role evidence plays in this process.

Our research highlights that the OSH evidence ecosystem is complex and often fragmented. There is high variability across HIC countries,[3] sectors and organisation types. While we did not find a consistently used definition of 'evidence', there was general agreement amongst stakeholders over which types of information they perceived as evidence and which not.

However, evidence is often underutilised in OSH decision making, possibly because it is not always available or accessible to some end users. Furthermore, even when evidence is available, end users may face challenges in finding, understanding, or implementing it. One way to encourage the use of evidence in OSH is to support workplaces by disseminating and translating evidence into formats end users can easily understand and implement.

Within organisations, the end users are the decision makers – often supervisors, leaders and managers. Their expertise and values significantly influence the degree to which evidence is used for decision-making at the organisational level. Supervisors, leaders and managers often do not possess OSH expertise but are nevertheless responsible for making safety decisions. This can be problematic, especially in SMEs that often lack the resources to hire OSH experts to help make informed decisions, especially in countries without well-developed evidence-based regulations for decision makers to follow. Furthermore, supervisors', leaders' and managers' values and beliefs shape the workplace's safety culture, which is an important predictor of safety outcomes. Decision makers might benefit from specific training, improving overall performance and safety.

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3   Information from LMIC is sparse and lacking sufficient representation within this study, therefore we are unable to confidently generalise the findings of our study to LMIC, hence the specific mention of HIC.

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