

Designing safety interventions for specific contexts: results from a literature review

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Abstract

A misalignment between safety interventions and the workplace context of their application could lead to diminished effectiveness or failure. This paper is the first of three of an umbrella study that aimed to understand whether and how researchers and organisations consider contextual factors in safety interventions. Through Rapid Evidence Assessment (REA) process, we searched and selected scholarly work indexed in the bibliographic databases Medline, APA PsycArticles, Web of Science and Scopus between January 2011 and June 2021. The studies were analysed using a framework developed according to translation theory about (de)contextualisation of knowledge. The framework was enriched to consider psychosocial factors at the organisational level and physical, cognitive and emotional factors of the interventions' recipients. We identified 73 eligible studies, of which 47 described safety interventions that had not been deployed in workplaces (e.g., pilot studies and concepts) and 26 studies referred to those deployed. No study considered all factors of the framework. Communication and support from management and colleagues were the most considered psychosocial factors, whereas conflicting demands and job security were the least considered. Moreover, cognitive factors of workers were mentioned in 77% of the sample, with only one study considering inclusively cognitive, emotional and physical factors of recipients. About 62% of the implemented interventions were functional (e.g., training, education and communication-related interventions), with only four studies reporting physical interventions. Also, most of the interventions were sourced from the literature and introduced as 'new practice' at the targeted workplaces, with only one article reporting a failed intervention. Overall, the findings of this research indicated that intervention studies did not visibly follow a translation-transformation path between sources and recipients, did not systematically consider contextual factors at the workplaces targeted, and all interventions represented administrative controls, contrary to the widely accepted principle of the hierarchy of controls.

1 Introduction

Globally, workplace fatalities number 1,000s per day. This number is compounded by daily workplace accidents and injuries, sometimes with life-changing consequences, and increased further by deaths due to work-related diseases¹. With around 500 million people affected by work each year², occupational safety and health (OSH) has become a significant global issue, which forms part of the United Nations sustainable development goals³. One explanation for these figures may lie in the poor introduction and implementation of safety interventions in particular contexts resulting in diminished effectiveness and poor results (Pilbeam et al., 2019). Therefore, one of the safety management challenges is to understand better the relationship between the workplace context and the safety interventions deployed. Furthermore, it is essential to understand whether and how a safety intervention sourced externally needs to be modified to fit a particular context better and achieve the desired outcomes.

¹ WHO/ILO joint estimates of work-related burden of disease and injury, 2000-2016: global monitoring report. Geneva: World Health Organization and the International Labour Organization, 2021.

² https://www.ilo.org/moscow/areas-of-work/occupational-safety-and-health/WCMS_249278/lang--en/index.htm (accessed 29 October 2021)

³ UN SDG <https://sdgs.un.org/goals>

Anecdotally, safety interventions are often ‘borrowed’ or ‘copied’ from one setting where they have been successfully deployed to another but not necessarily achieving the same positive outcome described elsewhere. Such ‘borrowing’ and variation in performance outcomes are consistent with the implementation of managerial practices more generally (Bloom et al., 2012). Røvik (2016, p. 292) noted that “... while everything is everywhere, it is also different everywhere”. A perceivably common practice may be performed differently in different settings. Nevertheless, this variation may be subtle and not immediately apparent.

Checklists are an example of a safety intervention widely adopted across sectors (Catchpole & Russ, 2015). However, safety outcomes following the deployment of checklists are not consistently and invariably high. While checklists have contributed significantly to safety in aviation, their contribution to safety in healthcare is variable and contested. Partly, this can occur because checklists are interventions introduced in complex socio-technical systems and require careful attention to their design and the basic skills needed to implement them successfully (Catchpole & Russ, 2015).

Hence, initiatives to minimise harm in the workplace and maximise worker well-being must be tightly coupled with introducing context-appropriate safety interventions for effective implementation that yields the desired outcome. Failure to consider contextual differences in adaption may explain why the ‘export’ of safety interventions from one sector to another is sometimes unsuccessful. However, the degree to which researchers and organisations contemplate contextualisation processes and the variables that influence these processes when designing and implementing safety interventions has not been explored systematically.

In light of the above, Lloyd’s Register Foundation commissioned a research project to understand whether and how researchers and organisations consider contextual factors in safety interventions. The project included three major parts: a review of the literature to identify the paths safety interventions are contextualised and the contextual factors considered; examination of Health & Safety syllabuses and training practices to reveal the extent to which they support the contextualisation of safety interventions; collection of data from case examples of successful and unsuccessful safety interventions through interviews with key industry stakeholders.

This article communicates the methodology, findings and conclusions from the literature review part of the project to answer the following questions:

- To what degree do safety interventions follow a (de)contextualisation path?
- What recipients’ contextual factors have been considered in safety interventions?

1.1 Theoretical background

The project drew on translation studies recognising that ideas and models are social constructions (Wæraas, 2021) subject to interpretation and translation (Lamb & Currie, 2012) as they are transferred in space and time (Øygarden & Mikkelsen, 2020). Translation is when a general management idea is transferred and reinterpreted in a new setting (Morris & Lancaster, 2006). Translation accepts that this transfer of an idea is not a ‘friction-less’ process, like diffusion, but change (transformation) is expected to occur in the translation process. This, therefore, implies that each translation is unique (Cassell & Lee, 2017).

Røvik (2016) developed an instrumental theory of translation, the basic components of which we have captured diagrammatically in Figure 1. This conceptual model, which we used as a framework for this study, draws attention to the micro-processes of change explaining “... how actors apply various translation rules when de-contextualising practices in source units and contextualising representations of practice in recipient units” (Røvik, 2016, p. 291). The model

has two elements. First, a decontextualisation process takes the idea from the source and creates an abstract concept. This extracts the idea from its contextual wrapper but retains the relevant information that explains how the practice functions in its source context. The second element is a contextualisation process whereby the abstract concept is recontextualised to fit the recipient conditions. This may require the replacement of old practices in the recipient, integrating the new practices with existing practices in the recipient or simple additions to the current practices.

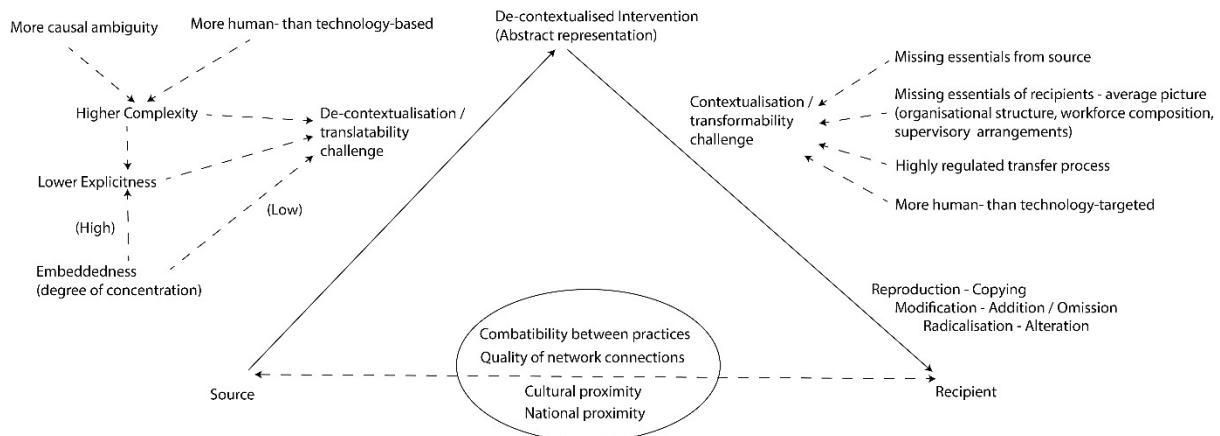


Figure 1. Conceptual framework for (de) contextualisation, based on Røvik (2016)

The ease with which a practice is decontextualised is a function of its complexity, embeddedness, and explicitness (Røvik, 2016). Practices that are complex, deeply embedded in the context and tacit are the most difficult to decontextualise and therefore translate from source to recipient. As the complexity and embeddedness decrease and the idea becomes more explicit, decontextualisation becomes easier. Complexity is a function of the combination of technology and people. A technology-related practice with a clear-cut application is less complex than one relying on a repertoire of human skills performed by different individuals. Practices that are concentrated can be easily identified and represented, making them easier to translate. Where they are dispersed and dependent on other practices to function, translation becomes more difficult. Furthermore, implicit practices are non-verbalised, non-codified and non-standardised. These need to be verbalised and made explicit before they can be translated.

The contextualisation path can also be influenced by four main parameters (Røvik, 2016). First, in hindsight, the abstract representation might be missing some essential information from the source. Second, the intervention agent might not have information about the overall context of the targeted recipients. Contextual factors that regularly differ across organisations include culture, processes, demographics and criticality of occupational safety & health (OSH) as part of the organisation's 'licence to operate' (Porter & McLaughlin, 2006). Third, the extent to which the introduction of the practice is externally regulated will decide the degrees of freedom to contextualise it. Fourth, as in the decontextualisation phase, the degree to which the practice targets human and/or technical elements must be considered.

Furthermore, the final translation product is guided by a set of 'editing' or 'translation rules' as ideas travel across space and time (Røvik, 2016). The trajectory of these runs from copying through modification to radical alteration. Copying attempts to achieve similar outcomes in the recipient as in the source by using the same intervention in the same way. Modifications can occur either by adding or omitting a few elements. These changes seek to align the intervention and the recipient's context better. A radical alteration fundamentally changes the original idea. Such changes may be so radical that the new intervention in the recipient

scarcely resembles the version in the source and the latter functions more as an inspiration instead of a source of specific and concrete practice. Notably, an organisation can proceed with any of the aforementioned translation trajectories without fully or partially considering the (de)contextualisation factors described in the previous paragraphs.

Finally, any differences between source and recipient create the 'space' within which the micro-processes of change can occur and influence the outcome of the translation process (Nielsen et al., 2020). Where source and recipient show greater similarity, successful translation is more likely. Nevertheless, various contextual factors that describe the source and recipient can influence this translation process. Røvik (2016) highlights the need for national, cultural and institutional proximity.

Notably, there have been published frameworks about the design and implementation of OSH interventions. However, those do not cover the whole path suggested by Røvik (2016), or they focus on specific intervention types. For example, Michie et al. (2011) introduced the behaviour change wheel, especially for characterising and designing behaviour change interventions. The authors above created a framework that links capability, opportunity and motivation sources of behaviours, nine types of intervention functions (e.g., education, modelling, enablement) and seven policy categories (e.g., legislation, communication, legislation) without, however, suggesting a concrete intervention path.

Robertson et al. (2013) introduced a staged approach to intervention design and analysis based on a participatory method. The specific work focuses more on the decision-making process with references to identifying and selecting alternatives without suggesting particular criteria. Also, although Robertson et al. (2013) refer to the importance of scoping the problem space and evaluating the effectiveness of interventions, they do not mention details about the translation of interventions at their source and their transfer to the desired context. On the other hand, Herrera-Sánchez et al. (2017) present a detailed list of 38 questions across ten intervention implementation steps, ranging from the problem definition to sustainability and integration. Under this practice-oriented approach, several conditions and prerequisites must be examined (e.g., resources and support, clear goals and objectives), and various actions must accompany the intervention (e.g., teambuilding). Nonetheless, the work by Herrera-Sánchez et al. (2017) does not visibly articulate how the answers to the 38 questions could collectively support the (de)contextualisation strategy or address the parameters proposed by Røvik (2016).

2 Methodology

This study analysed interventions that impact organisational safety outcomes, including accident and injury rates, safety behaviours and worker wellbeing. To be inclusive, we defined these safety interventions broadly as any physical artefact, process, procedure, set of skills or specialist knowledge that restores, maintains or strengthens safety (i.e., prevents or mitigates safety risks; influences culture and behaviours; improves health & wellbeing; ensures compliance with legal requirements).

We conducted a comprehensive Rapid Evidence Assessment (REA) review of the literature (Grant & Booth, 2009) to identify theoretical and empirical research references to the translation process, consideration of contextual factors and intervention effectiveness. To ensure a systematic, transparent and reproducible approach, we followed the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Moher et al., 2009).

The core REA study team included a Chief Investigator (NK) with postgraduate qualifications and long industry and academic experience in safety management, a Co-investigator (PB) with expertise in systematic literature reviews, and a Research Associate (SRK) who has conducted and published systematic reviews. The team was supported by the Chief Investigator (CP) of the overall project with long research experience in organisational safety and appointed personnel by the project sponsor with respective research expertise.

2.1 Eligibility criteria

Since the adoption of safety interventions can be described and evaluated using a wide variety of approaches and designs, we included publications of any study designs (e.g., experimental and observational, randomised and non-randomised) and data types (e.g., qualitative and quantitative). Also, we did not apply any inclusion/exclusion criteria regarding industry sectors and geographical regions represented. As we sought recent accounts of safety-related publications that reflect current practice and settings while discussing context-related variables, only studies published since January 2011 were included. We included scholarly work published in peer-reviewed journals to ensure the information provided represented formal evaluation and review. We were primarily interested in academic work, so we did not search for unpublished studies and grey literature. Also, although two of the authors are bilingual, we considered only publications in English to facilitate the peer-review of the results. Table 1 presents the inclusion and exclusion criteria applied.

Table 1: Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
Peer-reviewed publications (journal articles and conference papers)	Unpublished material Theses, dissertations, technical/industry/government reports, trade magazine articles, books and chapters
Full text published in English	Full text published in languages other than English
Published between 1-1-2011 and 30-6-2021	Published before 2011 and as from July 2021
Full text available online	Full text not available online
Occupational Safety and Health (OSH)	Other safety and health areas (e.g., patient safety, public health)

2.2 Identification and selection of studies

We constructed an inclusive search strategy encompassing both research questions on the bibliographic databases of Medline (via PubMed), APA PsycArticles (via EBSCOhost), Web of Science and Scopus. After the initial pilot testing of the search strategy by SRK, the results were discussed with the whole project team. Subsequently, the search strategy was modified to improve sensitivity and specificity in accordance with the scope of this study.

Table 2: Search strategy used on all bibliographic platforms

No.	Search
	TITLE and KEYWORDS
S1	Safety
S2	"case study" OR interven* OR program* OR strateg* OR polic* OR plan* OR develop* OR innovat* OR modif* OR transform* OR method* OR pract* OR activ* OR action* OR project* OR scenario* OR schem* OR system* OR approach* OR adapt* OR adopt* OR analys*
S3	S1 and S2
	TOPIC KEY WORDS (TITLE & ABSTRACT)

S4	(change OR cross* OR implement* OR appl* OR *design* OR creat* OR plan* OR translat* OR adapt* OR adopt*)
S5	(context* OR situation* OR setting) AND (factor* OR aspect* OR parameter* OR variable* OR criter*)
S6	(identif* OR diagn* OR find* OR select* OR consid* OR contempl* OR examin* OR explor* OR stud* OR specif* OR defin* OR determ* OR indic* OR analys* OR analyz* OR evaluat* OR investig*)
S7	S4 and S5 and S6
	FINAL STRING
S8	S3 and S7

SRK collated all the records from the database searches, imported them into EndNote 20 software and de-duplicated them. Then, SRK screened the titles and abstracts of the remaining citations, identified those fulfilling our inclusion criteria and reviewed their full text. NK reviewed the results from this screening; the researchers were overly inclusive at this stage, and, if in doubt, a citation was retained for further determination. Any disagreements between SRK and NK were resolved by a joint evaluation of each manuscript and further consultation with PB. At this stage, we excluded publications that did not entirely match the inclusion criteria and REA's scope, and we recorded the exclusion reasons. The analysis and synthesis included studies that fulfilled the inclusion criteria and were evaluated as within scope.

Where a publication described only part of an intervention (e.g., only evaluation results), SRK reviewed the reference lists for the presence of co-publications further describing the intervention. All eligible studies were divided into two groups. The first group comprised studies that discussed context in safety interventions but did not explain or describe how the interventions were implemented in the workplace. The second group consisted of studies that contained applied safety interventions where the context was also considered. For example, an article could refer to context when introducing a new safety risk management approach. If the study included a survey to assess the comprehension of the new approach but did not test its actual application, it was categorised as a Not-Deployed Intervention study (NDI). If the article included an applied case of this approach, it was classified as a Deployed Intervention study (DEI). Those cases could refer to the deployment of interventions across the whole or part of the organisation's workforce.

2.3 Data extraction and analysis

Given the nature of a REA is to survey the current evidence base and not derive causal relationships or epidemiological evidence (Grant & Booth, 2009), we did not assess the risks of biases or quality of reporting. Data were extracted for all studies that met the inclusion criteria. Initially, we constructed data extract forms tailored to meet the requirements of this REA. During this phase, we developed definitions, used standard classifications for the data items, and ensured they were applied consistently. Consistency was achieved through continual data review with the participation of SRK, NK and PB throughout the data extraction phase. Cases where information was unclear or appeared inconsistent in interpretation were resolved through repeated review of the documentation discussion amongst the researchers.

We extracted details of the region and subregion where each study was conducted⁴, year of publication, study design (EPOC, 2017), types of data collected, sample size, industry sector(s) addressed⁵, and contextual factors considered. The latter included:

- Psychosocial factors which represented variables of the internal organisational context: workload, conflicting demands, role clarity, involvement in making decisions, influence over the way the job is done, organisational change management, job security, communication, support from management and support from colleagues. The list was created based on the works of Méndez Rivero et al. (2021), Brown et al. (2020), Sujan (2015), Sujan (2012), Choudhry and Fang (2008) and information from EU-OSHA⁶.
- Absorptive capacity factors which reflected the opportunity of the intervention recipients to understand, accept, assimilate and action the intervention objectives, details and expectations. Due to the nature of REA, we adopted the general categories of physical factors (e.g., manual skills, anthropometrics, physical condition and health), cognitive factors (e.g., knowledge, experience) and emotional factors (e.g., feelings, trust, motivation) as proxies to record whether individual absorptive capacity was considered.

Specifically for the intervention studies, we considered the intervention type (i.e., physical, process or functional) as classified by Karwowski (2005), intervention area (e.g., training, communication, policy), source of intervention, intervention mode (i.e., reproduction/copying, modification/adaptation, radicalisation/alteration), national and cultural proximity between sources and recipients, outcomes aimed and achieved, and references to decontextualisation/translation and contextualisation/transformation paths according to Røvik (2016). Specific classifications and definitions adopted in this study are presented in Table 3.

Table 3: Classifications and definitions

Intervention type	Intervention mode	Source-recipient cultural proximity
<u>Physical intervention</u> The intervention targeted materials/natural environment of the workplaces with the intent to improve safety. These included environmental conditions, infrastructure, equipment, tools, etc.	<u>Reproduction</u> The intervention is a copy of the original practice/knowledge	<u>Same</u> Exactly same sector and/or operations
<u>Process intervention</u> The intervention targeted how the work is performed (flow, nature, duration, order, etc. of activities).	<u>Modification</u> The intervention is modified with addition(s) or omission of the original practice/knowledge	<u>Similar</u> When the operations/sector are similar but not necessarily the exact same (e.g., both the food services industry and dairy milk industry must ensure food quality)
<u>Functional intervention</u> The intervention was about the purpose and role of persons, goals and outcomes of activities, etc. This category included everything not falling under the physical and process categories above.	<u>Radicalisation</u> The intervention is significantly altered	<u>Different</u> No similarity between sectors/operations (e.g., the manufacturing industry and health services sector)

⁴ <https://unstats.un.org/unsd/methodology/m49/>

⁵ <https://www.ilo.org/global/industries-and-sectors/lang--en/index.htm>

⁶ <https://osha.europa.eu/en/themes/psychosocial-risks-and-stress>

SRK extracted the data from the included studies and entered the data in the entry forms in Microsoft Excel. NK independently checked the data, compared entries and any differences were discussed until an agreement was reached. Any disagreements were resolved through discussions with PB. Where the publications did not include the information sought, the respective variables were noted as missing data points. The data collected about intervention areas and sources and proximity between sources and recipients were coded in mutually exclusive categories to allow a basic descriptive analysis.

Statistical analysis was conducted by transferring the data from Excel to SPSS v.26. The frequencies of all the variables were determined first for the whole sample and subsequently for the subset of NDI and DEI studies. Furthermore, we explored possible variations of dependent variables (e.g., psychosocial and absorptive capacity factors, intervention modes and types and targeted outcomes) across the demographic data of the studies (e.g., sub(regions) and industry sectors) by conducting Fisher exact tests. Chi-square tests were not possible to perform as the initial screening of the data showed the assumptions of this test were violated in most cases due to highly uneven distributions of the sample. Moreover, to increase the accuracy of the statistical results, we selected the SPSS option of Monte Carlo simulation with 10,000 samples and a 99% confidence interval. The statistical significance level was set to $\alpha=0.05$, and the null hypotheses across all tests were of no significant variation.

3 Results

For the sake of brevity, the presentation of the REA results per dataset will refer to AS for All Studies, NDI for Not-Deployed Intervention studies and DEI for Deployed Intervention cases (i.e., AS=NDI+DEI). Furthermore, the results from the statistical tests are reported only for the cases of statistically significant variations. In addition to the tables with findings included in the following subsections, Tables 2 and 3 in the Supplement accompanying this paper present the basic characteristics of the NDI and DEI articles, respectively, supported by a nomenclature in Table 1 provided in the same file.

3.1 Study selection

The strategy produced initially over 5,000 hits, and deduplication resulted in 3,449 studies (Table 4). An additional study was identified by searching reference lists. Following the initial title and abstract screening, 2,880 articles were excluded. The review of the abstracts of the remaining 570 articles resulted in the exclusion of 410 articles. The excluded studies either reported irrelevant interventions and/or outcomes, did not report any intervention or contextual factors, or were not occupational studies. After reviewing the full text of 160 studies, we included a total of 73 studies in the final review, of which 47 were NDI, and the remaining 26 studies were DEI cases. The flow of information across the various stages of the REA is shown in Figure 2.

Table 4: Database search results (1-7-2021)

Index	Hits
Medline (via PubMed)	1,323
APA PsycArticles (via EBSCOhost)	5
Web of Science (incl. MEDLINE, Current Contents Connect, KCI-Korean Journal Database, Russian Science Citation Index and SciELO Citation Index)	2,662
Scopus	1,285
Total	5,275
Duplicates removed	1,826
Final count	3,449

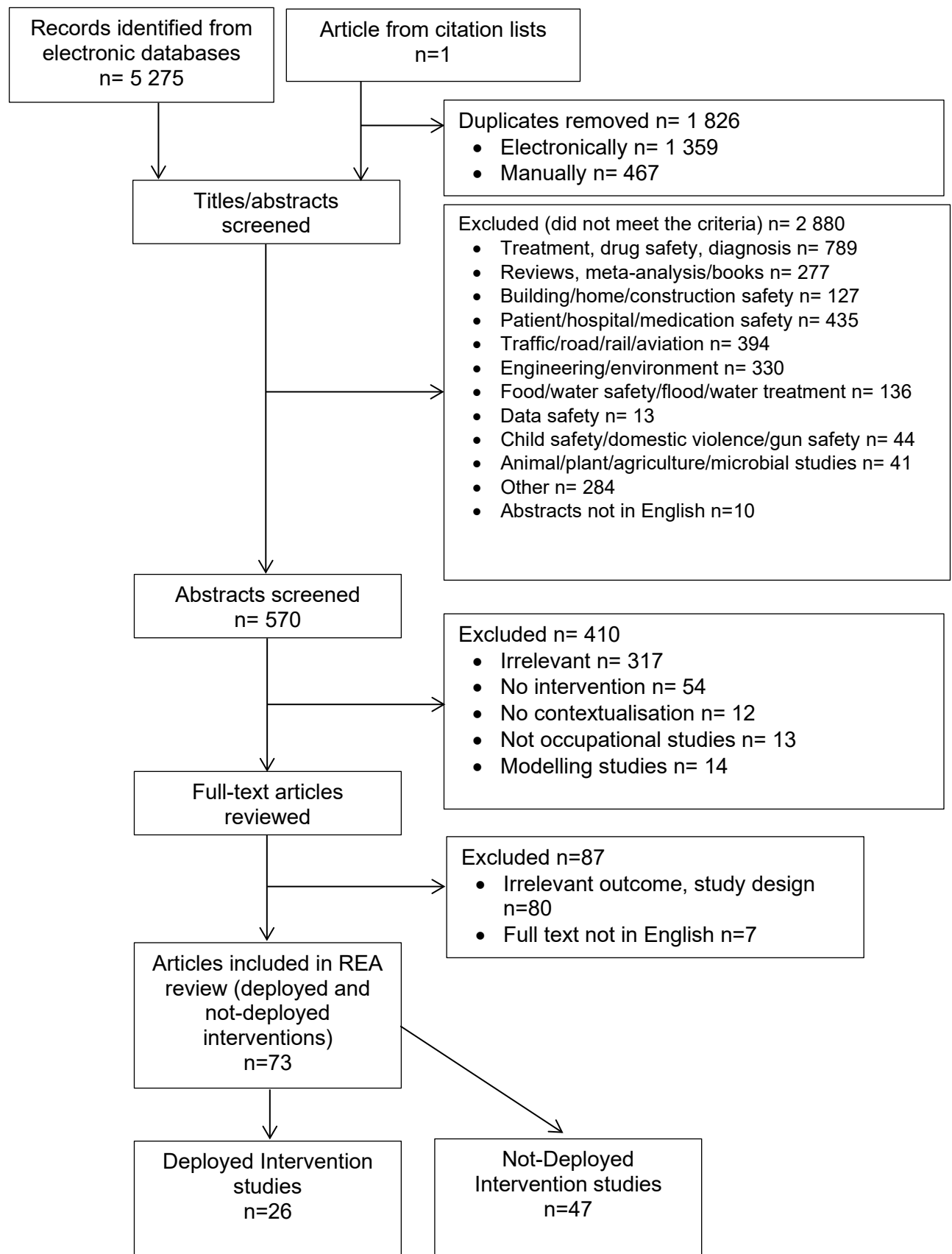


Figure 2. PRISMA flow diagram for study inclusion

3.2 Information and demographics

The number of studies published each year varied from two in 2011 to 13 in 2019. Among the 47 NDI, 20 were cross-sectional, 13 were opinion/review papers, 13 were non-comparative case studies, and one was a cohort study (Basil et al., 2013). Most NDI studies collected qualitative data (n=16), followed by ordinal data from 12 studies and continuous data from eight. The DEI dataset included 12 uncontrolled pre-post intervention studies, six case studies, five randomised control trials and several other study types with lower frequencies. Data collected from DEI were mostly ordinal data (n=14), while six studies collected continuous data. Sample sizes varied greatly in the studies we reviewed. The sample size of targeted recipients or records collected in NDIs ranged from 6 (Joss et al., 2017) to 12,959 (Pekovic, 2015) and in DEIs ranged between 20 (Ochsmann et al., 2016) to 1,784 (Buller et al., 2019).

Table 5 presents the data regarding the demographics of the whole sample and separately for the NDI and DEI studies. Most of the studies occurred either in Europe (n=26) or the Americas (n=22). However, the distribution within the NDI and DEI subsets was somewhat inverted, with more NDI articles coming from Europe (n=19, 40.4%) and most of the DEI publications coming from the Americas (n=11, 42.3%). All studies from the Americas were exclusively from the United States and Canada. In Europe, most of the AS (n=12) were carried out in Western Europe, followed by Northern Europe (n=9) and Southern Europe (n=4). Only four studies of the sample were conducted in Sub-Saharan Africa. The sample did not include Northern Africa, Latin America and the Caribbean, Central Asia, Eastern Europe, Melanesia, Micronesia, and Polynesia.

Table 5. Regions and subregions

Variables	n (%)		
	AS (N=73)	NDI (N=47)	DEI (N=26)
Regions			
Europe	26 (35.6)	19 (40.4)	7 (26.9)
America	22 (30.1)	11 (23.4)	11 (42.3)
Asia	14 (19.2)	10 (21.3)	4 (15.4)
Oceania	7 (9.6)	5 (10.6)	2 (7.7)
Africa	4 (5.5)	2 (4.3)	2 (7.7)
Sub-regions			
Northern America	22 (30.1)	11 (23.4)	11 (42.3)
Western Europe	12 (16.4)	8 (17.0)	4 (15.4)
Northern Europe	9 (12.3)	8 (17.0)	1 (3.8)
South-eastern Asia	8 (11.0)	6 (12.8)	2 (7.7)
Australia and New Zealand	7 (9.6)	5 (10.6)	2 (7.7)
Southern Europe	4 (5.5)	3 (6.4)	1 (3.8)
Sub-Saharan Africa	4 (5.5)	2 (4.3)	2 (7.7)
Western Asia	3 (4.1)	1 (2.1)	2 (7.7)
Southern Asia	2 (2.7)	2 (4.3)	-
Eastern Asia	1 (1.4)	1 (2.1)	-
Northern Africa	-	-	-
Latin America and the Caribbean	-	-	-
Central Asia	-	-	-
Eastern Europe	-	-	-
Melanesia	-	-	-
Micronesia	-	-	-
Polynesia	-	-	-
Not specified	1 (1.4)	-	1 (3.8)

As presented in Table 6, health services and construction were the industry sectors most studied, with a total of 20 and 15 studies, respectively. The industry sector where the study was conducted was significantly associated with the NDI or DEI category ($p = 0.04$, CI 99% 0.035-0.045). There were 12 studies conducted in the construction sector and 10 in the health services sector in the NDI category. Comparatively, in the DEI cases, the health services sector dominated the sample with 10 cases against three studies in the construction sector. The commerce, financial and professional services, forestry, wood, pulp and paper, hotels, tourism and catering, mining, mechanical and electrical engineering, media, and postal and telecommunications services sectors were not represented in any category.

Table 6. Industry sectors

Industry sectors	n (%)		
	AS (N=73)	NDI (N=47)	DEI (N=26)
Health services	20 (26.7)	10 (20.4)	10 (38.5)
Construction	15 (20.0)	12 (24.5)	3 (11.5)
Transport (civil aviation; railways; road transport)	7 (9.3)	5 (10.2)	2 (7.7)
Other	7 (9.3)	7 (14.3)	-
Education	4 (5.3)	1 (2.0)	3 (11.5)
Various	4 (5.3)	3 (6.1)	1 (3.8)
Food; drink; tobacco	3 (4.0)	2 (4.1)	1 (3.8)
Oil and gas production; oil refining	3 (4.0)	2 (4.1)	1 (3.8)
Public service	2 (2.7)	-	2 (7.7)
Shipping; ports; fisheries; inland waterways	2 (2.7)	2 (4.1)	-
Transport equipment manufacturing	2 (2.7)	-	2 (7.7)
Utilities (water; gas; electricity)	2 (2.7)	2 (4.1)	-
Agriculture; plantations; other rural sectors	1 (1.3)	-	1 (3.8)
Basic metal production	1 (1.3)	1 (2.0)	-
Chemical industries	1 (1.3)	1 (2.0)	-
Textiles; clothing; leather; footwear	1 (1.3)	1 (2.0)	-
Commerce	-	-	-
Financial services; professional services	-	-	-
Forestry; wood; pulp and paper	-	-	-
Hotels; tourism; catering	-	-	-
Mining (coal; other mining)	-	-	-
Mechanical and electrical engineering	-	-	-
Media; culture; graphical	-	-	-
Postal and telecommunications services	-	-	-

3.3 Recipients' contextual factors

Table 7 presents the descriptive results of the recipients' contextual factors derived from the studies. Notably, although the national setting and industry sectors also reflect the context, this section focuses on factors considered explicitly in the organisational settings the studies targeted. The statistical tests did not show significant differences in those contextual factors' frequency across (sub)regions and industry sectors.

Table 7. Contextual factors

Factors*	n, (% of studies, % of all factors counted)		
	AS (N=73)	NDI (N=47)	DEI (N=26)
Psychosocial factors			
Communication	33 (45.2, 23.4)	21 (44.7, 20.4)	12 (46.2, 31.6)
Support from management	25 (34.2, 17.7)	21 (44.7, 20.4)	4 (15.4, 10.5)
Support from colleagues	24 (32.9, 17.0)	17 (36.2, 16.5)	7 (26.9, 18.4)
Workload	13 (17.8, 9.2)	13 (27.7, 12.6)	-
Role clarity	11 (15.1, 7.8)	8 (17.0, 7.8)	3 (11.5, 7.9)
Involvement in making decisions	10 (13.7, 7.1)	8 (17.0, 7.8)	2 (7.7, 5.3)
Influence over the way the job is done	5 (6.8, 3.5)	4 (8.5, 3.9)	1 (3.8, 2.6)
Organisational change management	3 (4.1, 2.1)	2 (4.3, 1.9)	1 (3.8, 2.6)
Conflicting demands	2 (2.7, 1.4)	2 (4.3, 1.9)	-
Job security	2 (2.7, 1.4)	2 (4.3, 1.9)	-
Missing	13 (17.8, 9.2)	5 (10.6, 4.9)	8 (30.8, 21.1)
Absorptive capacity			
Cognitive factors	56 (76.7, 66.7)	37 (78.7, 63.8)	19 (61.5, 73.1)
Physical factors	9 (12.3, 10.7)	8 (17.0, 13.8)	1 (3.8, 3.8)
Emotional factors	9 (12.3, 10.7)	9 (19.1, 15.5)	-
Missing	10 (13.7, 11.9)	4 (8.5, 6.9)	6 (23.1, 23.1)

* The sum of the frequencies of the factors in the table exceeds the number of studies reviewed as each publication could refer to more than one factor

The psychosocial factors considered varied widely amongst the studies. Thirteen of the 73 publications (five NDI and eight DEI publications) mentioned no psychosocial factor. Across all the studies reviewed, communication (n=33), support from management (n=25) and support from colleagues (n=24) were the most considered psychosocial factors, while conflicting demands (n=2) and job security (n=2) were the least considered factors. While we identified all ten psychosocial factors across the NDI sample, the DEI sample considered seven psychosocial factors, with workload, conflicting demands, and job security not found in the DEI dataset. Furthermore, the extent of reference to psychosocial factors was inconsistent across the two datasets (Figure 3). Ten of the NDI considered one, 17 studies considered two, eight studies considered three, five studies considered four and two studies considered five psychosocial factors. Amongst the 18 DEI studies which mentioned psychosocial factors, nine considered one, six considered two and three considered three psychosocial factors.

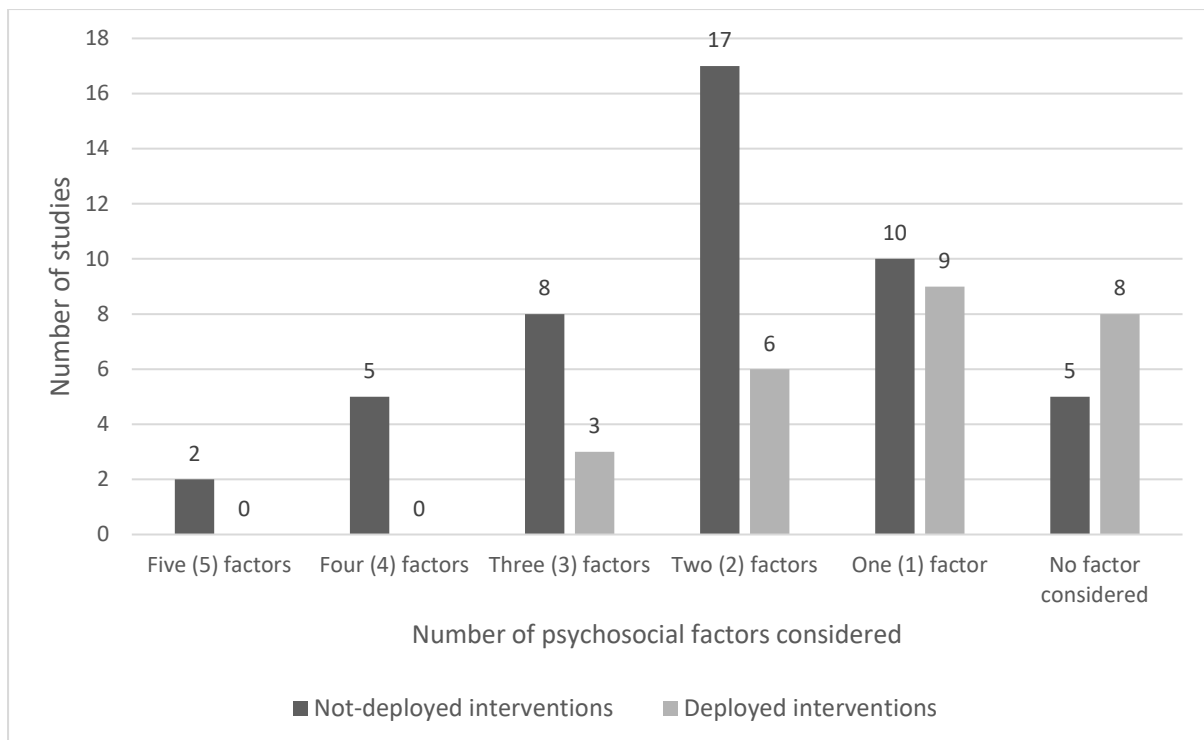


Figure 3: Number of psychosocial factors considered across studies

Regarding absorptive capacity, four NDI and six DEI studies did mention any physical, cognitive and emotional factors. Cognitive factors were the most often considered (56 out of 73 studies), and only nine studies considered emotional factors and nine studies physical factors. Only one of the 47 NDI considered all three factors (Micheli et al., 2018). Five NDI studies considered physical and cognitive factors, four considered emotional and cognitive factors, four considered emotional factors alone, and two considered physical factors only (Figure 4).

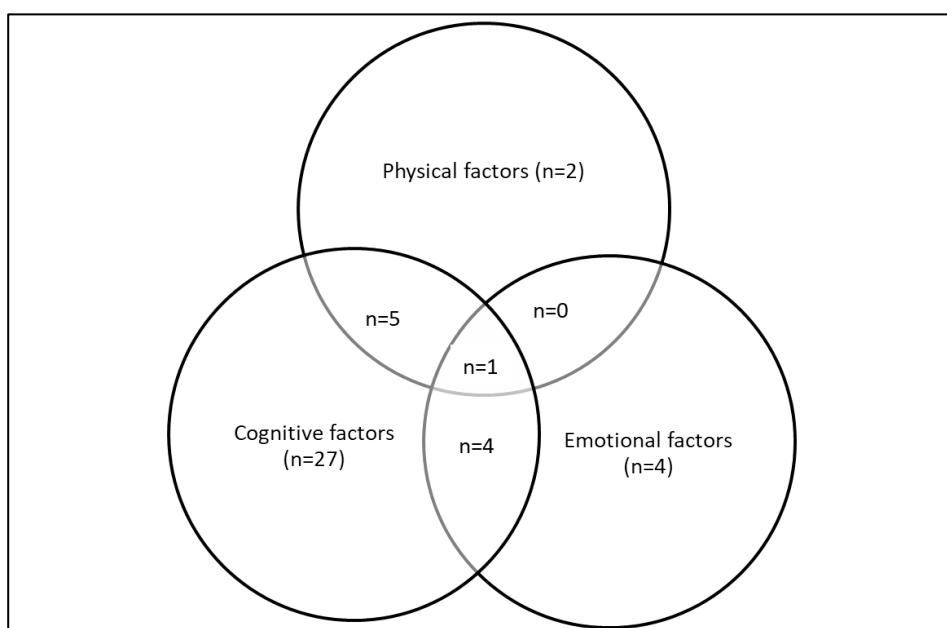


Figure 4: Absorptive capacity factors considered in not-deployed interventions

Some NDI studies referred to additional parameters influencing participants' absorptive capacity, including religious and cultural beliefs (Edwards et al., 2015; Gao et al., 2017; Morgan et al., 2021). One study stated project complexity, organisational complexity and contract management (Winge et al., 2019), and another study mentioned nationality (Gao et al., 2017) as factors influencing the absorptive capacity of participants. Other studies concluded that peer pressure (Furber et al., 2012) and team turnover (Chandrasekaran & Mishra, 2012) influenced absorptive capacity.

Among the DEI cases, none referred to more than one absorptive capacity factor. Only one study considered physical factors (Ochsmann et al., 2016). Most other studies (19 out of 26) considered cognitive factors only. When accounting for the missing data points, the frequency of absorptive capacity factors of recipients was significantly associated with whether the study was a DEI or NDI ($p = 0.05$, CI 99% 0.044-0.055). Across the sample, 78.7% of the NDI considered cognitive factors, 19.1% considered emotional factors, and 17.0% considered physical factors. On the other hand, 61.5% of the DEI considered cognitive factors and only 3.8% considered physical factors, with emotional factors not found in any DEI case.

3.4 Deployed intervention studies

As presented in Table 8, twelve of the 26 DEI used training or education as an intervention in the workplace. Communication was the second most frequently targeted area ($n=5$). However, if all individual risk-related interventions are aggregated, those interventions become the second most often targeted area ($n=7$), and communication comes third. Twenty-one of the DEI targeted one intervention area, and the other five studies employed more than one intervention. The study conducted by Haynes et al. (2018) provided sun safety training and sun safety resources to outdoor workers. Guo et al. (2018) used goal setting, feedback, training, reward and punishment as interventions in the construction industry. Olson et al. (2016) used goal setting, education, self-monitoring and social support as interventions in the health services sector. Senior management safety rounds, training for supervisors and online discussion forums were used as interventions in the health services by Bronkhorst et al. (2018). Changing the triage process and adding extra staff were interventions used in the study by Balfour et al. (2017).

Table 8: Intervention areas

Intervention areas	n (% of studies, % of all values counted)
Training/education	12 (46.2, 31.6)
Communication	5 (19.2, 13.2)
Risk control	3 (11.5, 7.9)
Behaviours	2 (7.7, 5.3)
Goals	2 (7.7, 5.3)
Rewards/awards	2 (7.7, 5.3)
Risk monitoring	2 (7.7, 5.3)
Culture	1 (3.8, 2.6)
Feedback	1 (3.8, 2.6)
Policy	1 (3.8, 2.6)
Punishment	1 (3.8, 2.6)
Risk assessment	1 (3.8, 2.6)
Risk management	1 (3.8, 2.6)
Safety management	1 (3.8, 2.6)
Self-monitoring	1 (3.8, 2.6)
Support	1 (3.8, 2.6)
Walkarounds	1 (3.8, 2.6)

According to the data shown in Table 9, sixteen studies reported functional interventions that targeted the purpose and role of persons and activity goals and outcomes (e.g., training, education and communication-related interventions). Seven studies reported process interventions that targeted how the work is performed. Four studies reported physical interventions that targeted materials or the natural environment such as environmental conditions, infrastructure, equipment, tools, etc. Only one of these studies reported using functional and physical interventions (Buller et al., 2019). This study described the modification of sun safety policy and education through training and the provision of sun safety protection. Most of the interventions were more human than technology-oriented (88.5%).

Table 9: Intervention types

Intervention type	n (% of studies, % of all values counted)
Functional	16 (61.5, 59.3)
Process	7 (26.9, 25.9)
Physical	4 (15.4, 14.8)

As presented in Table 10, published studies and reports were the most frequent sources of identifying interventions and/or informing the intervention design (n=11), followed by intervention initiatives sourced from knowledge from other industries (n=5). We identified only one study referring to two distinct sources, namely publicly available guidelines and training methods from various sources, and describing the implementation of an occupational safety programme with appropriate training methods in the education sector (Rodrigues et al., 2018).

Table 10: Sources of interventions

Source of intervention	n (% of studies, % of all values counted)
Literature/studies	11 (42.3, 40.7)
Various industries	5 (19.2, 18.5)
Healthcare	2 (7.7, 7.4)
Manufacturing	2 (7.7, 7.4)
Aviation	1 (3.8, 3.7)
Food	1 (3.8, 3.7)
Government	1 (3.8, 3.7)
Internal practice	1 (3.8, 3.7)
Investigations	1 (3.8, 3.7)
Public information (presentations, guidelines)	1 (3.8, 3.7)
Training	1 (3.8, 3.7)

Regarding the intervention mode, 12 studies employed modifications (46.2%), 11 were radical interventions (42.3%) and three employed reproductions of practices (11.5%) (Dusenberry & Robinson, 2020; González-Formoso et al., 2019; Rodrigues et al., 2018). The latter studies used the same programmes used in other industries to provide safety training to the targeted recipients; two were conducted in the education sector and one in the healthcare industry. The intervention mode was significantly associated with the source of the intervention ($p = 0.028$; CI 99% 0.024-0.032) as most of the radical interventions were sourced from the literature.

Excluding three DEI publications with no relevant information, in most of the other cases, the intervention applied was identified as 'new practice' for the recipients (n=17, 65.4%), and in six DEIs (23.1%), the intervention regarded existing practice. Only three interventions were undertaken in collaboration between the source and the recipient. Of these, Karanikas et al. (2020) reported how they developed a safety award programme in a large aviation

organisation at management's request. Bull et al. (2017) reported a training program for Portuguese-speaking nurses in Mozambique modified through collaboration between a hospital in the United Kingdom and a teaching hospital in Mozambique. Talbot et al. (2014) reported a collaborative effort within a large academic health centre to design a formalised system to improve the safety of healthcare personnel. The remaining interventions (n=23) were undertaken on an ad-hoc basis. The collaborative or ad-hoc connection between the source and recipient was significantly associated with the source of the intervention ($p = 0.048$; CI 99% 0.042-0.053), where all the interventions sourced from the literature were introduced on an ad hoc basis.

For 19 of the studies, it was impossible to detect information about the national proximity between source and recipient (e.g., no reference in the publication, the intervention was based on literature). Four of the studies (15.4%) were performed in the same country as the source (Buller et al., 2019; Karanikas et al., 2020; Talbot et al., 2014; Zohar et al., 2017), while three studies (11.5%) were performed in a different country than the source (Balfour et al., 2017; Bull et al., 2017; Guo et al., 2018). Information about cultural proximity was possible to distil in 13 out of the 26 DEIs and was almost evenly distributed between different (n=6, 23.1%), similar (n=7, 26.9%), and same (n=7, 26.9%) sectors and/or operations.

The three outcome types aimed and/or achieved were almost evenly distributed across the sample, with some precedence of OSH performance [OSH performance: n=12, 46.2%; Safe behaviours: n=11, 42.3%; Worker well-being, n=10, 38.5%]. No single study targeted all three outcomes, and only six DEI publications focused on two outcomes concurrently. Two studies aimed to improve OSH performance and safe behaviours (Ledo et al., 2021; Marquardt et al., 2021). One study aimed to improve OSH performance and worker wellbeing (Haynes et al., 2018). Three studies aimed to improve safe behaviours and worker wellbeing (Juárez-Carrillo et al., 2017; Newnam et al., 2012; Newnam & Oxley, 2016). Across the DEI sample, only one study reported a failed intervention (Karanikas et al., 2020).

None of the DEIs referred explicitly to the decontextualisation/translation -> abstract representation -> contextualisation/transformation path described by Røvik (2016), and no DEI study explicitly mentioned any parameters of complexity, embeddedness or explicitness regarding translatability at the source. Nevertheless, seven studies mentioned various factors affecting the design, implementation, and outcomes of interventions. González-Formoso et al. (2019) stated that some items of the original safety training source were difficult to interpret, Buller et al. (2019) recognised that the sun safety policies introduced relied on individuals to implement as they were not enforced, and Guo et al. (2018) acknowledged that the behavioural-based interventions assumed linear relationships between system elements. Bronkhorst et al. (2018) noted that improving safety climate was somewhat difficult due to the reactive mindset of managers. Also, McDonald and Durso (2015) recognised that task interruptions and high workload were counteracting the efforts to decrease attentional errors. Talbot et al. (2014) observed that the process improvement introduced was influenced by the limited time for decision-making. Randmaa et al. (2014) expressed concerns the intervention effectiveness would decrease due to lower adherence over time.

Moreover, several studies mentioned limitations regarding the size and composition of the samples of targeted recipients or the timeframe and opportunities available to assess the intervention effectiveness. Such limitations could not allow the generalisation of the results or afford high confidence in the outcomes measured. Other concerns expressed by various authors included incompatibilities between previous and new practices, which were realised retrospectively (Karanikas et al., 2020), diverse priorities (Haynes et al., 2018) and reversion to past behaviours due to the unsustainability of positive effects (Guo et al., 2018).

4 Discussion

In general, the uneven sample of scholarly studies about Not-Deployed Interventions (NDI, $n=47$) and Deployed Interventions (DEI, $n=26$) suggest that the publication of theoretical concepts and pilot applications significantly outnumber the publications of full-scale studies in real-world settings. This means it is almost twice as likely to find peer-reviewed studies discussing contextual factors in general terms as case studies of actual interventions in a specific setting. Although this difference could be partially attributed to the nature of REAs, since we used a common search string and applied the same screening criteria, the possibilities of missing publications from any of the NDI or DEI categories remains equal. Hence, even if the numbers above do not fully represent the whole set of safety intervention studies published, their relative frequency of 26 DEIs vs 47 NDIs can be claimed as valid.

The above could be attributed to the fact that some NDIs did not mature enough to the level of full implementation, or they were deployed but failed. The first presumption is indirectly supported by the fact that we did not identify DEI and NDI studies on the same interventions. It is also possible that the authors directly published the actual implementation and did not perceive the necessity or have the resources to share any conceptual approaches and trials. Nevertheless, notably, only one DEI shared a failed intervention, which confirms the effects of publication and outcome reporting biases of sharing strong and confirmatory results (Franco et al., 2014; Harrison et al., 2017; Olson et al., 2002).

4.1 Study demographics

The differences regarding the study types between the NDI and DEI datasets were expected since most of the former did not include actual interventions. They focused more on introducing concepts, pilot/small-scale test cases, and collecting perceptions regarding the intervention design, feasibility, acceptance, etc. The prevalence of uncontrolled pre-post intervention studies in the DEI cohort can be justified by the difficulty to design and run case-control and randomised controlled trials in real-world settings, along with possible human research ethical considerations.

The distribution of the publications across geographical regions accords with the results of the bibliometric analysis by Merigó et al. (2019), who processed data from articles published in Safety Science between 1976 and 2016 and found the United Kingdom had most of the publications, closely followed by the USA, whereas China and Australia held the third and fourth positions, respectively. Merigó et al. (2019) also observed that the US and Europe initially led the particular journal, but publications from Asia and Australia grew significantly during the last years. Similarly, Wang et al. (2020) analysed 4,852 journal articles published in the Web of Science in 1900-2018 and related to OSH management. North America, especially the USA and Canada, Europe, mainly the United Kingdom, the Netherlands, Italy and Germany, and Australia had the highest contribution rates (Wang et al., 2020).

Therefore, the regions of the interventions we reviewed seem to represent the overall trend of safety-related publications. This indirectly verifies the reliability of the search and screening strategy employed in the REA. Still, it does not directly constitute an accurate reflection of the relative frequency to which safety interventions occur in practice across regions. Also, the difference between the percentages of regions for the DEI and NDI publications, where the Americas prevailed in the former and Europe in the latter, could be attributed to some form of publication bias or national cultural elements. Regarding the latter, for example, Rice et al. (2021) acknowledged that whereas most healthcare team training programmes were developed in the USA, it is imperative to understand the interplay between national culture and team dynamics and incorporate the values of different cultures into team training to create more effective interventions.

Furthermore, Zotzmann et al. (2019) found that countries, cultural values, and personality dimensions are related to an individual's error orientation. The latter was defined as the attitude and behaviour toward dealing with, communicating, and learning from errors. Employees working in the US reported the highest mean levels on error orientation (Zotzmann et al., 2019), which could indirectly explain the more frequent DEI publications in this region. Additionally, works in other fields, such as medicine and conservation biology and ecology, have recognised that the geographical region could play a role in various aspects such as reporting of positive/adverse outcomes (Sood et al., 2007), actual or perceived impact and significance of the study's subject (Hickisch et al., 2019) and available research resources (Bellard & Jeschke, 2016).

The relatively increased frequency the healthcare and construction sectors were studied in both DEIs and NDIs can be explained by the combination of their workforce sizes and the rate/prevalence of workplace incidents and accidents. Considering the countries and regions where most of the publications focused, in the US, healthcare and construction rank as the 2nd and 9th largest sector respectively out of 19 industries⁷, with construction presenting the highest number of worker fatalities⁸. In Europe, the healthcare sector is the 3rd largest employer and construction ranks 6th out of 17 industries⁹, but construction suffers from the highest number of fatal accidents at work¹⁰. Especially in the UK, human health and social work comprise the largest employer, and construction ranks 7th out of 16 sectors¹¹. Construction in the UK had the highest number of fatalities in 2020-21¹², and healthcare and social workers reported the highest rate of work-related illnesses and non-fatal injuries¹³. In Australia, healthcare and social assistance is the largest employer amongst 19 sectors, with the construction industry positioned in the 4th place¹⁴. The latter industry is the 3rd highest in worker fatalities and disease and injury claims, whereas the healthcare industry ranks 1st in the number of serious claims¹⁵.

Moreover, apart from the figures presented above, other differences between and within industry sectors might influence the degree to which they share interventions through publications. For instance, the study by Olsen and Aase (2010) showed that the safety climate level and safety performance were generally higher in the petroleum sector than in healthcare in Norway, which could indicate that the latter industry might feel the need to share lessons from interventions more frequently as a means to contribute to safety improvements across the sector.

Also, differences in the structures of different industry sectors could influence whether they perceive the value and/or urgency of publishing safety intervention cases instead of sharing those only internally through professional bodies and agencies. As Lindøe et al. (2011) observed, a limited number of big enterprises dominates the petroleum industry. In contrast,

⁷ <https://www.bls.gov/emp/tables/employment-by-major-industry-sector.htm>

⁸ <https://www.bls.gov/charts/census-of-fatal-occupational-injuries/number-and-rate-of-fatal-work-injuries-by-industry.htm>

⁹ <https://skills Panorama.cedefop.europa.eu/en/dashboard/employed-population-occupation-and-sector?year=2019&country=EU&occupation=#1>

¹⁰ https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Accidents_at_work_statistics#Number_of_accidents

¹¹ <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/datasets/employmentbyindustryemp13>

¹² <https://www.hse.gov.uk/statistics/fatals.htm>

¹³ <https://www.hse.gov.uk/statistics/industry/>

¹⁴ https://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/pubs/rp/rp2021/Quick_Guides/EmployIndustry

¹⁵ <https://www.safeworkaustralia.gov.au/statistics-and-research/statistics/disease-and-injuries/disease-and-injury-statistics-industry>

the coastal fishing industry has large numbers of small fishing boats, a low degree of formal organisation, a high degree of personal freedom and a tradition to engage in risky activities. On the other hand, maritime enjoys some form of self-regulation through classification societies (Lindøe et al., 2011). Although our data did not show considerable differences in the numbers of studies conducted in those sectors, the small sample size yielded cannot guarantee conclusive results.

4.2 Recipients' contextual factors

The picture of the inclusion of psychosocial factors in the NDI and DEI publications did not present any observable trend, and the frequencies those factors were considered within each dataset could be instead viewed as random than systematic. The fact that in about 18% of the publications there was no reference to such factors and most of the NDI and DEI studies addressed only a few psychosocial factors could be alarming and indicative of underappreciation of their importance. Undoubtedly, it is a positive sign that communication, management and collegial support and workload parameters were addressed in many publications as several books, industry standards, and even legislation view those factors as crucial in OSH management (Archer, 2018; Australian Government, 2018; Bhagwati, 2006; BSI, 2007; Cox et al., 2000; Dekker, 2017; Hollnagel, 2014; ISO, 2018; Lutchman, 2012; NSW Government, 2019; WHSQ, 2011).

However, the sufficient coverage of the factors above should not justify the exclusion or underrepresentation of other psychosocial parameters. Adequate organisation-wide support, worker consultation and role clarity are essential but alone might not lead to successful interventions. Especially regarding job security, several studies over time and across industries have shown effects of precarious employment on risk perception and safety behaviours, compliance and participation (Abri et al., 2021; Choudhry & Fang, 2008; Wareham-Fowler & Fowler, 2010), increased vulnerability to injuries (Underhill & Quinlan, 2011), mental health (Méndez Rivero et al., 2021) and overall employee performance (Wang et al., 2021). Therefore, this factor can influence the degree to which the targeted workforce will accept and realise a safety intervention. Although for the DEI studies we cannot exclude the case they included only workers with permanent employment status, we expected job security to have been addressed more frequently in NDI studies, most of which were about conceptualising and introducing safety interventions and, possibly, could afford the time and space to contemplate additional psychosocial factors.

Similarly, the factor of competing demands has been flagged in the literature for decades as influential on the priorities individuals set under different settings in domains such as public safety (Stevens, 1997), agriculture (Beretti & Stuart, 2008) and healthcare (Grosso, 2008; Walter et al., 2014). Notably, a survey of 1375 workers across 33 organisations from the US and Italy revealed that organizational-level production pressure climate exacerbated the positive relationship between workload and risky safety behaviours (Ghezzi et al., 2020). When considering that most of the interventions we reviewed were introduced on an ad-hoc basis, the investigation of possibly competing goals and priorities should be expectedly examined. Moreover, change management and employee participation in influencing the way jobs tasks are executed and safety management is applied have been mentioned in several publications as essential organisational approaches to gaining worker buy-in and enhancing the effectiveness and sustainability of interventions (Capodaglio, 2020; Gerbec, 2017; Hasle & Jensen, 2006; Masso, 2015; Schneid & Schneid, 2019; Wincek et al., 2015).

Regarding the frequency to which cognitive, physical and emotional factors appeared in the publications reviewed, it can be hypothesised that the picture reflects expectations and/or perceptions related to their possible influence and/or visibility. Although it would be unsafe to

argue that the change agents in the intervention studies did not appreciate the importance of all the three categories of factors, the relative overemphasis on individual cognitive parameters is justified by the intervention areas targeted. Education and communication, collectively found in 17 out of the 26 DEI and represented 44.8% of all interventions, aim mainly to develop cognitive skills (e.g., awareness, decision making, evaluation). The same applies to other interventions such as policies, self-monitoring programmes and risk management. In turn, this could explain the lower concentration on physical factors, possibly under the assumption that all workers were physically able and healthy to participate in cognition-focused interventions.

However, regardless of the intervention area, emotions regulate and drive mental and physical responses and, at the same time, are shaped through cognition and physiology under a continuous interplay (Barrett et al., 2016; Lord et al., 2002). The absence of emotional factors from DEI studies and their low frequencies in NDI studies could be attributed to where emotions are perceivably positioned in the operational envelope and when their effects are considered. Emotions could be mainly viewed as reactions to threats or enforced and unexpected changes or seen as additional variables in decision-making during daily activities. Hence, a proactive inclusion of emotional factors in the design and deployment of interventions might not be perceived as a necessity or priority. Indicative studies supporting the arguments above are presented in the two following paragraphs.

For instance, in the hospitality sector, Zhang et al. (2021) examined the interrelationship between negative emotions, safe behaviours and corporate social responsibility in response to COVID-19 measures. In the aviation industry, Causse et al. (2013) showed that a failure to execute a go-around was associated with temporary impairment of rational decision-making due to the negative emotional consequences attached with the go-around. In the same industry sector, Catino and Patriotta (2013) investigated how the interaction of cognition, emotions, and safety culture influence the detection, reporting, and analysis of errors.

Mou and Lin (2014) investigated whether negative emotions develop after exposure to food safety information and result in changes in risk perception and prevention actions. Moreover, the findings from an experiment in a virtual construction environment suggested that emotional responses to the construction hazards did not affect hazard identification performance but modulated risk evaluation and decision-making (Bhandari et al., 2020). In the context of emergency response, Lu et al. (2014) illustrated the relationships between several environmental emergencies and their effects on the emotional state of the rescuers involved.

Furthermore, the statistically significant differences between NDI and DEI studies could be probably attributed to various factors, the investigation of which was outside the scope of the REA. For example, as NDI regarded concepts and pilot tests of interventions, they might have had more time to consider the full envelope of physical, cognitive and emotional factors. On the other hand, in the DEI cases, time and other resource limitations, along with the parameters discussed in the previous paragraphs, might have led to the omission of or assumptions about emotional and physical factors and an emphasis on the individual cognitive skills and abilities.

Although the studies we reviewed were independent and not part of the same projects, the above could indirectly suggest that the transition from concepts and tests to real-world applications under constraints might lead to narrower consideration of absorptive capacity elements. Also, we could not exclude the case that the DEI studies followed unpublished concepts and trials during which the change agents considered more factors than the ones included in the final DEI publications.

Nevertheless, overall, the results show a lack of holistic approaches to human capacity and capability drivers, with only one NDI study addressing cognitive, physical and emotional factors concurrently. The lack of a holistic and systems approach is also evident by the outcomes DEI studies aimed and measured. According to the results, no DEI study targeted concurrently OSH performance, safe behaviours, and worker well-being. Only six out of the 11 publications aimed at two outcomes, whereas all three are interconnected.

4.3 Deployed interventions

Overall, the lack of explicit information in DEI studies about the intervention path, from decontextualisation to abstraction and contextualisation (Røvik, 2016), suggests that translations at the source and transformations to match the context of recipients could either be partially or fully omitted, or they could occur intuitively based on the experience, skills and backgrounds of the agents involved. Admittedly, the framework developed based on the work by Røvik (2016) is theoretical and not a standardised approach, industry practice, etc. As such, we did not expect to record in the studies exact references to the process of (de)contextualising practices and the respective translatability and transformability challenges. Nevertheless, the absence of references to such challenges related to the design, implementation and outcomes of interventions from 73% of the DEI studies strongly indicates the lack of consistent consideration of parameters that could determine the success or failure of an intervention.

Training was the intervention area in about half of the DEI sample, suggesting its appreciation. However, together with most of the other intervention areas, it indicates a focus on lower levels of the widely accepted concept of the hierarchy of risk controls: elimination, substitution, engineering, administration and personal protection (Alvino & Caughell, 2021; Floyd, 2015; Morris & Cannady, 2019; Spigarelli, 2020). Training, communication and feedback, safety and risk management tools, rewards and punishment, behaviours, culture and support constitute administrative controls. This suggests that controls of higher order, which are more effective as they rely less on human performance, were not covered by the intervention studies.

The picture above aligns with findings from studies where administrative controls prevailed over elimination, substitution and engineering. For example, Turner et al. (2021) analysed 277 recommendations from 30 incidents between 2001 and 2018 in Contra Costa Health Services, California. They classified 75% of the corrective actions as administrative and 14% as passive or active engineering, with only 8% targeting system redesign. In an earlier study, the analysis of 63 reports, studies, and bulletins from process incident investigations by the U.S. Chemical Safety Board showed elimination through design counted for 36% of the risk reduction measures, 22% were classified as passive and active engineering, and procedural safety was introduced as a measure in 42% of the sample (Amyotte et al., 2011).

In the aviation sector, the analysis of 625 recommendations included in the investigation reports published by four agencies concluded that only 11% of the sample regarded suggestions for elimination, substitution and engineering controls, with the rest 89% of the recommendations aiming procedures, training, policies, strategies, etc. (Karanikas et al., 2019). Interestingly, in the same domain, a survey of 42 professionals with safety-related roles revealed that the participants almost uniformly perceived administrative controls as more effective than other measures (Karanikas, 2018), contrary to the concept of the hierarchy of controls.

The results from somewhat different findings from the studies discussed above could be attributed to several organisational factors. Hudson et al. (2021) explored how the principles of the hierarchy of controls included in the Total Worker Health guidelines of the US National Institute for Occupational Safety and Health were implemented among seven organisations.

They found that elimination, substitution and redesign controls were commonly used and trialled, and education was often discussed as a method to complement other controls. However, leadership, culture, available resources, access to information and the implementation process (e.g., implementation climate, readiness for implementation) were the determinants of control choices and their success or failure (Hudson et al., 2021). Similarly, Karanikas (2018) found that aviation professionals acknowledged the relative vulnerability of administrative controls but attributed the focus on the latter to pressures from authorities, who ask for more and better procedures, and the decreased feasibility to implement technical controls due to their cost.

However, transformative changes associated with the reduction of injuries and fatalities mainly include technical interventions that physically suppress hazards, reduce risk exposure or improve responses to incidents (e.g., seatbelts and ABS in vehicles, fall prevention, metal fire escapes, explosion-proof lighting, roll-over cages, gas detectors, elimination of asbestos and passive smoking). Notably, in the studies reviewed, training and education, which are mainly transactional behavioural interventions, do not visibly appear as complementary to physical/technical interventions. This, along with the results showing that most interventions were imposed and not performed under a collaborative approach, could indicate an emphasis on controlling workers through behavioural interventions and a lack of focus on structural weaknesses and other system improvement opportunities.

Moreover, the fact the interventions reviewed were mainly sourced from published studies and reports could be attributed, on the one hand, to the natural tendency of academic authors to derive ideas from previous publications, and, on the other hand, a possible tendency of the industry to import ideas and be tempted by the “new” (Busch, 2018) rather than learning from inside and scoping the problem space (Herrera-Sánchez et al., 2017; Robertson et al., 2013). Nonetheless, the prevalence of the specific intervention sources might also explain the low frequency of reproduced practices and higher percentages of radical and modified interventions. Journals typically accept and publish studies that offer new scientific insights and do not merely share the application of established practices from one setting to another. Hence, as reproduction-type interventions could be seen as mandatory (e.g., compliance with standards and requirements) and might not present scientific interest, we cannot claim the distribution of the three interventions modes in our sample reflects the industry reality.

4.4 Study limitations

Although the researchers screened papers from a wide range of scientific indexes and used a systematic approach to develop and apply the eligibility and search criteria, we cannot exclude the possibility of not capturing and including articles within the scope of our review. Also, the exclusion of non-peer-reviewed and non-online publications and the focus on articles published between 2011 and July 2021 does not allow to claim generalisability of the findings outside the online scientific publications landscape and before or after the specific timeframe.

Moreover, due to the uneven distribution of the sample across industry sectors and regions, the findings cannot be claimed as entirely representative of all countries and industry domains. Additionally, the representation of the sectors in our REA must be seen under the lens of its scope as the current project focused on OSH and excluded operational, service, product, food, patient, etc. safety. Across many countries, several industries (e.g., aviation, transport and mining) can be regulated by authorities other than the ones with an OSH focus. This means there might be publications about safety interventions in areas other than OSH, and such interventions can still have implications for worker health, safety, wellbeing and performance.

Furthermore, assessing the quality of the study designs and strength of evidence in the papers reviewed was outside the scope of this REA. As such, this paper does not provide information

about the degree of bias in any measurements about the effectiveness or other aspects of the safety interventions introduced, pilot tested or implemented. Also, we cannot exclude that several of the contextual parameters we recorded in this research were considered more intuitively by the authors or were not perceived as important to report. Moreover, a different classification of the contextual factors could yield a different picture of their distribution across the studies reviewed.

Last, the relatively higher frequency of conceptual papers and lower representation of articles about implemented interventions could be attributed to the fact that several successful and failed intervention cases in the industry are not shared through peer-reviewed channels, especially if these cases do not involve academic researchers and/or their publication is not required by any funding organisation or regulatory authorities. As such, although our findings could raise awareness for scholar and industry practice when designing and deploying safety interventions, the results of this study cannot accurately reflect actual industry practice.

5 Conclusions and recommendations

The analysis of peer-reviewed literature revealed there are considerably more studies about early-stage, pilot-tested or concept-stage OSH interventions than the real-world, full-scale implementation of interventions. This, along with the fact that failed cases of interventions, deployed or not, were not published, indicates missed opportunities to learn from both successes and failures in real-world settings. Also, as the studies reviewed were an uneven representation of industry sectors and geographical regions, more insights could be yielded from other industries and regions, which correspond to different contexts.

Furthermore, in the studies analysed, there were interventions where psychosocial factors were not mentioned. When those were mentioned, they did not cover the whole range of the factors included in this study. Missing or underrepresented factors included role clarity, involvement in making decisions, influence over the way the job is done, organisational change management, conflicting demands and job security. Additionally, the emotional capacity of recipients of interventions was rarely considered. Many publications referred to one or two categories of capacity factors, suggesting a lack of a holistic approach to workers' physical, cognitive and emotional capacity to accept and realise interventions.

The literature review also showed that training and education was the most frequently applied intervention. Importantly, all interventions represented administrative controls, contrary to the concept of hierarchy of controls. Although exact reproductions of practices were not often published, this was attributed to sharing scientific works communicating some type of innovation. Therefore, the limited number of these papers might not reflect the reality in the industry.

Collectively, the scope, findings and conclusions from this study lead to the following recommendations:

1. Analysis of non-academic safety intervention publications, such as industry and government reports, to gain a more complete picture of whether and how context influences safety interventions.
2. Extension of similar literature research to other safety fields, such as process, food, fire, operational, etc., safety.
3. Empirical investigation of whether and how the whole range of psychosocial factors and workers' physical, cognitive and emotional capacities are included as parameters of organisation changes, OSH education and training, and professional practice.

4. Empirical research of the sources of new safety interventions within organisations and the extent to which they borrow from other settings. This may build on the previous work on knowledge and information sources funded by the Institution of Occupational Safety and Health (Crawford et al., 2016).
5. Empirical studies of how organisations adopt interventions to develop practical guidelines on how this may be achieved more effectively by considering theoretical approaches (Røvik, 2016) and published frameworks (Herrera-Sánchez et al., 2017; Michie et al., 2011; Robertson et al., 2013).

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References

- Abri, M., Vosoughi, S., Abolghasemi, J., Rahimi, J., & Ebrahimi, H. (2021). The effect of job security on safety behavior with the moderating role of salary: a structural equation model. *International Journal of Occupational Safety and Ergonomics*, 1-6. <https://doi.org/10.1080/10803548.2021.1929697>
- Alvino, R. T., & Caughell, C. M. (2021). COVID-19 in the Perioperative Setting: Applying a Hierarchy of Controls to Prevent Transmission. *AORN Journal*, 113(2). <https://doi.org/10.1002/aorn.13301>
- Amyotte, P. R., MacDonald, D. K., & Khan, F. I. (2011). An analysis of CSB investigation reports concerning the hierarchy of controls. *Process Safety Progress*, 30(3), 261-265. <https://doi.org/10.1002/prs.10461>
- Archer, R. (2018). *WHS : a management guide* (5th ed.). Cengage Learning.
- Work Health and Safety Act 2011, (2018). <https://www.legislation.gov.au/Details/C2018C00293>
- Balfour, M. E., Tanner, K., Jurica, P. J., Llewellyn, D., Williamson, R. G., & Carson, C. A. (2017). Using Lean to Rapidly and Sustainably Transform a Behavioral Health Crisis Program: Impact on Throughput and Safety. *Joint Commission Journal on Quality and Patient Safety*, 43(6), 275-283. <https://doi.org/10.1016/j.jcjq.2017.03.008>
- Barrett, L. F., Lewis, M., & Haviland-Jones, J. M. (2016). *Handbook of Emotions* (4th ed.). Guilford Publications.
- Basil, M., Basil, D., Deshpande, S., & Lavack, A. M. (2013). Applying the Extended Parallel Process Model to workplace safety messages. *Health Communication*, 28(1), 29-39. <https://doi.org/10.1080/10410236.2012.708632>
- Bellard, C., & Jeschke, J. M. (2016). A spatial mismatch between invader impacts and research publications. *Conservation Biology*, 30(1), 230-232. <https://doi.org/10.1111/cobi.12611>
- Beretti, M., & Stuart, D. (2008). Food safety and environmental quality impose conflicting demands on Central Coast growers. *California Agriculture*, 62(2), 68 – 73. <https://doi.org/10.3733/ca.v062n02p68>
- Bhagwati, K. (2006). *Managing Safety*. Wiley – VCH.
- Bhandari, S., Hallowell, M. R., Boven, L. V., Welker, K. M., Golparvar-Fard, M., & Gruber, J. (2020). Using Augmented Virtuality to Examine How Emotions Influence Construction-Hazard Identification, Risk Assessment, and Safety Decisions. *Journal of Construction Engineering and Management*, 146(2), 04019102. [https://doi.org/10.1061/\(ASCE\)CO.1943-7862.0001755](https://doi.org/10.1061/(ASCE)CO.1943-7862.0001755)
- Bloom, N., Genakos, C., Sadun, R., & Van Reenen, J. (2012). Management Practices Across Firms and Countries. *Academy of Management Perspectives*, 26(1), 12-33. <https://doi.org/10.5465/amp.2011.0077>
- Bronkhorst, B., Tummers, L., & Steijn, B. (2018). Improving safety climate and behavior through a multifaceted intervention: Results from a field experiment. *Safety Science*, 103, 293-304. <https://doi.org/10.1016/j.ssci.2017.12.009>

- Brown, S. D., Dahill, D., Karakilic, E., King, D., Misha, P., Pirrioni, S., Shipton, H., & Vedi, P. (2020). *Psychological Wellbeing and Safety in a Global Context: A Rapid Evidence Assessment*. Nottingham Trent University. <https://irep.ntu.ac.uk/id/eprint/41682/>
- BSI. (2007). *Occupational Health and Safety Management (OHSAS-18001)*. B. S. Institution. <https://www.bsigroup.com/en-AU/OHSAS-18001/>
- Bull, E. R., Mason, C., Domingos, F. J., Santos, L. V., Scott, A., Ademokun, D., Simiao, Z., Oliver, W. M., Joaquim, F. F., & Cavanagh, S. M. (2017). Developing nurse medication safety training in a health partnership in Mozambique using behavioural science. *Globalization and Health*, 13, Article 45. <https://doi.org/10.1186/s12992-017-0265-1>
- Buller, D. B., Walkosz, B. J., Buller, M. K., Wallis, A., Andersen, P. A., Scott, M. D., Meenan, R. T., & Cutter, G. R. (2019). Implementation of Occupational Sun Safety at a 2-Year Follow-Up in a Randomized Trial: Comparison of Sun Safe Workplaces Policy Intervention to Attention Control. *American Journal of Health Promotion*, 33(5), 683-697. <https://doi.org/10.1177/0890117118814398>
- Busch, C. (2018). Brave New World: Can Positive Developments in Safety Science and Practice also have Negative Sides? International Cross-industry Safety Conference (ICSC) - European STAMP Workshop & Conference (ESWC) (ICSC-ESWC 2018), Amsterdam.
- Capodaglio, E. M. (2020). Participatory ergonomics for the reduction of musculoskeletal exposure of maintenance workers. *International Journal of Occupational Safety and Ergonomics*, 1-11. <https://doi.org/10.1080/10803548.2020.1761670>
- Cassell, C., & Lee, B. (2017). Understanding Translation Work: The evolving interpretation of a trade union idea. *Organization Studies*, 38(8), 1085-1106. <https://doi.org/10.1177/0170840616670435>
- Catchpole, K., & Russ, S. (2015). The problem with checklists. *BMJ Quality & Safety*, 24(9), 545-549. <https://doi.org/10.1136/bmjqs-2015-004431>
- Catino, M., & Patriotta, G. (2013). Learning from Errors: Cognition, Emotions and Safety Culture in the Italian Air Force. *Organization Studies*, 34(4), 437-467. <https://doi.org/10.1177/0170840612467156>
- Causse, M., Dehais, F., Péran, P., Sabatini, U., & Pastor, J. (2013). The effects of emotion on pilot decision-making: A neuroergonomic approach to aviation safety. *Transportation Research Part C: Emerging Technologies*, 33, 272-281. <https://doi.org/10.1016/j.trc.2012.04.005>
- Chandrasekaran, A., & Mishra, A. (2012). Task design, team context, and psychological safety: An empirical analysis of R&D projects in high technology organizations. *Production and Operations Management*, 21(6), 977-996. <https://doi.org/10.1111/j.1937-5956.2012.01329.x>
- Choudhry, R. M., & Fang, D. (2008). Why operatives engage in unsafe work behavior: Investigating factors on construction sites. *Safety Science*, 46(4), 566-584. <https://doi.org/10.1016/j.ssci.2007.06.027>
- Cox, C., Makin, P., & Sutherland, V. (2000). *The Management of Safety*. Sage Publications.
- Crawford, J., Davis, A., Cowie, H., Ritchie, P., Rashid, S., Dixon, K., & Walker, G. (2016). *OSH knowledge and its management*. Institution of Occupational Safety and Health. <https://iosh.com/media/3420/osh-knowledge-and-its-management.pdf>
- Dekker, S. (2017). *Safety differently: human factors for a new era* (2nd ed.). CRC Press.
- Dusenberry, L., & Robinson, J. (2020). Building Psychological Safety Through Training Interventions: Manage the Team, Not Just the Project. *Ieee Transactions on Professional Communication*, 63(3), 207-226. <https://doi.org/10.1109/tpc.2020.3014483>
- Edwards, J., Davey, J., & Armstrong, K. (2015). Cultural Factors: Understanding Culture to Design Organisational Structures and Systems to Optimise Safety. *Procedia Manufacturing*, 3, 4991-4998. <https://doi.org/10.1016/j.promfg.2015.07.650>
- EPOC. (2017). *EPOC Resources for review authors*. Cochrane Effective Practice and Organisation of Care. epoc.cochrane.org/resources/epoc-resources-review-authors

- Floyd, H. L. (2015). A Practical Guide for Applying the Hierarchy of Controls to Electrical Hazards. *IEEE Transactions on Industry Applications*, 51(5), 4263-4266. <https://doi.org/10.1109/TIA.2015.2431634>
- Franco, A., Malhotra, N., & Simonovits, G. (2014). Publication bias in the social sciences: Unlocking the file drawer. *Science*, 345(6203), 1502-1505. <https://www.jstor.org/stable/24917654>
- Furber, A., Duncan, S., Smith, S. D., & Crapper, M. (2012). The health and safety implications of socio-cultural context for community construction projects in developing countries. *Construction Management and Economics*, 30(10), 857-867. <https://doi.org/10.1080/01446193.2012.707324>
- Gao, R., Chan, A. P. C., Utama, W. P., & Zahoor, H. (2017). Workers' Perceptions of Safety Climate in International Construction Projects: Effects of Nationality, Religious Belief, and Employment Mode. *Journal of Construction Engineering and Management*, 143(4), Article 04016117. [https://doi.org/10.1061/\(ASCE\)CO.1943-7862.0001226](https://doi.org/10.1061/(ASCE)CO.1943-7862.0001226)
- Gerbec, M. (2017). Safety change management – A new method for integrated management of organizational and technical changes. *Safety Science*, 100, 225-234. <https://doi.org/10.1016/j.ssci.2016.07.006>
- Ghezzi, V., Probst, T. M., Petitta, L., & Barbaranelli, C. (2020). Multilevel Job Demands and Resources: Cross-level Effects of Competing Organizational Facet-Specific Climates on Risky Safety Behaviors. *International Journal of Environmental Research and Public Health*, 17(10), 3496. <https://doi.org/10.3390/ijerph17103496>
- González-Formoso, C., Clavería, A., Fernández-Domínguez, M. J., Lago-Deibe, F. L., Hermida-Rial, L., Rial, A., Gude-Sampedro, F., Pita-Fernández, S., & Martín-Miguel, V. (2019). Effectiveness of an educational intervention to improve the safety culture in primary care: A randomized trial. *Bmc Family Practice*, 20(1), Article 15. <https://doi.org/10.1186/s12875-018-0901-8>
- Grant, M. J., & Booth, A. (2009). A typology of reviews: an analysis of 14 review types and associated methodologies. *Health Information & Libraries Journal*, 26(2), 91-108. <https://doi.org/10.1111/j.1471-1842.2009.00848.x>
- Grosso, M. B. (2008). Patient safety, quality of care, and physician professionalism: Do these goals conflict? *Journal of Family Practice*, 57, S17-S19.
- Guo, B. H. W., Goh, Y. M., & Wong, K. L. X. (2018). A system dynamics view of a behavior-based safety program in the construction industry. *Safety Science*, 104, 202-215. <https://doi.org/10.1016/j.ssci.2018.01.014>
- Harrison, J. S., Banks, G. C., Pollack, J. M., O'Boyle, E. H., & Short, J. (2017). Publication Bias in Strategic Management Research. *Journal of Management*, 43(2), 400-425. <https://doi.org/10.1177/0149206314535438>
- Hasle, P., & Jensen, P. L. (2006). Changing the internal health and safety organization through organizational learning and change management. *Human Factors and Ergonomics in Manufacturing & Service Industries*, 16(3), 269-284. <https://doi.org/10.1002/hfm.20053>
- Haynes, E., Kramer, D. M., Strahlendorf, P., Holness, D. L., Kushner, R., & Tenkate, T. (2018). A cross-Canada knowledge transfer and exchange workplace intervention targeting the adoption of sun safety programs and practices: Sun Safety at Work Canada. *Safety Science*, 102, 238-250. <https://doi.org/10.1016/j.ssci.2017.10.013>
- Herrera-Sánchez, I. M., León-Pérez, J. M., & León-Rubio, J. M. (2017). Steps to Ensure a Successful Implementation of Occupational Health and Safety Interventions at an Organizational Level. *Frontiers in Psychology*, 8, 2135. <https://doi.org/10.3389/fpsyg.2017.02135>
- Hickisch, R., Hodgetts, T., Johnson, P. J., Sillero-Zubiri, C., Tockner, K., & Macdonald, D. W. (2019). Effects of publication bias on conservation planning. *Conservation Biology*, 33(5), 1151-1163. <https://doi.org/10.1111/cobi.13326>
- Hollnagel, E. (2014). *Safety-I and safety-II : the past and future of safety management*. Ashgate.
- Hudson, H. L., Schill, A. L., & Richards, R. (2021). An Exploratory, Qualitative Study of How Organizations Implement the Hierarchy of Controls Applied to Total Worker Health.

- International Journal of Environmental Research and Public Health*, 18(19), 10032. <https://doi.org/10.3390/ijerph181910032>
- ISO. (2018). *Occupational health and safety management systems—Requirements with guidance for use (ISO Standard No. 45001)*. International Organization for Standardization.
- Joss, N., Dupré-Husser, E., Cooklin, A., & Oldenburg, B. (2017). The emergence of integrated approaches to worker health, safety and wellbeing in Australia. *Australian Journal of Primary Health*, 23(2), 154-161. <https://doi.org/10.1071/PY16065>
- Juárez-Carrillo, P. M., Liebman, A. K., Reyes, I. A. C., Ninco Sánchez, Y. V., & Keifer, M. C. (2017). Applying learning theory to safety and health training for Hispanic immigrant dairy workers. *Health promotion practice*, 18(4), 505-515.
- Karanikas, N. (2018). Engineering Safety Recommendations: Results from a Survey in Aviation. Safety and Reliability – Safe Societies in a Changing World, Proceedings of the European Safety & Reliability Conference ESREL 2018, London.
- Karanikas, N., Obadimu, S. O., & Plioutsias, A. (2020). Safety contributions, events and operating context as criteria in safety awards: A case study from a large organisation. *Sustainability*, 12(22), 1-25, Article 9498. <https://doi.org/10.3390/su12229498>
- Karanikas, N., Roelen, A., & Piric, S. (2019). Design, scope and focus of safety recommendations: results from aviation safety investigations. *Policy and Practice in Health and Safety*, 17(1), 14-31. <https://doi.org/10.1080/14773996.2018.1539385>
- Karwowski, W. (2005). Ergonomics and human factors: the paradigms for science, engineering, design, technology and management of human-compatible systems. *Ergonomics*, 48(5), 436-463. <https://doi.org/10.1080/00140130400029167>
- Lamb, P., & Currie, G. (2012). Eclipsing adaptation: The translation of the US MBA model in China. *Management Learning*, 43(2), 217-230. <https://doi.org/10.1177/1350507611426533>
- Ledo, J., Hettinga, K. A., Bijman, J., Kussaga, J., & Luning, P. A. (2021). A tailored food safety and hygiene training approach for dairy farmers in an emerging dairy chain. *Food Control*, 124, Article 107918. <https://doi.org/10.1016/j.foodcont.2021.107918>
- Lindøe, P. H., Engen, O. A., & Olsen, O. E. (2011). Responses to accidents in different industrial sectors. *Safety Science*, 49(1), 90-97. <https://doi.org/10.1016/j.ssci.2009.12.007>
- Lord, R. G., Klimoski, R. J., & Kanfer, R. (2002). *Emotions in the Workplace: Understanding the Structure and Role of Emotions in Organizational Behavior*. Pfeiffer Imprint.
- Lu, J., Yang, N., Ye, J., & Wu, H. (2014). The Influence Paths of Emotion on the Occupational Safety of Rescuers Involved in Environmental Emergencies- Systematic Review Article. *Iranian Journal of Public Health*, 43(11), 1478-1485.
- Lutchman, C. (2012). *Safety management a comprehensive approach to developing a sustainable system*. CRC Press.
- Marquard, N., Hoebel, M., & Lud, D. (2021). Safety culture transformation—The impact of training on explicit and implicit safety attitudes. *Human Factors and Ergonomics In Manufacturing*, 31(2), 191-207. <https://doi.org/10.1002/hfm.20879>
- Masso, M. (2015). The determinants of employee participation in occupational health and safety management. *International Journal of Occupational Safety and Ergonomics*, 21(1), 62-70. <https://doi.org/10.1080/10803548.2015.1017959>
- McDonald, J. D., & Durso, F. T. (2015). A Behavioral Intervention for Reducing Postcompletion Errors in a Safety-Critical System. *Human Factors*, 57(6), 917-929. <https://doi.org/10.1177/0018720815584232>
- Méndez Rivero, F., Padrosa, E., Utzet, M., Benach, J., & Julià, M. (2021). Precarious employment, psychosocial risk factors and poor mental health: A cross-sectional mediation analysis. *Safety Science*, 143, 105439. <https://doi.org/10.1016/j.ssci.2021.105439>
- Merigó, J. M., Miranda, J., Modak, N. M., Boustras, G., & de la Sotta, C. (2019). Forty years of Safety Science: A bibliometric overview. *Safety Science*, 115, 66-88. <https://doi.org/10.1016/j.ssci.2019.01.029>

- Micheli, G. J. L., Cagno, E., & Calabrese, A. (2018). The transition from occupational safety and health (OSH) interventions to OSH outcomes: An empirical analysis of mechanisms and contextual factors within small and medium-sized enterprises. *International Journal of Environmental Research and Public Health*, 15(8), Article 1621. <https://doi.org/10.3390/ijerph15081621>
- Michie, S., van Stralen, M. M., & West, R. (2011). The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implementation Science*, 6(1), 42. <https://doi.org/10.1186/1748-5908-6-42>
- Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & Group, P. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Plos Medicine*, 6(7), e1000097.
- Morgan, J. I., Curcuruto, M., Steer, M., & Bazzoli, A. (2021). Implementing the theoretical domains framework in occupational safety: Development of the safety behaviour change questionnaire. *Safety Science*, 136, Article 105135. <https://doi.org/10.1016/j.ssci.2020.105135>
- Morris, G. A., & Cannady, R. (2019). Proper Use of the Hierarchy of Controls. *Professional Safety*, 64(08), 37-40.
- Morris, T., & Lancaster, Z. (2006). Translating Management Ideas. *Organization Studies*, 27(2), 207-233. <https://doi.org/10.1177/0170840605057667>
- Mou, Y., & Lin, C. A. (2014). Communicating Food Safety via the Social Media: The Role of Knowledge and Emotions on Risk Perception and Prevention. *Science Communication*, 36(5), 593-616. <https://doi.org/10.1177/1075547014549480>
- Newnam, S., Lewis, I., & Watson, B. (2012). Occupational driver safety: Conceptualising a leadership-based intervention to improve safe driving performance. *Accident Analysis and Prevention*, 45, 29-38. <https://doi.org/10.1016/j.aap.2011.11.003>
- Newnam, S., & Oxley, J. (2016). A program in safety management for the occupational driver: Conceptual development and implementation case study. *Safety Science*, 84, 238-244. <https://doi.org/10.1016/j.ssci.2015.12.020>
- Nielsen, J. A., Wæraas, A., & Dahl, K. (2020). When management concepts enter the public sector: a dual-level translation perspective. *Public Management Review*, 22(2), 234-254. <https://doi.org/10.1080/14719037.2019.1582689>
- Work Health and Safety Consultation Cooperation and Coordination: Code of Practice, (2019). <https://www.safework.nsw.gov.au/resource-library>
- Ochsmann, E., Noll, U., Ellegast, R., Hermanns, I., & Kraus, T. (2016). Influence of different safety shoes on gait and plantar pressure: A standardized examination of workers in the automotive industry. *Journal of Occupational Health*, 58(5), 404-412. <https://doi.org/10.1539/joh.15-0193-OA>
- Olsen, E., & Aase, K. (2010). A comparative study of safety climate differences in healthcare and the petroleum industry. *Quality & Safety in Health Care*, 19. <https://doi.org/10.1136/qshc.2009.036558>
- Olson, C. M., Rennie, D., Cook, D., Dickersin, K., Flanagan, A., Hogan, J. W., Zhu, Q., Reiling, J., & Pace, B. (2002). Publication Bias in Editorial Decision Making. *Jama*, 287(21), 2825-2828. <https://doi.org/10.1001/jama.287.21.2825>
- Olson, R., Thompson, S. V., Elliot, D. L., Hess, J. A., Rhoten, K. L., Parker, K. N., Wright, R. R., Wipfli, B., Bettencourt, K. M., Buckmaster, A., & Marino, M. (2016). Safety and Health Support for Home Care Workers: The COMPASS Randomized Controlled Trial. *American Journal of Public Health*, 106(10), 1823-1832. <https://doi.org/10.2105/ajph.2016.303327>
- Øygarden, O., & Mikkelsen, A. (2020). Readiness for Change and Good Translations. *Journal of Change Management*, 20(3), 220-246. <https://doi.org/10.1080/14697017.2020.1720775>
- Pekovic, S. (2015). Quality and environmental management practices: Their linkages with safety performance. *Production Planning and Control*, 26(11), 895-909. <https://doi.org/10.1080/09537287.2014.996623>

- Pilbeam, C., Denyer, D., Doherty, N., & Davidson, R. (2019). Designing safer working interventions through a literature review using a mechanisms-based approach. *Safety Science*, 120, 352-361. <https://doi.org/10.1016/j.ssci.2019.07.017>
- Porter, L. W., & McLaughlin, G. B. (2006). Leadership and the organizational context: Like the weather? *The Leadership quarterly*, 17(6), 559-576. <https://doi.org/10.1016/j.leaqua.2006.10.002>
- Randmaa, M., Mårtensson, G., Swenne, C. L., & Engström, M. (2014). SBAR improves communication and safety climate and decreases incident reports due to communication errors in an anaesthetic clinic: A prospective intervention study. *BMJ open*, 4(1), Article e004268. <https://doi.org/10.1136/bmjopen-2013-004268>
- Rice, J., Daouk-Öyry, L., & Hitti, E. (2021). It's time to consider national culture when designing team training initiatives in healthcare. *BMJ quality & safety*, 30(5), 412-417. <https://doi.org/10.1136/bmjqs-2020-010918>
- Robertson, M., Henning, R., Warren, N., Nobrega, S., Dove-Steinkamp, M., Tibirica, L., & Bizarro, A. (2013). The Intervention Design and Analysis Scorecard: a planning tool for participatory design of integrated health and safety interventions in the workplace. *Journal of Occupational and Environmental Medicine*, 55(12 Suppl), S86-88. <https://doi.org/10.1097/jom.0000000000000036>
- Rodrigues, M. A., Vale, C., & Silva, M. V. (2018). Effects of an occupational safety programme: A comparative study between different training methods involving secondary and vocational school students. *Safety Science*, 109, 353-360. <https://doi.org/10.1016/j.ssci.2018.06.013>
- Røvik, K. A. (2016). Knowledge Transfer as Translation: Review and Elements of an Instrumental Theory. *International Journal of Management Reviews*, 18(3), 290-310. <https://doi.org/10.1111/ijmr.12097>
- Schneid, T. D., & Schneid, S. L. (2019). *Human resources and change management for safety professionals*. Taylor & Francis, CRC Press. <https://doi.org/10.1201/9780429029660>
- Sood, A., Knudsen, K., Sood, R., Wahner-Roedler, D. L., Barnes, S. A., Bardia, A., & Bauer, B. A. (2007). Publication bias for CAM trials in the highest impact factor medicine journals is partly due to geographical bias. *Journal of Clinical Epidemiology*, 60(11), 1123-1126. <https://doi.org/10.1016/j.jclinepi.2007.01.009>
- Spigarelli, C. (2020). Understanding the Hierarchy of Controls Through a Pandemic. *Professional Safety*, 65(5), 20-21.
- Stevens, K. (1997). *Implementing new technologies for public safety communication: competing frequency demands and standardization issues* Enabling Technologies for Law Enforcement and Security,
- Sujan, M. (2015). An organisation without a memory: A qualitative study of hospital staff perceptions on reporting and organisational learning for patient safety. *Reliability Engineering & System Safety*, 144, 45-52. <https://doi.org/10.1016/j.res.2015.07.011>
- Sujan, M. A. (2012). A novel tool for organisational learning and its impact on safety culture in a hospital dispensary. *Reliability Engineering & System Safety*, 101, 21-34. <https://doi.org/10.1016/j.res.2011.12.021>
- Talbot, T. R., Wang, D., Swift, M., St. Jacques, P., Johnson, S., Brinsko, V., Thayer, V., Dail, T., Feistritz, N., & Polancich, S. (2014). Implementation of an enhanced safety-engineered sharp device oversight and bloodborne pathogen protection program at a large academic medical center. *Infection Control and Hospital Epidemiology*, 35(11), 1383-1390. <https://doi.org/10.1086/678417>
- Turner, L., Amyotte, P., & Rayner Brown, K. (2021). Hierarchy of controls in Contra Costa Health Services (CCHS) incident investigations. *Process Safety Progress*, e12250. <https://doi.org/10.1002/prs.12250>
- Underhill, E., & Quinlan, M. (2011). How Precarious Employment Affects Health and Safety at Work: The Case of Temporary Agency Workers. *Relations Industrielles*, 66(3), 397-421. <https://doi.org/10.7202/1006345ar>

- Wæraas, A. (2021). Understanding change in circulating constructs: collective learning, translation and adaptation. *The Learning Organization*, 28(1), 1-14. <https://doi.org/10.1108/TLO-08-2020-0140>
- Walter, S. R., Li, L., Dunsmuir, W. T. M., & Westbrook, J. I. (2014). Managing competing demands through task-switching and multitasking: a multi-setting observational study of 200 clinicians over 1000 hours. *BMJ quality & safety*, 23(3), 231. <https://doi.org/10.1136/bmjqs-2013-002097>
- Wang, Y., Chen, H., Liu, B., Yang, M., & Long, Q. (2020). A Systematic Review on the Research Progress and Evolving Trends of Occupational Health and Safety Management: A Bibliometric Analysis of Mapping Knowledge Domains. *Frontiers in Public Health*. <https://doi.org/10.3389/fpubh.2020.00081>
- Wang, Y. M., Ahmad, W., Arshad, M., Yin, H. L., Ahmed, B., & Ali, Z. (2021). Impact of Coordination, Psychological Safety, and Job Security on Employees' Performance: The Moderating Role of Coercive Pressure. *Sustainability*, 13(6), 3175. <https://doi.org/10.3390/su13063175>
- Wareham-Fowler, S., & Fowler, K. (2010). Risk perception, safety behaviour, employment precarity and community attachment: the case of Newfoundland and Labrador fibreglass boat-building workers. *Policy and Practice in Health and Safety*, 8(1), 43-60.
- WHSQ. (2011). *Work health and safety consultation, co-operation and co-ordination code of practice 2011*. https://www.worksafe.qld.gov.au/_data/assets/pdf_file/0026/72647/whs-consultation-cooperation-coordination-cop-2021.pdf
- Winckel, J., Sousa, L. S., Myers, M. R., & Ozog, H. (2015). Organizational change management for process safety. *Process Safety Progress*, 34(1), 89-93. <https://doi.org/10.1002/prs.11688>
- Winge, S., Albrechtsen, E., & Arnesen, J. (2019). A comparative analysis of safety management and safety performance in twelve construction projects. *Journal of Safety Research*, 71, 139-152. <https://doi.org/10.1016/j.jsr.2019.09.015>
- Zhang, J., Xie, C., & Morrison, A. M. (2021). The effect of corporate social responsibility on hotel employee safety behavior during COVID-19: The moderation of belief restoration and negative emotions. *Journal of Hospitality and Tourism Management*, 46, 233-243. <https://doi.org/10.1016/j.jhtm.2020.12.011>
- Zohar, D., Werber, Y. T., Marom, R., Curlau, B., & Blondheim, O. (2017). Modifying head nurse messages during daily conversations as leverage for safety climate improvement: a randomised field experiment. *BMJ quality & safety*, 26(8), 653-662. <https://doi.org/10.1136/bmjqs-2016-005910>
- Zotzmann, Y., van der Linden, D., & Wyrwa, K. (2019). The relation between country differences, cultural values, personality dimensions, and error orientation: An approach across three continents – Asia, Europe, and North America. *Safety Science*, 120, 185-193. <https://doi.org/10.1016/j.ssci.2019.06.013>



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