

# Effectiveness of occupational safety and health interventions: A long way to go

**Background:** Occupational Safety and Health (OSH) has become an area of increasing concern for organizations and institutions. As it evolves, it has gradually posed ongoing challenges, becoming more complex, for organizations. Consequently, more comprehensive studies are required to advance academic and institutional research. From this perspective, this study aims to gather research contributions on the effectiveness of existing interventions for OSH improvement and identify areas for further exploration.

**Methods:** According to the nature of scientific literature, the overall process of a literature review was investigated following an integrative approach, which involved searching for, selecting, and analyzing various literature in a creative and integrated manner, without a predefined structure.

**Results:** The analysis suggests that there is room for improvement in understanding the effectiveness of OSH interventions and more concrete guidance is still desirable. Based on the literature, some research areas for future developments in OSH interventions are identified. One potential area to explore further is fostering a more conscious network of stakeholders, with higher coordination, shared knowledge, and open communication.

**Implications:** Focusing on the proposed directions will support scholars and practitioners in pursuing continuous OSH improvement through more effective and well-grounded workplace interventions and encourage organizations to be proactive in daily OSH management.

**Keywords:** literature review; integrative review; interventions; effectiveness; occupational health; occupational safety; management

## 36 **1. Introduction: a practical issue**

37 Considering the international statistics on occupational accidents and diseases, an alarming situation  
38 with an increasing trend is evident. Recently, the International Labour Organization (ILO) (1)  
39 estimated the annual global work deaths to be 2.78 million, approximately 7,600 per day (2). Work-  
40 related deaths in Asia account for two-thirds of the total global workplace fatalities, whereas those  
41 in Africa and Europe account for less than 12% (3). ILO calculated approximately 340 million  
42 occupational accidents worldwide and 160 million victims of work-related diseases annually, with  
43 an increasing trend (4). The corresponding loss of workdays accounts for US \$3.2 trillion,  
44 comparable to nearly 4% of the global GDP (3). Workplace health and safety management and  
45 promotion may positively impact workers and leadership and engagement at all levels are key issues  
46 in changing the workplace culture (5).

47 In this context, effective Occupational Safety and Health (OSH) interventions are a leading priority,  
48 particularly for organizations struggling to manage health and safety in the workplace (6,7). OSH is  
49 a discipline focusing on the prevention of work-related injuries and diseases and the promotion of  
50 the health, safety, and well-being of the workers at the workplace by improving their working  
51 conditions (8). Advancing research on OSH towards more theoretical and strategic perspectives and  
52 investigating how to constantly improve OSH management at the system level could enhance OSH  
53 interventions on the ground (9). There is, in this respect, a growing interest in OSH management  
54 performance among public institutions, which are allocating considerable resources towards  
55 improving workplace OSH conditions (10–12); however, it is essential, and more studies are still  
56 needed, to assess the effectiveness of these efforts (13).

57 In the last years, scholars have emphasized that assessing the effectiveness of interventions is crucial  
58 for maximizing their impact and working for their continuous improvement (13). Nonetheless, their  
59 effectiveness is still rarely monitored and often assumed without proper assessment since considered  
60 too difficult to measure as interventions often operate in nuanced contexts, relying on myriad  
61 qualitative factors that are difficult to track (14–16). Hence, a discussion has been introduced in the  
62 literature on the effectiveness of OSH interventions, however, a comprehensive view of the overall  
63 problem is still not plain and understanding the status quo and identifying potential improvement  
64 areas will make scholars and practitioners aware of the major issues and will support them in  
65 pursuing higher effectiveness in OSH interventions.

66 In this regard, through a review of the OSH literature, this study aimed to gather research  
67 contributions on the effectiveness of existing interventions, derive knowledge on how researchers  
68 are moving forward towards more effective interventions for OSH improvement and identify areas  
69 that merit deeper exploration.

70 According to the nature of scientific literature, the overall literature review process has been  
71 investigated following an integrative approach (17), which involves searching for, selecting, and  
72 analyzing various literature in a creative and integrated manner, without a predefined structure. This  
73 allows researchers to provide a comprehensive understanding of complex concepts while not aiming  
74 to include all published work on the topic, which would potentially turn into an endless process, but  
75 rather to consistently pursue the research objective by combining different perspectives and obtaining  
76 relevant findings. Accordingly, this study examined a specific branch of literature that investigated  
77 the effectiveness of interventions from different perspectives, and options for their improvement  
78 without intentionally including all extant literature on OSH interventions, which is beyond the scope  
79 of this study.

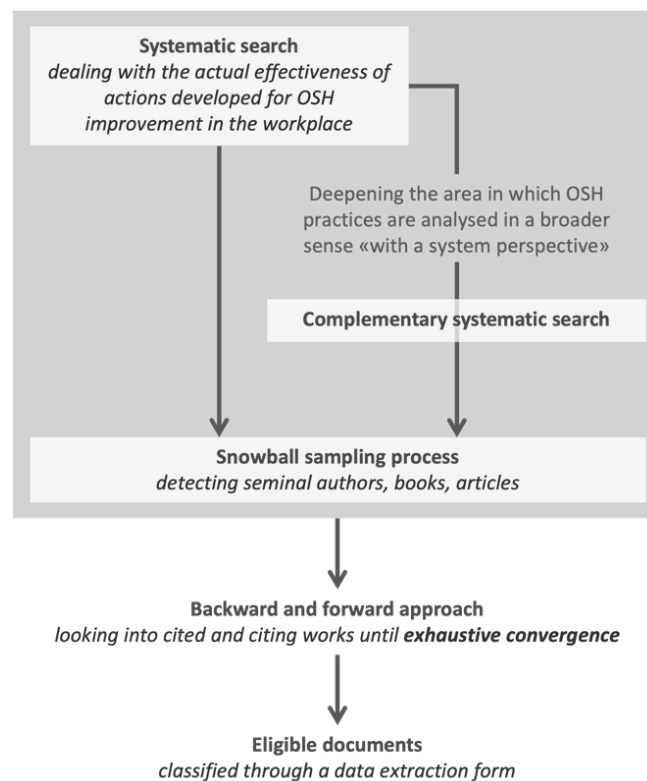
## 80 **2. Methods: literature review process**

81 To examine the current state of interventions for OSH improvement, this study reviewed OSH  
82 literature, following Snyder's (17) integrative approach. Different types of literature reviews exist;  
83 according to Snyder (17), they can be classified as purely systematic, semi-systematic, or integrative  
84 reviews. A "best option" does not exist, and the choice depends on the field and scope of the study.  
85 This study adopted an integrative approach (18). According to Torraco (18), an integrative literature  
86 review is a sophisticated form of research that requires a great deal of research skill and insight and  
87 is not less rigorous than other types of research. An integrative literature review is a form of research

88 that searches for, selects, and analyzes documents in an integrated manner (18), which implies that  
 89 there is no canonical structure to follow; it is shaped by the research itself.  
 90 Since exhaustiveness for literature selection is outside of the scope, or simply not possible, in  
 91 integrative literature reviews, authors are expected to justify the selection of included literature and  
 92 analyze and critique the literature by applying techniques that are not set in advance, since there is  
 93 no well-established format to organize collected articles (18).  
 94 Integrative literature reviews are suggested to address both mature and newly emerging topics and  
 95 strategies for searching and reviewing papers change according to the maturity of the addressed topic.  
 96 The OSH field might be considered a mature topic, although the literature is less structured and quite  
 97 dispersed, with high research potential. In this case, an integrative approach can grasp different facets  
 98 of the OSH literature and more sufficiently answer the research objective.  
 99 Although an integrative literature review article can be organized in various ways, it is expected to  
 100 follow a process that includes the literature search, selection, analysis, and critical synthesis.  
 101 Regarding other review types, readers of an integrative literature review expect transparency  
 102 concerning the review process, that is, how the findings of the study are obtained (18). Integrative  
 103 literature reviews combine different search processes, which do not prevent researchers from  
 104 performing systematic searches; instead, they provide the chance to perform more than one  
 105 systematic search complemented by other sources derived from a snowballing process. Therefore, a  
 106 single systematic search would not be exhaustive and might ignore relevant sources; hence, an  
 107 integrative literature search provides added value.

## 108 2.1. The search process

109 During the search process, two main systematic searches were applied to investigate the OSH  
 110 literature from theoretical and practical perspectives. This supported the subsequent snowball  
 111 sampling process until the final eligible documents for review were identified. The search process  
 112 phases are illustrated in Figure 1.



113 **Figure 1.** The search process.

114

115 The main search protocol in the Scopus database was developed to deepen the core themes of this  
116 study and identify possible seminal documents. It aimed to locate documents in the OSH field dealing  
117 with the actual effectiveness of interventions developed to improve OSH in the workplace. It was  
118 divided into three major blocks:

- 119 • The context: OSH.
- 120 • The area of application: interventions, and synonyms.
- 121 • The aim: performance, outcome, and synonyms.

122 The resulting query was TITLE-ABS-KEY ([“occupational” W/3 “health” W/3 “safety” OR “OSH”  
123 OR “OHS” AND “occupational” AND “health” AND “safety”] W/4 [“intervention\*” OR  
124 “initiative\*” OR “program\*” OR “instrument\*” OR “project\*” OR “measure\*” OR “practice\*”]  
125 AND [“performance\*” OR “effect\*” OR “effic\*” OR “indicator\*” OR “outcome\*” OR “output\*”  
126 OR “impact\*”). A total of 1,042 documents were identified.

127 The choice of keywords and all potential synonyms was based on the Authors’ previous knowledge  
128 of the topic and was complemented by reading the keywords applied in a recent EU-OSHA report  
129 for the European project SESAME (19). This project was developed in collaboration with nine EU  
130 Member States and identified effective programs at the operational and policy level that could lead  
131 to improvements in OSH in Micro and Small Enterprises (MSEs), by defining “what works, for  
132 whom, and in what circumstances” (20). The operator *W/4* (within 4) was used instead of *AND*  
133 because the selected documents should only refer to OSH interventions (or synonyms) and not to  
134 general ones developed in the OSH field. However, it was not possible to precisely quantify the  
135 maximum distance between the words “intervention” and “performance”.

136 By reading documents, it seemed that studies with a system view of OSH matters showed higher  
137 effectiveness in OSH interventions; therefore, another complementary search protocol was  
138 performed in the Scopus database to examine a specific cluster of documents. The resulting query  
139 was TITLE-ABS-KEY ([“occupational” W/3 “health” W/3 “safety”] OR [“OSH”] OR [“OHS”]  
140 AND [“occupational” AND “health” AND “safety”] W/3 [“network\*” OR “system\*” OR  
141 “framework\*”). A total of 1,208 documents were identified.

142 Once the first batch of documents was identified, other documents were selected following both  
143 backward and forward approaches by examining the cited studies of the selected documents  
144 (Figure 1). Both authors employed these approaches to integrate additional documents into the  
145 analysis. Consensus was achieved through a comparison of newly included documents by both  
146 authors, and any discrepancies were reviewed together to determine their inclusion or exclusion.

147 This process was guided by co-citation analysis conducted using the VOSviewer software, which is  
148 open-source software used to visualize and analyze networks that display connections between  
149 different elements, visualizing clusters of similar elements, i.e., relationships between authors,  
150 concepts, or topics within a corpus of texts. In particular, co-citation analysis identifies connections  
151 between documents, authors, or journals based on their co-citation patterns. This analysis facilitated  
152 the tracing of seminal studies and connections between different areas of study. However, despite its  
153 advantages, co-citation analysis relies on cited articles and citations take time to accumulate, making  
154 it challenging to relate new publications directly to existing literature. For this reason, a forward  
155 approach, which involves identifying recent documents citing seminal studies identified through co-  
156 citation analysis, was considered crucial to also include new relevant publications.

157 The search and selection processes were considered reasonably exhaustive when documents almost  
158 converged, that is when selected studies showed a significant number of commonly cited sources.

## 159 2.2. Data analysis

160 Among the relevant studies for analysis, a document reduction was performed by reading the  
161 abstracts, titles, and keywords and eliminating those that were outside of the scope. The final batch  
162 of documents to be included was determined by reading the full studies of the selected abstracts.  
163 Both authors meticulously reviewed the documents, collaborating to identify the final set of studies  
164 for inclusion. Specifically, one author primarily undertook the task of reviewing documents from the

165 two systematic searches and the snowballing sampling process, while the other mostly supervised  
166 the whole process, defining the set of documents for analysis.

167 To ensure a quality data analysis process, documents were analyzed and coded into a data form that  
168 included the normal identification data and the core literature review data, which was selected by  
169 reading the studies. This approach facilitated the process of comparing primary sources because,  
170 owing to the built data extraction form, documents were reduced to a single-page format with similar  
171 data extracted for each of them, which is critical for the review process (21). As in the previous  
172 stages, both authors engaged in document analysis, with one primarily responsible for inputting data  
173 into the extraction form, while the other oversaw and refined the information by reviewing the full  
174 texts of the selected studies.

175 Once the documents were coded into the data extraction form, a constant data comparison approach  
176 was implemented to identify the main patterns and lines of research by iteratively comparing the  
177 studies and collaborative discussing them between the two authors undertaking the task (21,22). The  
178 results of this process are presented in the results section, where the literature review findings are  
179 grouped by topic.

### 180 3. Results: Effectiveness discussion in the OSH literature

181 The literature review examined current research streams focusing on understanding successful  
182 interventions that can improve workplace OSH management. For these reasons, the selected  
183 documents address effectiveness from different perspectives by including both theoretical analyses  
184 of interventions' effectiveness and practical studies from real-world applications.

185 Through a comprehensive analysis of these documents, the review identified a highly debated topic  
186 embedded in the discussion of OSH interventions – the OSH Management Systems (OSHMSs) – to  
187 which a sub-section is dedicated. It is worth noting that in the OSH field, a prominent part of OSH  
188 interventions relies on OSHMSs, which are designed to foster improvement in OSH management at  
189 the organizational level. This connection emphasizes the significance of delving into OSHMSs when  
190 discussing OSH interventions, making them a natural area of investigation within the discussion of  
191 OSH interventions.

192 Before reviewing the literature, definitions of OSH interventions and OSHMSs are stated below.

- 193 • OSH interventions are actions taken to prevent injuries and diseases in the work environment  
194 by improving employees' safety, health, and well-being.
- 195 • OSHMSs do not share a consensus on what they are (14). The OSHMSs are either mandatory  
196 or voluntary (14,23). Mandatory OSHMSs are developed from government legislation, and  
197 their use is enforced through inspections, fines, etc., as specified by the EU Directive  
198 89/391/EEC (24). Voluntary OSHMSs are established to guide action at the national and  
199 enterprise levels, although they are not intended to replace national regulations. ILO (25)  
200 defined a voluntary OSHMS as: "A set of interrelated or interacting elements to establish  
201 OSH policy and objectives, and to achieve those objectives". Frick et al. (26) defined a  
202 voluntary OSHMS as a comprehensive framework for policy development, risk assessment,  
203 risk management, and evaluation of effectiveness within an organization. In addition, every  
204 employer should establish a voluntary OSHMS in their workplace to better manage  
205 occupational accidents and diseases and continuously improve OSH performance (25).  
206 OSHMSs usually arise through private enterprises, employer groups, the government and its  
207 agencies, insurance carriers, professional organizations, and standards associations. The  
208 introduction of international standards, such as the ISO 45001:2018 (27), moves in this  
209 direction by providing frameworks for OSHMSs to manage risks and opportunities.

210 The following sections cover the effectiveness of OSH interventions (*Section 3.1*) and OSHMSs  
211 (*Section 3.2*), and **Table 1** summarizes the essential findings.

212

213 **Table 1.** Findings on the effectiveness of OSH interventions and OSHMSs.

OSH interventions	Planning all the phases of interventions from the initial design to the ongoing monitoring for durable positive effects
	Considering the complexity of the environment where interventions take place

	Viewing context as a dynamic and essential part of the intervention process
	Adopting a realist perspective, considering the mechanisms that positively or negatively affect interventions
	Rising interest in methodologies, such as the program theory, which investigates the context and mechanisms influencing intervention development and outcomes
	Continuous monitoring of intervention effects rather than time-limited evaluations
<b>OSHMSs</b>	Exploring OSHMSs for improving workplace OSH management and enhancing intervention outcomes
	Enhancing OSHMSs in organizations with <ul style="list-style-type: none"> <li>• Alignment with internal organizational culture and management</li> <li>• Management commitment and effective leadership</li> <li>• Workers' awareness and active involvement</li> <li>• Engagement with external entities, such as collaborative relationships with trade unions</li> </ul>
	Fostering collaboration between policymakers and OSH stakeholders for balanced perspectives on regulations
	Promoting the benefits of self-regulation as a complementary approach to OSHMSs, by developing guidelines and frameworks that can facilitate the smooth integration of self-regulation within existing OSHMS structures
	Encouraging organizations to adopt and regularly review evaluation criteria and Key Performance Indicators (KPIs) to assess OSHMS effectiveness and drive continuous improvement

### 214 3.1. Effectiveness of OSH interventions

215 A significant segment of the OSH literature focuses on the evaluation of OSH interventions to detect  
216 how they have (or should have) effectively contributed to improving OSH work conditions and a few  
217 examples are reported below. Micheli et al. (28) conducted research aiming to understand the  
218 mechanisms determining the success or failure of OSH interventions, considering both barriers and  
219 drivers along with contextual factors. Utilizing a multiple case study approach, 58 techno-  
220 organizational interventions were evaluated to assess the key factors influencing the interventions'  
221 outcomes. In another study, Olsen et al. (29) showed how the application of realist analysis and  
222 program theory to a specific New Zealand intervention could be generally used as a framework for  
223 evaluating, developing, and improving other national interventions. Fridrich et al. (15), as another  
224 example, introduced a Context, Process, and Outcome (CPO) evaluation model designed to assess  
225 complex organizational health interventions (OHIs), which was tested in an OHI at a Swiss hospital.  
226 General interventions, potentially applicable to several working environments, have often been  
227 described in the literature (6,14,15,28,30–39). Other studies, attempting to develop more effective  
228 interventions, have targeted specific working contexts, such as Small and Medium-sized Enterprises  
229 (SMEs), which are normally more vulnerable than larger organizations and require ad hoc measures  
230 (6,7,40,41). Other studies have examined precise typologies of interventions, such as  
231 musculoskeletal disorders (42) and training (43,44).

232 Several scholars have expressed concerns about the limited guidance provided for building up  
233 effective interventions (13,28,36,38). In this regard, several systematic literature reviews on OSH  
234 interventions have aimed to detect possible categories of interventions with higher effectiveness  
235 (7,14,30,35,44,45). However, most of these reviews concluded that there were little to no quantitative  
236 results to assess the effectiveness of interventions. Owing to the considerable variability in the  
237 environment, interventions often exhibited a high degree of heterogeneity, making systematic  
238 comparisons challenging in literature reviews (14,44,45).

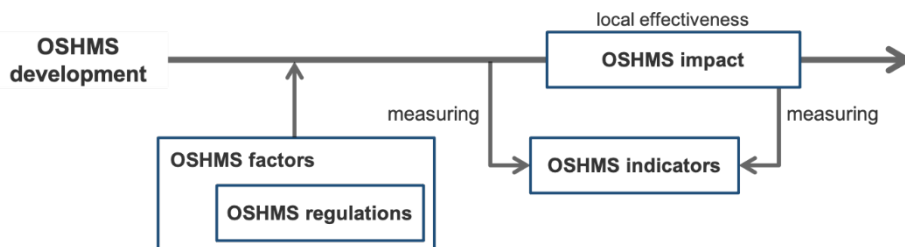
239 Predicting the true impact of interventions can be challenging (15) as their success is likely to depend  
240 on various factors such as their nature, specific workplace characteristics, and the broader external  
241 environment (14). Typically, these interventions are assessed under controlled ideal conditions,  
242 leading to outcomes that may not always meet expectations (28,46). As such, further research is  
243 needed to enhance the effectiveness of these interventions, an aspect that sometimes does not receive  
244 the attention it deserves (35,47–49). In this vein, scholars have questioned the appropriate  
245 methodology for evaluating interventions, and some have highlighted challenges linked to the

246 diverse results (due to the high heterogeneity of the results) seen in quantitative evaluations. Some  
 247 systematic literature reviews have implicitly emphasized the need to understand the mechanisms  
 248 (what has or has not worked) that positively or negatively affect interventions (9,14,30,33). Recent  
 249 studies have been exploring alternative methods to evaluate and compare interventions, moving away  
 250 from the commonly used Randomized Control Trials (RCTs). Instead, there is a growing interest in  
 251 methodologies grounded in program theory (20). This allows the analysis of interventions through a  
 252 more qualitative approach by considering the chains of events that affect their development and  
 253 effectiveness. Thus, similar interventions can lead to divergent results because several contextual  
 254 factors and mechanisms can affect the outcome, leading to success or failure. As Zwetsloot et al. (6)  
 255 pointed out: “Whether OSH implementation will be successful depends on mechanisms, the  
 256 characteristics of organizations, and their context”. In this vein, recent scholarly studies, such as Hale  
 257 (50), Pryor et al. (51), and Uhrenholdt Madsen et al. (52), have focused on the roles of various OSH  
 258 stakeholders. Zwetsloot et al. (6) and Hasle et al. (53) have explored the orchestration of these diverse  
 259 stakeholders aiming to identify potential improvement areas beyond the confines of individual  
 260 organizations. Key stakeholders, including representatives from trade unions and employer  
 261 associations, play a pivotal role in shaping interventions that are well-grounded in real settings (54).  
 262 Furthermore, several scholars have proposed models based on program theory both for designing  
 263 (16,28,55,56) and evaluating (6,15,16,28,29,39,57) OSH interventions. Notably, Fridrich et al. (15)  
 264 introduced a perspective that views the “context not only as a static and confounding factor that  
 265 hinders or facilitates the implementation process but also as a transformable and essential part of the  
 266 intervention”. Outcome evaluation is thus seen as a continuous process rather than a particular, time-  
 267 limited intervention phase. This provides a dynamic view of program theory, enabling the monitoring  
 268 of intervention effects over time, which is rarely performed. However, little evidence of the sustained  
 269 positive impacts of such interventions over the long term has been provided in the literature (13).  
 270 Therefore, further research is required, and the OSHMSs presented below, from various angles, hold  
 271 promise for enhancing workplace OSH management and potentially amplifying the positive effects  
 272 of OSH interventions.

273 **3.2. Effectiveness of OSHMSs**

274 Through the review of OSHMS’s literature, macro-research areas were identified (Figure 2), and the  
 275 findings are presented following the classification below.

- 276 • OSHMS impact, i.e., the estimated impact on organizations.
- 277 • OSHMS factors are elements that can facilitate (drivers) or hinder (barriers) OSHMSs’  
 278 development.
- 279 • OSHMS regulations, i.e., the role played by laws and regulations.
- 280 • OSHMS indicators, i.e., how the effectiveness of OSHMs should be assessed and measured.



281 **Figure 2.** The relationship between macro-research areas on OSHMSs.

282 Each of these categories highlights significant areas that previous scholars have identified and begun  
 283 to address in recent years, contributing to a better understanding of OSHMSs and their effects on  
 284 workplace OSH management. The results from the literature are presented below, highlighting both  
 285 challenges and promising opportunities related to OSHMSs.  
 286

287 **3.2.1. OSHMS impact**

288 Regarding OSHMS impact, a significant amount of literature referred to voluntary OSHMSs,  
 289 especially international standards – i.e., OHSAS 18001:2007 (58), ISO 45001:2018 (27) – by  
 290 assessing the estimated impact of those strategies on organizations. Two principal lines of thought  
 291 exist regarding the impact of OSHMS standards.

- 292 • A positive effect, i.e., higher OSH performance (59–70).
- 293 • A neutral effect since a certification does not guarantee better OSH performance (71–80).

294 Scholars have highlighted the positive impacts of OSHMSs on organizations, particularly  
 295 emphasizing two major aspects: OSH performance like work-related and fatal accident rates  
 296 (63,66,67) and financial performance such as sales growth, enhanced labor productivity, and reduced  
 297 accident-related expenses (59,60,68). While none stated that OSHMSs negatively affect an  
 298 organization’s OSH performance, it is recognized that simply obtaining a voluntary OSHMS  
 299 certification does not necessarily imply better organizational OSH performance, since it needs to be  
 300 sustained by the organization’s culture and management (71). Furthermore, OSHMSs might  
 301 sometimes address generic concerns rather than the specific needs of an organization (72,80).  
 302 OSHMS audits are generally well-perceived and have the potential to be transformative tools, but,  
 303 in some cases, become “a ritual rather than a means of improving workplace health and safety” (73)  
 304 Notably, certified OSHMS adopters generally provide a higher level of OSH management than non-  
 305 adopters. However, there are instances where the actual efforts towards OSH within certified  
 306 organizations may seem less pronounced, suggesting that certification alone does not ensure a high  
 307 level of OSH management for all adopters (70). Yet, the direct correlation between such certifications  
 308 and enhanced OSH performance is not always linear (26). Building on this, Frick (81) outlined three  
 309 integral components that define a robust OSHMS: procedures for risk assessment (what should be  
 310 done), empowering stakeholders to implement procedures (how to do it), and management control  
 311 (doing the right thing).

312 **3.2.2. OSHMS factors**

313 The effective implementation of OSHMSs relies on several factors that can facilitate or hinder their  
 314 development. A comprehensive review by da Silva and Amaral (82) has provided a consistent  
 315 number of OSHMS factors, those contributing to the success of OSHMSs and other potential  
 316 obstacles in their implementation. This analysis was further enriched by incorporating insights from  
 317 other scholarly studies to integrate and confirm the initially identified factors. Table 2 offers a  
 318 consolidated overview, summarizing all the drivers and barriers associated with OSHMS  
 319 implementation.

320 **Table 2.** Drivers and barriers to OSHMS implementation.

<b>OSHMS DRIVERS</b>		<b>OSHMS BARRIERS</b>	
<b>Organization commitment</b>		<b>Organization commitment</b>	
Workers’ awareness	(83)	Lack of management commitment	(82,84,85)
Workers’ participation	(82,84–87)	Lack of knowledge regarding the importance of OSHMSs, particularly in SMEs	(82,88,89)
Management commitment and leadership	(66,82,84–87,90,91)	Differing visions between organization managers and OSH managers	(63,82)
		Lack of workers’ participation	(82,84)
		Lack of safety culture	(82,84)
<b>Organization synergies</b>		<b>Availability of resources</b>	
Trade unions’ involvement	(85)	Lack of specialized personnel	(82,88,92)
More participatory and flatter organizational structures	(93)	Lack of economic resources, particularly in SMEs	(82,88,89)



Cooperative relations among labor-market	(93)	Lack of time (time-wasting), particularly in SMEs	(89)
<b>OSH management</b>		<b>OSH management</b>	
Training	(82,84,86,93)	Often underestimate the risks within organizations, particularly in SMEs	(89)
Risk assessment	(82,86)	Lack of safe communication	(82,84)
Definition of responsibilities	(82,86)		
Communication and dissemination of results	(82,86)		
OSH policy and programs	(82,84,91,94)		
Supervision	(82,90)		
Safe work procedures	(82,90)		

321  
322 The commitment of an organization and its approach to OSH management play a crucial role in  
323 facilitating or hindering OSHMS' development. Management commitment and good leadership  
324 (66,82,84–87,90,91) on one side and workers' awareness (83) and active participation (82,84–87) on  
325 the other are core drivers encouraging the establishment of OSHMSs. Positive OSH management  
326 strategies, such as transparent communication, robust risk assessments, and proactive supervision,  
327 act as drivers, while their neglect or mismanagement can be deterrents (82). Furthermore, the  
328 alignment of OSHMS efforts with other internal – like fostering a more inclusive organizational  
329 structure (93) – and external – like collaborating with trade unions (85) – processes is always  
330 welcome, and organizations can leverage them. Concerning external factors, Rocha (93) brought a  
331 fresh perspective by examining how national institutional settings influence OSHMS dynamics and  
332 recognizing that beyond an organization's internal capacities, the broader national context also plays  
333 a crucial role in shaping OSHMS outcomes. Consequently, organizations in different countries  
334 should deal differently with OSHMS requirements.

### 335 3.2.3. OSHMS regulations

336 Another stream of the literature focuses on the interplay of OSHMSs' effectiveness and regulations.  
337 While laws and regulations can sometimes be perceived as obstacles to the development of OSHMSs,  
338 their true value on OSH performance can be perceived when effectively managed and implemented  
339 (95). For instance, Hale and Swuste (96) called regulations “invisible barriers,” and Hollnagel (97)  
340 considered legislation as an “invisible barrier system”. There is a tendency for policymakers to have  
341 optimistic views about how mandatory OSHMSs operate (95). Hale et al. (98) viewed self-regulation  
342 – the application of voluntary norms and codes of good practice – as a way to reduce the perceived  
343 regulatory pressures on OSHMSs.

### 344 3.2.4. OSHMS indicators

345 To foster confidence in OSHMSs and motivate organizations to adopt them, it is essential to establish  
346 clear evaluation criteria and Key Performance Indicators (KPIs) (64,99). Three studies have been  
347 selected that identified optimal KPIs for OSHMSs (64,82,100). Podgórski (100), for instance, applied  
348 the Analytic Hierarchy Process (AHP) to select 20 KPIs out of a larger set of candidate indicators  
349 (109), categorized under areas such as Policy, Organizing, Planning and Implementation, Evaluation,  
350 and Action for Improvement.

## 351 4. Discussion: Status quo and implications

352 The results of the literature review indicated that scholars wondered about the effectiveness of  
353 interventions, including OSHMSs, developed for OSH improvement.

#### 354 **4.1 About OSH interventions**

355 Considering OSH interventions, practitioners have begun to describe several field interventions from  
356 an operational perspective. However, drawing broad conclusions from the literature has seldom been  
357 possible due to the unique dynamics at play. Several systematic literature reviews have analyzed  
358 interventions in an attempt to identify common threads and strategies to achieve higher effectiveness,  
359 but the diverse and varied environments often rendered them too distinct for direct comparison.  
360 Different theoretical lenses among researchers may indeed prevent the comparison of similar  
361 interventions. A critical realism perspective offers a promising approach to examining OSH  
362 interventions. The realist analysis, consistent with the above epistemological perspective, is rooted  
363 in understanding the underlying causal chains of events and their effects – essentially, discerning  
364 what works, for whom, under what conditions, and how (20). This aligns with the literature, where  
365 scholars have underlined the value of studying the mechanisms – what has or has not worked – of  
366 the interventions (14,30,33).

367 Given the above considerations, it is worth analyzing interventions not as black boxes but  
368 considering the different factors affecting them (28). Contextual factors play a paramount role in all  
369 phases of the design, implementation, and evaluation of interventions (15). Giving attention to these  
370 factors can enhance the probability of achieving desired outcomes. Quantitative assessments may  
371 not always be the most suitable or feasible for OSH interventions, as quantifiable data are rarely  
372 tracked and often difficult to retrieve. It is important to understand that qualitative methods can be  
373 equally insightful and, in certain settings, may be more appropriate.

374 The design, implementation, and evaluation phases should be equally considered, while processes  
375 with greater short-term benefits are still often prioritized, inhibiting the crucial final evaluation phase.  
376 Indeed, interventions should be evaluated in advance, and the study of ad hoc indicators would enable  
377 long-term monitoring of the impact of interventions (13). In addition, monitoring induces the  
378 development of more effective interventions that rely on grounded knowledge (29). Therefore, it is  
379 crucial to ensure continuity between interventions to gain mutual benefits and contribute value at the  
380 system level. The newly released ISO 45001:2018 (27) takes this direction by moving from a focus  
381 on individual system components towards a better understanding of the entire socio-technical system  
382 – i.e., multidirectional interactions and information flow across the system, networks of stakeholders  
383 and their interdependency, and the effects of internal and external factors and constraints (101).

#### 384 **4.2 About OSHMS impact**

385 The second macro-area of the literature review included the implementation of OSHMSs in practice  
386 for OSH improvement, and similar considerations to OSH interventions applied to their  
387 effectiveness. Their development is comparable to that of field interventions and is generally more  
388 structured, long-lasting, and potentially more powerful when implemented in organizations. In  
389 *Section 3.2*, four macro-areas of research were detected for OSHMSs – their impact, influential  
390 factors, regulatory aspects, and performance indicators – and insights for effective OSHMSs were  
391 gathered.

392 Effective OSHMSs should ensure safe and healthy workplaces by continuously improving the OSH  
393 performance of organizations (25). The literature analysis highlighted that there is considerable  
394 research on OSH to study OSHMSs, their relationship with the surrounding environment, and the  
395 affecting factors. Although several studies explored ways to enhance the performance of OSHMSs  
396 and their potential is recognized, there remains a gap in understanding their tangible effectiveness at  
397 the organizational level. This presents an opportunity for both scholars and practitioners to delve  
398 deeper into this area of research.

#### 399 **4.3 About OSHMS regulations**

400 The literature suggests that having certification is valuable, but it alone does not guarantee optimal  
401 effectiveness within a specific context. Certification is an important tool for organizations to ensure  
402 better performance; however, positive organizational culture and management are required (71).

403 “Regulatory burden” is a common periphrasis in the literature, which is clear proof that regulations  
404 are often perceived as potential barriers or “invisible barriers” (96) to OSH improvement. However,  
405 collaboration between organizations and policymakers can pave the way for more tailored and  
406 effective solutions. As national authorities increasingly recognize the importance of this  
407 collaboration, it presents an opportunity for both policymakers and organizations. Policymakers can  
408 secure interventions to prevent them from becoming backburners, and organizations can be  
409 incentivized to join such interventions by developing something that would fit well with their  
410 specificities.

#### 411 **4.4 About OSHMS factors**

412 Other studies on OSHMSs have highlighted the key factors that promote their development and those  
413 that might pose challenges. As outlined in Table 2, there are internal factors related to the  
414 organization’s structure and external factors influenced by the outer environment. Some  
415 characteristics have been identified both as potential barriers and drivers. Identified factors are often  
416 classified by their characteristics as barriers or drivers and by considering whether their presence or  
417 absence facilitates or inhibits the development of OSHMSs. For example, a strong management  
418 commitment is vital for successful OSHMS implementation, while its unavailability is considered a  
419 barrier. Based on Kano et al.’s theory (102), these factors can be divided into three major categories:  
420 must-haves, performers, and delighters. Factors simply evaluated as barriers can be considered must-  
421 have requirements that would hinder the development of OSHMSs or interventions in general, such  
422 as a lack of time and resources (82,88,89). Most of these factors are regarded as performers because  
423 their existence can change the actual deployment of OSHMSs. For example, good leadership can  
424 support collaboration between individuals and, therefore, the OSHMSs’ work, whereas bad  
425 leadership can inhibit their implementation. Lastly, delighters represent the factors that represent true  
426 value added. As highlighted by Frick (85), the involvement of trade unions offers invaluable insights  
427 and is a key driver for employers to leverage their field knowledge to build new competencies at the  
428 organizational level. Key stakeholders, including representatives from trade unions and employer  
429 associations, play a pivotal role in shaping interventions that are well-grounded in real settings.

#### 430 **4.5 About OSHMS indicators**

431 [In a similar vein, a few studies have looked at KPIs to measure the effectiveness of OSHMSs. As for](#)  
432 [OSH interventions, ad hoc indicators offer a means for longitudinally assessing OSHMS impact,](#)  
433 [enabling continuous monitoring of OSHMS effectiveness and also promoting the development of](#)  
434 [more robust systems. Indeed, by leveraging insights from prior OSHMS implementations,](#)  
435 [organizations can refine their practices, adhere to industry best standards, and mitigate the risk of](#)  
436 [unsuccessful initiatives.](#)

#### 437 **4.6 Implications**

438 As shown in the literature, higher coordination between OSH stakeholders improves the  
439 effectiveness of OSHMSs by increasing their adoption levels and, in general, OSH interventions  
440 (54,93). The EU-OSHA’s ESENER report (103) emphasizes this element, noting that the “presence  
441 (and involvement) of employee representation is a factor in ensuring that such OSH policies and  
442 action plans are put into practice”. A conscious network of stakeholders is indeed vital to OSH  
443 improvement, which would enable any implemented intervention to be sustainable and effective in  
444 the long run (54). In addition, the broader environment, encompassing various contextual factors,  
445 plays a pivotal role in shaping national OSH management. National laws determine the key  
446 differences between nations concerning stakeholder involvement, functions, and more. As noted by  
447 Rocha (93), institutional effects strongly affect the OSH network of stakeholders and often remain  
448 relatively stable in the short term. Consequently, organizations across different nations should deal  
449 with these requirements differently, thus requiring tailored approaches.

450

451 Table 3 summarizes the above discussion by revealing the status quo of the effectiveness of OSH  
 452 interventions and suggesting future research directions.  
 453

454 **Table 3.** Status quo of OSH interventions' effectiveness and research directions.

Status quo	Research directions
<b>OSH interventions</b>	
<p>There is increasing attention to all the phases of interventions' development – design, implementation, and evaluation – but their effectiveness requires sufficient proof.</p>	<p>Higher attention should be paid to the evaluation of OSH interventions, which is still less developed than the other two phases of design and implementation. The effectiveness of interventions should be measured through clear indicators before and soon after their end and their impact should be monitored over time. Indeed, the study of ad-hoc indicators would enable long-term monitoring of interventions' impact and their monitoring induces the development of future, more effective, interventions that rely on grounded knowledge.</p>
<b>OSHMS impact</b>	
<p>OSHMSs have been believed to ensure safe and healthy workplaces by continuously improving the OSH performance of organizations. There is considerable research studying OSHMSs, their relations with the surrounding environment, and the affecting factors, but low evidence of their tangible effectiveness at the organizational level.</p>	<p>Further research on the determinants – factors, indicators, regulations – that make OSHMSs more impactful at the organizational level is required.</p>
<b>OSHMS regulations</b>	
<p>Regulations are predominantly viewed as barriers to OSH improvement. Organizations view regulations as top-down directives not properly working in their environment. Literature has been questioning ways for improvement.</p>	<p>Being familiar with regulations makes OSHMSs more effective in the environment, thus leveraging enabling factors and controlling hindering factors. Working with policymakers could be an effective strategy for the medium and long term to entice organizations to work for shared solutions, causing regulations no longer to be viewed as top-down directives. Collaboration between OSH stakeholders at various levels is the key. National authorities are moving in that direction; thus, developing interventions for OSH improvement that involve stakeholders in the field.</p>
<b>OSHMS factors</b>	
<p>There are enabling factors (drivers) and potential barriers that can inhibit the development of OSHMSs. Internal factors, related to the organization's structure, and external factors, depending on the outer environment, are being studied. For example, a positive organization's culture and management can foster better performance in OSHMSs.</p>	<p>The development of OSHMSs should consider all inherent dynamics of the environment in which they are implemented. Enabling factors (drivers) and potential barriers of OSHMSs have been identified; however, how to foster drivers and inhibit barriers in real OSHMSs has not been studied. It is unclear whether such factors generate synergies and trade-offs when combined.</p>
<b>OSHMS indicators</b>	
<p>The best set of KPIs has been enquired from researchers (e.g., by applying the AHP to select KPIs out of a larger set of candidate indicators).</p>	<p>The same considerations for OSHMS factors apply to indicators. Scholars have started to identify sets of KPIs for OSHMS assessment and monitoring; however, they remain untested in the real field. Indicators enabling the monitoring over time of implemented OSHMSs should be encouraged.</p>

455 **5. Limitations**

456 This study has a few limitations that stem from the integrative process of the literature review, which,  
457 beyond the benefits detailed in *Section 2*, entails some inherent limitations. Although reliability has  
458 been secured by providing details on the entire process of the literature review, from the search to  
459 the analysis and categorization of data, the replicability of the results is not as strong as for systematic  
460 literature reviews, where the process is fully falsifiable. The use of search protocols increases the  
461 replicability of the process by providing an initial batch of documents to be evaluated and identifying  
462 initial literature clusters.

463 The Authors believe that the applied literature review process enabled the results to reach a  
464 satisfactory level of comprehensiveness and exhaustiveness, which was otherwise unattainable  
465 through a systematic approach. The integrative literature review does not claim to be exhaustive in  
466 terms of the included documents, as it might have potentially turned into an endless process, but  
467 rather, consistently pursues the objective of the research by combining different perspectives,  
468 obtaining relevant results, and keeping the number of documents affordable (17,18).

469 In support of this, several studies in the OSH literature, such as Dyreborg et al. (9), Fridrich et al.  
470 (15), and Hasle et al. (55), have shown that systematic literature reviews may be unsuccessful in  
471 finding robust results due to high heterogeneity and lack of available standardized data. Research on  
472 health and safety has great potential because human-based science focuses on several thematic areas  
473 that address OSH issues from a multitude of aspects. However, this increases the amount of  
474 potentially retrievable information and the number of pertinent documents. Another direct  
475 consequence is the low awareness of keywords, which often have several synonyms, and their  
476 meanings might differ. For example, construction activities implemented in the workplace are  
477 predominantly called “projects,” whereas in the manufacturing industry, “intervention” is the most  
478 common term. In addition, because the literature has shown low topic categorization, there are no  
479 available frameworks for data classification. Therefore, this study suggested a straightforward  
480 structure to read the results by defining a fil rouge between OSH interventions and OSHMSs and  
481 their evaluation of effectiveness, which was constructed by iteratively comparing documents  
482 according to a data comparison approach (22).

483 Similar to most exploratory studies, the results cannot be considered exhaustive; instead, they enable  
484 the identification of patterns that might be beneficial to future research because they are still  
485 underdeveloped and have high potential. Consequently, other literature analyses are suggested to  
486 further explore and validate the findings of this study.

487 **6. Conclusions**

488 Through an integrative review of OSH literature, this study examined extant research contributions  
489 to the effectiveness of OSH interventions, including OSHMSs, by revealing their status quo and  
490 identifying room for improvement.

491 Studying appropriate ways to develop interventions is currently a matter of discussion. Since its  
492 inception, many steps have been taken; however, there is still a long road ahead. The literature  
493 includes several analyses of interventions implemented in the workplace and specifically, the  
494 OSHMSs for OSH improvement. Their implementation in organizations might be comparable to that  
495 of field OSH interventions, and they are generally more structured, long-lasting, and potentially more  
496 powerful. Their potential is high, as shown by theoretical research, yet there remains a rich vein of  
497 exploration regarding their real-world deployment within workplaces.

498 Based on the literature, some research streams for future developments in OSH interventions were  
499 identified and summarized in Table 3. In particular, coordination among OSH stakeholders,  
500 knowledge awareness, and information sharing are only a few drivers that can improve the  
501 effectiveness of field OSH interventions. A conscious network of stakeholders would support the  
502 development of interventions and work toward continuous improvement (54). A recent EU-OSHA  
503 report (104) shares the same view by stating that orchestrated/coordinated actions may be more  
504 effective than unilateral ones in leveraging better OSH, but strong leadership is required. Further  
505 research in this direction is highly recommended and, except for a few studies, such as Hasle et al.  
506 (53) and Zwetsloot et al. (6), it is an unexplored path with high potential.

507 The Authors hope that future research will pursue the proposed directions that, from different  
508 perspectives, would support OSH improvement through interventions that leverage more structured  
509 processes and encourage organizations to be proactive in daily OSH management.  
510

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512

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