

Systematic Review

Sustainable Safety Management: A Safety Competencies Systematic Literature Review

Fazil A. Rahman ¹, Kadir Arifin ^{1,*}, Azlan Abas ¹, Mahfudz Mahfudz ², Muhammad Basir Cyio ², Muhammad Khairil ³, Muhammad Nur Ali ³, Ilyas Lampe ³ and Muhammad Ahsan Samad ³

¹ Faculty of Social Sciences & Humanities, National University of Malaysia, Bangi 43600, Malaysia; fazil1880@gmail.com (F.A.R.); azlanabas@ukm.edu.my (A.A.)

² Faculty of Forestry, Universitas Tadulako, Palu City 94118, Central Sulawesi, Indonesia; mahfudz62@gmail.com (M.M.); basircyio@yahoo.com (M.B.C.)

³ Faculty of Social and Political Sciences, Universitas Tadulako, Palu City 94118, Central Sulawesi, Indonesia; muh.khairil02@gmail.com (M.K.); ali.mnur@yahoo.com (M.N.A.); ilyaslampe7@gmail.com (I.L.); ahsanasamademail@gmail.com (M.A.S.)

* Correspondence: kadir@ukm.edu.my; Tel.: +60-12-503-1011

Abstract: Title: Safety competencies: A systematic literature review. Background: Safety competency is believed to be a pillar of an organization's safety culture and one of the safety climate dimensions. Safety competencies can be a vital point to controlling and maintaining the sustainability of safety and health in a society and organization. The sustainability of the industries' and society's safety relationship can be driven by the controlled hierarchy in the society and the competencies of its members. Failure to identify social sustainability indicators such as a leading competency in safety will cause a failure in the safety development program. Hence, a systematic literature review of published studies is essential for easing the dissemination of useful research findings and gaining access to future trends in safety competencies research. The review aimed to identify studies about safety competency and identified the basic safety competencies for the workforce to maintain a sustainable safety climate. Methods: This review provided a five-step approach guided by The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement and published systematic review framework. The studies from the past 20 years were retrieved from electronic databases such as Scopus, Science Direct, and Web of Science. The review only involved article papers, research papers, and review papers which are written in English. The quality of the review was assessed using a standard PRISMA 2020 checklist. This review is registered on the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) with registration number INPLASY202230246 and DOI number 10.37766/inplasy2022.3.0146. Findings: The unbiased and wide review produces a new, feasible alternative to a social sustainability safety index. The number of studies on safety competencies study has expanded in recent years which shows the importance of the item to sustain the safety climate. This review suggests teamwork, communication skills, and a foundation of safety knowledge as the basic safety competencies for workers based on the competencies being most discussed. The review process suggests the possibility of future research regarding safety competencies after a catastrophic event such as the COVID-19 pandemic and sustainability of industrial safety regarding human-machine integration through 4.0 Industrial Revolution era.

Keywords: safety competencies; safety expertise; safety management; safety competence; safety skills



Citation: Rahman, F.A.; Arifin, K.; Abas, A.; Mahfudz, M.; Basir Cyio, M.; Khairil, M.; Ali, M.N.; Lampe, I.; Samad, M.A. Sustainable Safety Management: A Safety Competencies Systematic Literature Review. *Sustainability* **2022**, *14*, 6885. <https://doi.org/10.3390/su14116885>

Academic Editors: Muhammad Bilal, Pau Loke Show, Wai Yan Cheah and Vijai Singh

Received: 7 April 2022

Accepted: 2 June 2022

Published: 5 June 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

The issue of workplace safety has become very important globally. Each year, approximately 2.78 million deaths are recorded because of occupational accidents or work-related illnesses that occur daily. In addition, there are approximately 374 million nonfatal work-related injuries each year that impact the loss of working hours of more than 4 days. These

daily adversity stem from poor Occupational Safety and Health (OSH) practices, thus having a significant impact on human resources and the economy where an estimated 3.94% of global gross Domestic Product has been affected each year [1]. Around the world, occupational injuries are a major problem that particularly serves negative impacts especially on developing countries. Therefore, to control and prevent this pitfall, comprehensive occupational safety and health management systems (OSHMS) need to be developed and implemented to control the risk of occupational accidents as has been practiced in high-income countries [2]. In Malaysia, rates of accidents and deaths due to occupational illness and hazards have shown an increase over the years 2014 to 2018 as shown in Figure 1 [3]. Although these numbers are small, the causes of their incidents and precautions need to be taken. While there was a lot of promotion such as awareness programs and introduction to safety culture and safety behavior through training, accidents still can occur if the employer and employee lack safety competencies [4,5].

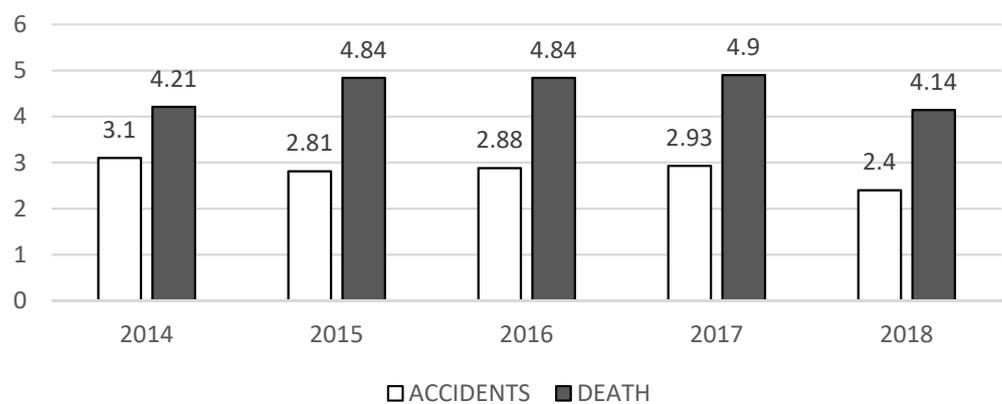


Figure 1. Rate of Occupational Accident and Death in Malaysia [3]. Notes: Accidents rate as per 1000 workers, Death rate as per 100,000 workers.

Safety competencies are known as a crucial part of developing a safety culture [6]. Workers with higher competencies are capable of preventing accidents from happening and also able to reduce the effects of accidents if it happens [7]. They also would be able to study the fault from the accident that occurred to avoid it in the future. This is because competence is referred to as a set of explicit knowledge and skills, awareness of implicit social roles, self-concepts, traits, and motivations inherent in an individual. According to Harvard University's competency dictionary, competency is a criterion that encompasses the work behavior, motivation, and knowledge that an individual needs to demonstrate in ensuring the effectiveness of one's job, role, and job function. Furthermore, competency refers to the knowledge, skills, and attitudes which is crucial to the successful implementation of a task. This is due to the fact that a worker's competencies can influence their work performance [5]. Moreover, competencies can influence individual's behavior, for which lower competencies can lead to mistakes and negative outcomes [8]. By coordinating, improving, and clarifying the need for safety competencies, a positive safety culture and environment can be created [9]. In addition, the competence of colleagues also affects the safety climate of the organization because competency is a basic criterion for improving the job performance of individuals including attitudes, skills, self-image and social roles [10].

In the field of safety and health, safety professionals are required to practice their skills to demonstrate their credibility to the business and to achieve the best safety performance. An understanding of the roles and functions of safety professionals, and their respective levels of competence, can develop their professional safety capabilities and enhance business support for employment and occupational safety and health (OSH) programs [11]. According to the American National Standard Institute (ANSI), the scope and functions of the professional safety position are being able to: (a) identify, anticipate and evaluate hazardous conditions and practices; (b) develop hazard control designs, methods, procedures,

and programs; (c) implement, administer, and advise others on hazard controls and hazard control programs; and (d) measure, audit, and evaluate the effectiveness of hazard controls and hazard control programs [5,12]. Therefore, safety professionals need to understand what an administrator needs, provide the right information, ask the right questions, and suggest the right solution [13]. Appropriate safety professionals should have experience in safety technology, have interpersonal skills, constantly strive to improve interpersonal skills, and update safety management technology to meet existing needs [5]. They should be aware of not just accidents and diseases, but also trends in human behaviors, technology, and lifestyles [14]. In short, competencies are the standards-based knowledge and skills required in the workplace that are applied to apply those knowledge and skills in a variety of new situations and environments [15].

Safety management is one of the dimensions of an organization's safety climate [16]. Furthermore, the core section of the Institution of Occupational Safety and Health (IOSH) competencies framework has given a bigger picture about the importance of safety management in order to harvest the safety culture. Safety management plays a bigger role in the core of an organization's safety performance where leadership and management will rule out the strategy derived from the planning towards a better safety culture and performance of the organization. Therefore, to maintain the sustainability of the safety climate in an organization, the importance of safety competencies should be highlighted. In order to establish an organizational safety climate, the worker's safety competencies should be developed through training activities [17]. The number of accidents and death can be reduced with proper training and proper installation and maintenances of safety devices [18]. This also suggested that the competencies of the workers are important when performing the installation and maintenances process. Competencies are persevering and can impact individual characteristics, conduct, and consideration [19]. With a steady hierarchical environment, individual competencies can serve as the drive that moves associations forward. The Iceberg Model of competencies conceptualizes five types of competency characteristics which are: (1) motive; (2) traits; (3) social role and self-concept; (4) knowledge; and (5) skills [11]. Skills and knowledge are visibly measurable and can be developed through training. On the other hand, motivation, personality traits, social roles, and self-concept depend on personality. However, it can be developed through basic training in work environments and foundation education in school.

As mentioned earlier, safety competency is a very important factor in developing a sustainable organization's safety culture. Consistent and ongoing research on safety competencies is essential to developing safety professionals in a global environment [11]. The results from the previous studies can be used as a reference for decisions to establish a comprehensive model of learning to grow the competencies in occupational safety and health glossary. Furthermore, safety and health departments in different industries can use these basic competencies as a basis for recruiting workers and training their workers. This is also important when facing challenges arising from the Industry Revolution 4.0 where the entire change through advanced integration and intelligence engineering made a tremendous jump toward cutting edge innovation [20]. It is very crucial to build a really strong integration between man and machine to maintain the sustainability of a healthy environment [21]. Despite the need to have competent OSH professionals is very high, there is a general concern to identify the necessary competencies required in the safety and health profession for the effective performance and maintaining the sustainable culture of OSH-related functions [11]. Therefore, this study was conducted to identify previous studies regarding safety competencies and the definition of safety competencies related to occupational safety and health. On the other hand, this study also will identify the core competencies for different roles in occupational safety and health.

2. Materials and Methods

This study adopts the systematic review as a methodological approach to review the existing literature regarding safety competencies to explore useful findings and identify

knowledge gaps for future research agendas in the field of occupational safety and health. According to The Preferred Reporting Items for Systematic Reviews (PRISMA) 2020 statement, a systematic review is a review that uses explicit, systematic procedures to collect and synthesize information from research that addresses a specific area [22]. Although in most cases, a literature review is usually part of a larger study but it can also be a stand-alone piece of work. A literature review study is more than just a report on the references. Instead, this type of study synthesizes the findings of individual studies to produce a coherent and integrated argument about a single research topic [22]. A review article's principal purpose is to critically analyze literature in a certain research area, subject, or field, identifying significant theories, key constructs, empirical methods, settings, and remaining research gaps in order to define a future research agenda based on those gaps [23].

In the current era, a systematic review has become popular in research trends because of the information that researchers can obtain from it. This systematic review was conducted and guided by referring to the protocol proposed by [22–24]. Khan et al., have drawn the line for researchers to conduct systematic reviews by introducing the five-step approach which is: (i) Framing questions for a review; (ii) Identifying relevant works; (iii) Assessing the quality of studies; (iv) Summarizing the evidence, and; (v) Interpreting the findings [24]. On the other hand, Paul & Criado have suggested the rule of thumbs to develop an impactful review analysis [23]. Page et al., advise reviewers to publish the review transparently reflecting methods to identify, select, assess, and synthesize research using the PRISMA 2020 statement [22]. The PRISMA Statement allows for a comprehensive search for terms related to safety competencies and their influence on safety performance and outcomes. This study simplified the review step into 3 major processes which include formulating review questions, identifying relevant publications, and summarizing the relevant work. The protocol of this review has been registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) with registration number INPLASY202230246. The protocol has been published on the INPLASY website and also can be found on the website of the International DOI Foundation (<https://www.doi.org/10.37766/inplasy2022.3.0146>, accessed on 4 April 2022).

2.1. Formulating Review Questions

As the first step of a systematic review, the research question should be formulated and mentioned clearly before beginning the study [24]. Generally, this study is aiming to review the concept of safety competencies in OSH world. The main challenge in the world of OSH is the lack of understanding of the required safety competencies including knowledge of OSH, skills required in OSH, and also a safe attitude [15]. Therefore, this review is guided by the following free form research questions:

1. What is the pattern of safety competency studies?
2. What are safety competencies in occupational safety and health?
3. What are the key competencies that should be possessed in order to improve an organization's safety culture?

2.2. Identifying Relevant Publications

Identification is a process that involves conducting a search utilizing the research's main keywords, which include occupational safety and health and safety competencies. The identification technique was based on previous research, keywords suggested by guidelines, and keywords proposed by experts. We began our literature quest by searching the electronic databases of Science Direct, Web of Science (WOS), and Scopus for applicable studies published since 2000 until August 2021 using a search string such as "occupational safety and health" and "safety competencies." (Table 1). The timeline represents the 20 years of OSH development. In addition, we also manually handpicked 5 papers that we believed to be relevant to the review regarding safety competencies. This process produced 317 studies from a variety of fields, including nursing, occupational medicine, multidiscipline social sciences, engineering, and applied psychology. We evaluated all empirical reports to

determine whether they met the criteria for us to include in our review before we proceeded to the screening process.

Table 1. Search strings.

Database	Search String
Scopus	TITLE-ABS-KEY (“occupational safety and health” OR “occupational health and safety”) AND (“safety competencies” OR “safety competency” OR “safety competence”)
Science Direct	(“occupational safety and health” OR “occupational health and safety”) AND (“safety competency” OR “safety competencies” OR “safety competence”)
Web of Science (WOS)	((((ALL = (“occupational safety and health”)) OR ALL = (“occupational health and safety”)) AND ALL = (“safety competencies”)) OR ALL = (“safety competency”)) OR ALL = (“safety competence”)

The first phase of the screening method was to identify and removed duplicate articles. By the end of this method, 2 articles were removed, and the remaining 315 articles were then continued into the second section of the screening. Within the second section, inclusions, and exclusion criteria as in (Table 2) were applied to the screening process. This is often the most important criteria and the heart of this analysis where our main purpose is to identify safety competencies related to the OSH field. Second inclusion of the screening process is concerning the ability or competencies in occupational safety and health. These competencies were mostly associated with one who connected within the industries like safety professionals. We also excluded publications in the form of conference papers, book chapters, books, editorials, conference reviews, interviews, brief surveys, and notes during the second step of the screening process, where we were only focused on the form of study and review posts. Publications from medical, pharmacy, and nursing journals were also removed. This is because we agree that the medical community has its own set of safety competencies that are more focused on patient care and ensuring their safety, as opposed to the Quality and Safety Education for Nurses (QSEN). However, since the content was important to the report, 6 publications in process safety and organization management were manually selected. At the end, we finalized 44 papers which met all the requirements after the second phase of screening. Figure 2 reflects the PRISMA 2020 flowchart of the review process.

Table 2. Inclusions and Exclusions Criteria.

Criteria	Inclusion	Exclusion
Timeline	From 2000 till August 2021	-
Literature type	Indexed journal (articles, research, review)	Conference paper, book chapter, book, editorial, conference review, report, short survey, note
Language	English	Non-English
Field of research	-	Medicine, Medical, Nursing, Clinical, Food safety

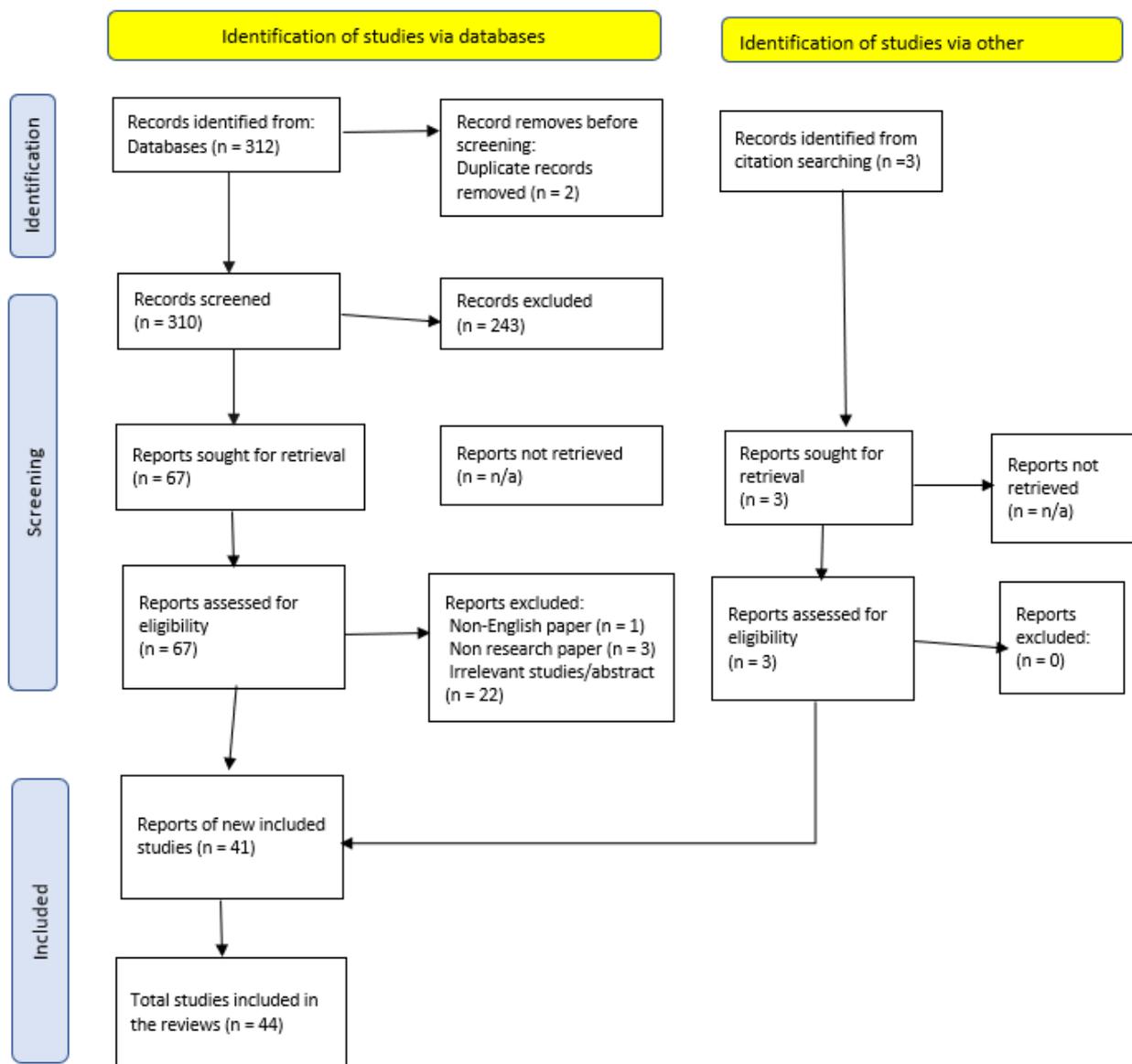


Figure 2. The Review Process Flow [19].

2.3. Summarizing the Evidence

During this step, we identified the explanations about safety competencies from all relevant articles. In addition, we also identified the safety competencies which are stated clearly in the previous research, and extracting only high-quality output. The selected articles were coded, and analyzed based on review aspects and questions. The article's titles, abstracts, and keywords were utilized for literature coding. When the essential information could not be gleaned from the title, abstract, and keywords, the complete document was examined to aid in coding. The coding concentrated on the study procedure and findings portions. During the coding process, the following information was recorded in the database: (1) paper title; (2) year of publication for each paper; (3) country or region (this information pertains to the location of the research, not the authors' origins); (4) research field area; (5) Research population (profession) and (6) safety competencies definition and concept. A standard checklist which is PRISMA 2020 checklist was used to minimize the risk of bias to ensure the quality of the review.

3. Results

From the 44 relevant articles, we could see the trend of the safety competencies research. The distributions of the relevant studies such as the year and the country of the studies, field or industries of the research, and the profession that is included in the research can be drawn clearly. On the other hand, we could also obtain the safety competency definition and the core competencies that were suggested by earlier scholars. A total of 44 articles were finalized for the review.

3.1. Year of Publication

In the selected 44 papers, 2 articles were captured as the earliest studies regarding safety competencies in OSH. The first article was published in *The Journal of Occupational and Environmental Medicine* in 2008 [25]. It presented an empirical study of the OSH graduates' perceptions of 29 educational competencies. While the other article was published in *Safety Science* which examines the opinions, attitudes, and perceptions of construction workers on the skills, knowledge, and behaviors that contribute to safety culture [26]. The number of relevant papers published annually is not high, as seen in Figure 3, with fewer than four before 2015. Since 2008, there has been a gradual increase in the number of relevant papers published. The number of papers rise incredibly in 2019. The trend of publication increased after 2015 and this gave a good reflection about the priority of safety and health research regarding safety competencies. However, the trend drops in 2020 and 2021 probably because of pandemic issues. Since The COVID-19 outbreak, researchers tend to put their effort and focus more on pandemic impact and new norm.

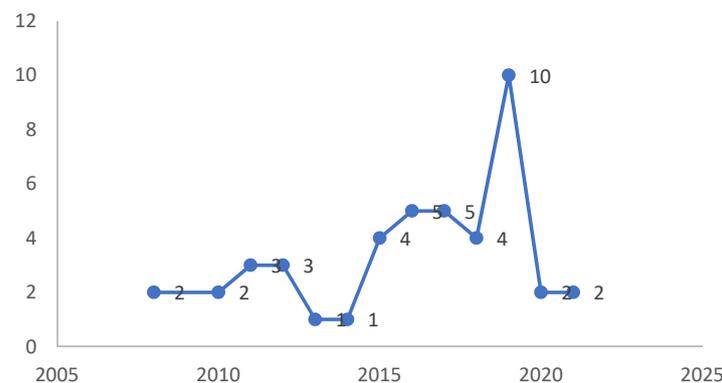


Figure 3. Publications by Year.

3.2. Publication by Country

Figure 4 reflects the distribution of the relevant article's origin. Align with [27], this review analyzed the country of the publication based on the authors or institutions whereabouts. This is because some of the studies did not involve a specific country or region, but they were discussing the safety competencies in general. Referring to Figure 4, the United States leads the research on safety competencies with 12 studies. The distribution of the remaining studies was quite even which includes five studies from Australia, four studies from China, three studies from both Finland and Malaysia, and two studies equally from Singapore, Brazil, and Taiwan. There was only one study each from Belgium, Canada, Czech Republic, Germany, India, Iran, Italy, Qatar, and Turkey. The result shows the consistent development of safety competencies concept in OSH world and as a part of safety culture. The study in the United States were richly conducted probably as a response to the introduction of the eight core competencies framework by United States NIOSH [28]. In Australia, OSH competencies have been integrated into the national industry competency standards in 1994 and 1998. We believe this triggered the researchers to focus more on safety competencies in Australia. Surprisingly, as a continent, Asian countries lead the research regarding safety competencies with 14 papers. This could be a positive sign of

OSH awareness and safety culture in developing countries such as Malaysia. However, not a single study was conducted in the African region.

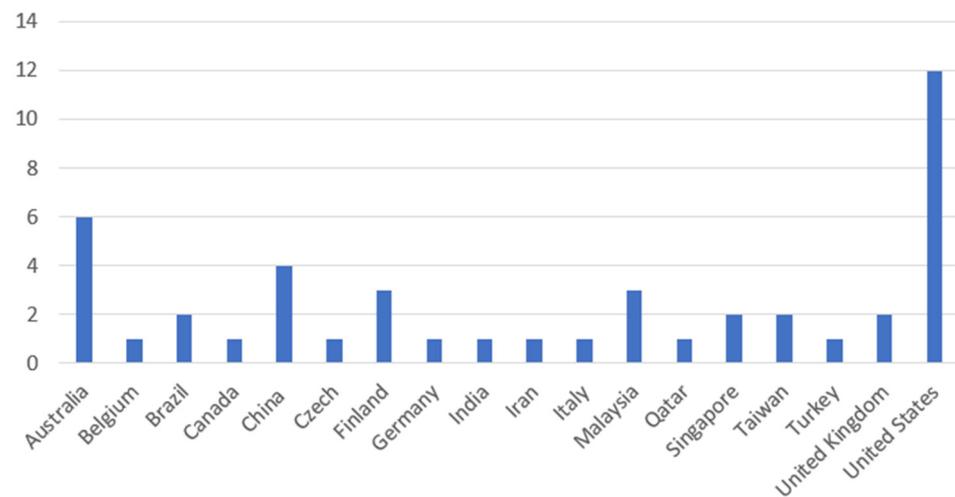


Figure 4. Research by Country.

3.3. Field of Publication

In 1970, the US congress has enacted the US Occupational Safety and Health Act of 1970 (OSHA) in the United States. Since then, a lot of effort has been put through by government and organizations into the development of OSHA around the world. Implementation of OSHA is broad and diversified into all industries and various job roles and positions. As a result of categorizing the relevant publications, we can see the studies involving safety competencies in OSH were conducted in five main fields of work as shown in Figure 5. There were 16 research works conducted in education field mostly in United States. For this review, every study that was conducted in secondary and tertiary school was categorized as research in the education field. The development of safety competencies research in the education field shows the importance of preparing the young workforce with core competencies before they join the occupational world. The remaining studies were equally conducted in the other field of work which are the construction field, process safety area, safety management, and manufacturing. These four areas were the main implementation of OSHA in most regions. Construction and manufacturing fields are old industries that is known with their high-risk tasks involving workers and machines. For process safety area, the OSH risk is also high because this field consists of chemical and petrochemical industry which needs strong competence workforce. All these studies were conducted mostly involving construction supervisors, safety practitioners, workers, students, and management teams in general.

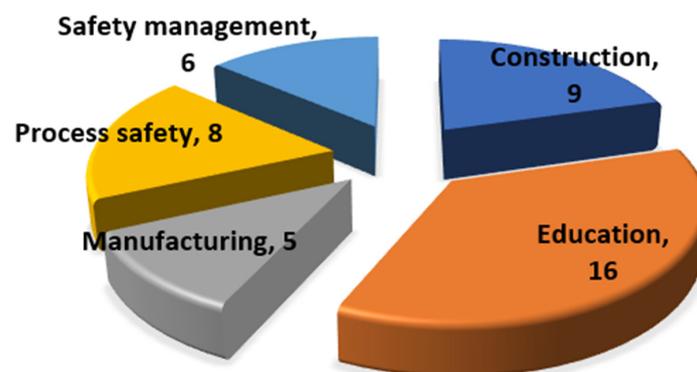


Figure 5. Field of Research.

3.4. Safety Competencies

Competencies are the underlying traits of people that show their behaviors and ways of thinking in different environments [11]. Therefore, safety competencies are very important traits that every individual should pose to ensure every task is performed safely. In answering research questions about safety competencies, few publications which discussing the definitions and core competencies that should be considered in developing safety competencies framework have been identified. Some of the articles were suggesting the same competencies. In Table 3, we summarized the definitions of safety competencies. The review only uses seven definitions which we believe stand out above the other publications. On the other hand, the core safety competencies which we believe could be established as core safety competencies in OSH competencies framework are shown in Table 4. There were some articles reviewing and discussing a ready framework which has been established. Okun et al. reviewed the eight core competencies of United States NIOSH which is a good foundation for a young worker or student to prepare themselves when leaving school and entering the occupational world [28].

Table 3. Safety Competencies definitions.

Scholar	Safety Competencies
(Li et al., 2020)	Worker's knowledge, skills, and experience to complete their work safely [29].
(Li et al., 2018)	Personality trait linked to improved safety performance on construction sites [8]
(Liang et al., 2019)	The underlying qualities of a worker that are causally correlated to criterion-referenced safe daily organizations' performance [30]
(Sigmann 2018)	Knowledge, skill, and attitude are three interconnected safety components that appear as a recurring safety theme [31]
(Mkpat et al., 2018)	Professional capability, skills, and experience gained through systematic process safety education and training which motivates employees to do duties in a safe and effective manner [32]
(Pryor 2019)	Skills and traits in addition to knowledge [33]

Table 4. Relevant Safety Competencies.

Competencies	Authors
Knowledge	[5,7,11,31–41]
<ul style="list-style-type: none"> • Safety knowledge [8,11,25,29,42–46] • Task knowledge [11,19,30,32,47–49] • Experience [29,42,47,50] • Hazard identification [8,25,28,43,44,50,51] • Qualifications/Training [11,30,46–48,51] • Controlling hazard [8,19,28,49,50] • Emergency response [11,28,42,43,49] 	
Skills	[51]
<ul style="list-style-type: none"> • Appropriate working skills [11,43,44,47] • Communications skills [11,19,25,26,28,43–45,47,48] • Troubleshooting / problem solving skills [19,43,50] • Ability to work in team [11,19,30,46,48] • Leadership skills [19,25,26,48] 	
Behavior	[51]
<ul style="list-style-type: none"> • Appropriate attitude [30,42,46,47,52] • Physical. Medical & mental fitness [19,30,47,48] • Work ethics [11,19,25,43] • Change management [42,49] • Safety locus of control [11,19,53] • Safety belief/awareness/preparedness [11,28,30,43–45,52] • Responsibility [11,19,28,30,36,46] • Achievement orientation [11,19,30] 	

Pryor et al., was discussing the International Network of Safety & Health Professional Organizations (INSHPO) Occupational Health and Safety Professional Capability Framework: A Global Framework for Practice [15]. This framework was introduced in 2017 and will be a beautiful guide to preparing and strengthening OSH Professional and the safety culture itself. In general, safety professional competencies can be divided into three clusters: cognitive competencies, interpersonal competencies, and intrapersonal competencies. These clusters then comprise 16 competencies, that is, achievement orientation, analytical thinking, conceptual thinking, impact and influence, information seeking, involving others, negotiating skills, order, accuracy and clarity, perceptual objectivity, perseverance, planning, relationship building, self-control, technical expertise, translation capability, and visioning [11].

Occupational Health and Safety Professional Capability Framework

In 2017, the International Network of Safety & Health Professional Organizations (INSHPO) introduced its Occupational Health and Safety Professional Capability Framework: A Global Framework for Practice. This framework outlines the role, knowledge, and skills of OHS professionals. It establishes high standards of OHS professionals and informs employers of OHS professional capabilities [54]. This knowledge and skills section of the framework sets the benchmark for OHS education and training bodies and professional associations in developing the details of ongoing certification schemes, educational programs, and professional development. On the other hand, the Institution of Occupational Safety and Health (IOSH) has released its updated competency framework in 2020. Figure 6 shows The IOSH competencies framework.



Figure 6. IOSH competencies framework [54].

‘This competency framework provides a set of skills, knowledge, and behaviors that managers and staff can use to guide and take responsibility for their own learning and development. The development needs of everyone will vary, depending on their role, level, aspirations, and sector. Emphasis on the core

or efficiency of a particular behavior may vary from one company to another, depending on size, structure or culture' [54]

Both INSHIPO and IOSH frameworks have given the world of safety and health a new dimension towards safety culture and safety performance itself. This framework can be used either in providing education and training for the workers or can also be used in recruiting new workers to the organizations. IOSH framework has identified 69 competencies for an OSH professional to demonstrate while the INSHIPO framework draws the level of skills and knowledge one should pose in their profession. These could answer the result we obtain for the most study conducted by profession. We can see that safety competencies studies were mostly conducted on OHS professional.

4. Discussion

4.1. Safety Competencies; Definition and Relevant Competencies

Safety competencies can be defined as a person's ability to practice the combination of education, skills, experience, and knowledge they possess to perform a task safely [55]. It is an inherent trait of a person that is related to a higher level of safety [8] where a competent person is defined as an individual possessing qualifications through education, certification, and professional status or knowledgeable and experienced in performing duties [9]. Most of the article reviewed has agreed that safety competencies are about the ability to identify safety risks in performing tasks safely. This ability refers to individual characteristics in terms of knowledge, skills, and behaviors based on occupational safety and health. From the interpretations of previous researchers, it can be concluded that this safety competencies are a mastery of skills and practices of safe behavior based on strong safety knowledge. This safety knowledge refers to employees' understanding and involvement in aspects of occupational safety and health management such as legal compliance, safety, and health policy, safety and health committee, safety and security procedures, training, emergency preparedness, complaint, and accident investigation, and so on [56–58].

Using the model developed by Leemann, Daud et al., used the Delphi technique to investigate 36 experts to identify key competencies in Malaysia's OSH [11]. These competencies are related to the following four functions: specification, enforcement, promotion, and specific functions. The results show that based on their importance, these competencies can be classified into three categories (cognitive, interpersonal, and intrapersonal). In Taiwan, Chen (2010) employed 12 safety professionals and 6 safety educators to determine the competency of safety professionals [5]. The results show that for safety professionals and safety educators (both considered Safety Professional) most important competencies are to be proficient with safety and health regulations, employee safety and health knowledge, efficiency analysis, and communication and efficiency coordination. INSHIPO and IOSH both have introduced its competencies and capabilities framework. Based on these frameworks and this review, safety competencies are identified and categorized into three major groups which are: technical, core, and behavior. Although these frameworks are focusing for safety professionals, it can be applied to another worker as well. All these safety competencies can be divided into these three groups and these competencies will be the foundations in an organization's OSH management. For example, in an organization, a worker needs to have basic and general safety behavior, skills, and knowledge. They do not have to depend on safety and health officer to identify hazards at their workplace. Stakeholders must provide workers with safety education as they need to work safely as an individual and communicate with each other to work safely as a team as outlined by the behavioral section.

On the other hand, there were also studies about preparing the young workers and students about safety competencies as they were fragile when entering the occupational world [46]. A common contributor to the high burden of injuries and illnesses among young and contingent workers is a lack of essential OSH knowledge and skills due to lack of or insufficient OSH training [59]. Their risk-taking attitudes were so high because they were energetic and eager to do the job without knowing the hazard of the job [53].

The NIOSH 8 core competencies in the Safe, Skilled, Ready workforce program is the best platform to guide other institutions to prepare the young workforce with relevant knowledge and skill to enter the adult working world. However, they cannot just be equipped with knowledge and skill but also, they must practice appropriate behavior or code of conduct in order to create a safe workplace. Early exposure to the significance of OSH in the workplace can help students develop strong safety habits. Incorporating OSH modules into school curricula is an excellent place to start.

Based on the definition of safety competencies, this study concludes that these competencies are a combination of knowledge, skills, and behaviors required to perform a task safely for individuals and those working around them. For the knowledge element, all employees need to have a basic knowledge of safety such as the proper usage of protective equipment before starting a task [8]. Safety knowledge also refers to understanding laws, regulations, and even procedures regarding OSH [8,11,25,43]. In addition, knowledge is also related to the mastery of knowledge about the task performed [11,19,30,47,48], related experience that one's possess [29,42,47,50]. However, this study sees that an important competency in this element of knowledge is the ability to identify hazards [8,25,28,43,44,49,50] and knowledge to control hazards [8,19,28,49,50]. Furthermore, employees also need to have knowledge related to emergency response such as first aid so as not to panic when an incident occurs. In order to gain all this knowledge, workers must have sufficient qualifications through relevant training programs to make them competent while performing their job. Effective health and safety training may help organizations satisfy their legal health and safety duties as mandated by health and safety law while also reducing workplace incidents [60].

As for the skills element, accidents can be avoided if the employee has the job skills and does his job safely. These task-related skills are one of the key competencies for creating a safe workplace [11,43,44,47]. This ability can guarantee that personnels complete their tasks in a professional and timely manner. A competent worker can contribute to a safe workplace. Communication skills are also important in developing safety competencies. These communication abilities encompass not just speaking but also interpretation, writing, language [25] and interpersonal skills [11]. The main purpose of communication is to deliver information, which may be accomplished through a variety of means such as information signs and even policy writing. In the context of occupational safety and health, safety communication is a critical safety ability because it allows all safety rules and procedures to be conveyed. Furthermore, communication can provide management with information regarding potential hazards in the workplace. Communication is the most effective strategy to enhance safety performance at the workplace [61]. Another competency that plays important role in developing a safe workplace is leadership skills, troubleshooting, and problem-solving skills. These competencies are important especially to the supervisor and safety managers because it is the first step to identifying the cause of an incident. Teamwork among the organization members will emphasize communication and hazard identification [62].

In this study, safety behaviors are another element of safety competencies. A relevant safety knowledge and safety skills should shape good and quality safety behaviors. Appropriate attitudes [30,42,46,47,49,52] and a strong work ethic [11,19,25,43] are critical characteristics that might influence safety behaviors. This appropriate behavior is correlated with employee discipline as well as locus control over OSH [11,19,52,53]. This locus control refers to an individual's level of self-confidence in his or her ability to carry out work safely. Individuals and organizations are mostly told what they can not do by laws and regulations, but ethics tells them what they should do. Doing the right thing is more important than not doing the wrong thing when it comes to ethics. To protect the safety of himself and others around him while working, an employee must be mentally and physically fit [19,30,47,48]. A person's physical and mental health can have an impact on their job performance as well as their safety performance. Employees can do their jobs in a more alert condition if they have a healthy body, and if they have a healthy mentality, they may be more aware of work

safety. Furthermore, employees' safety awareness and preparedness will be at their peak with a healthy mind. All organization members should carry along the responsibility to create a safe culture in the organization. Responsibility is also a safety competency that influences individual safety behavior to enhance the organization's safety performance.

4.2. Pattern of Safety Competencies Studies

This review has given the overall view of research and publications specifically about "safety competencies" to answer the first review question. We have identified a number of publications based on years, country/region, field/industries, job roles, and the core competencies themselves. From year 2000 to 2021, studies on safety competencies showed an uptrend pattern, particularly after 2015. In 2019, ten articles were published that highlighted the growing interest of safety competencies [15,30,33,43,46,53,63,64]. This might be attributed to INSHIPO and IOSH introducing a safety competencies framework in 2017 and 2020, respectively. This safety competencies framework provides a set of skills, knowledge, and behaviors that managers and employees may utilize to steer and take responsibility for their own learning and development. Everyone has distinct developmental requirements based on their position, level, objectives, and industry. However, research on these safety competencies has decreased in 2020 and 2021, maybe because of the advent of the COVID-19 pandemic.

Most of the studies reviewed were conducted in United States [19,25,28,31,41–43,48,50,65,66]. However, the Asian region leads the studies on safety competencies with 14 papers [5,8,11,22,30,36–38,45,49,67–69]. The raising study in Asia shows a good sign of recognizing safety competencies concept among the developing country. Studies in the United States focus more on safety education in school and tertiary institutions to prepare young adults with proper safety education and relevant safety competencies align with NIOSH 8 core competencies framework. It is also the best way to take an example and study the past incident to learn from the mistakes just like a competency that one should possess [42,50]. The best practice of safety and the relevant safety competencies can be introduced into the education curricula to prepare the workforce with proper knowledge in the field.

In sequence with this, the studies about safety competencies in the education field also show a higher publication around the world with 16 studies [25,28,31–33,38–40,46,48–50,52,53,56,66]. Elements of knowledge and competence on safety and health in the workplace are not much highlighted in most current frameworks for providing job readiness skills to the young workforce. Because of their attractiveness and interest in the nature of a work organization, these young employees have the opportunity to switch jobs throughout their careers. This transition will expose and introduce students to new or different dangers or risk situations, emphasizing the significance of continuing to apply fundamental occupational safety and health knowledge. Therefore, [28] suggested that these young workforces should be prepared with strong basic safety knowledge and skills before they enter the world of work in line with NIOSH 8 core competencies framework. On the other hand, to determine the various abilities in this field of OSH, studies on safety competencies must be conducted via the field of education. This will serve as a guide for companies in providing safety training opportunities to their employees based on relevant competencies, since safety training has a significant association with an organization's safety performance [56].

In addition, studies on safety competencies are also conducted in the fields of construction [8,22,24,26,29,30,35,43,51,69], process safety [34,37,41,42,47,65,67,70], safety management [5,11,15,44,63,64] and manufacturing [7,19,36,45,68]. All these fields except safety management are areas with high safety risks and hazards. The safety competencies required in these areas may vary but the safety knowledge base and skills are the same. In addition, safety in these areas also depends on the ability of employees to master their job-related skills [11,43,44,47]. Failures in safety management in these areas can have serious consequences. Basic OSH knowledge and competencies, such as hazard identification and appropriate protective equipment usage, are critical in all of these sectors. Effective safety

management practices depend on a proactive and ongoing hazard identification and assessment process [57]. Workplace safety and health management is a critical system in risk management because it includes a safety and health policy, a safety and health committee, safety and health procedures, safety and health training, emergency response readiness, complaint and accident investigation, and commitment and safety behaviors [71]. In this review, there were only 5 main industries being studied for the past years; construction, process safety, manufacturing, and safety management, and most of it are in the education field. The higher number of research conducted in the academic world shows that the development of the safety competencies concept is on the right track. The review shows that there is still an opportunity to establish studies regarding safety competencies in other fields of work such as the field of law enforcement and the military as well as transportation. These will contribute to expanding the OSH competency dictionary in practice.

5. Conclusions

The study revealed the potential, and the gaps in the knowledge of safety competencies that one should possess when performing their task. It was found that the number of studies on safety competencies research has increased in recent years. Safety competencies play an important role in developing a safety culture and improving safety performance in a workplace. It is a big task to change a culture of an organization, but we can start it by introducing safety competencies to the organization members. For example, communications and hazards identification has become major safety issues and challenges in industrial safety when going through the 4.0 industry revolution [20]. Therefore, an organization and society should emphasize and provide more training related to communication and hazard identification in order to sustain a safe climate in the future. Everyone in the organizations can play their role in achieving a sustainable safety culture where they should be able to recognize any hazard at their workplace and communicate to the others about work safely. After reviewing and discussing the previous studies on safety competencies, three major categories of competencies have been recognized which are knowledge, skill, and behavior. Every member of the organization should have knowledge about OSH and also about their job role. With the right knowledge and skills, they will perform the job safely and effectively. However, without proper attitude and behavior, the possibility for incidents to happen will become bigger. Throughout these studies, we found that to control the sustainability of a safe and healthy relationship between the workers and organization, there is a need to strengthen or introduce new competencies especially during and after the world facing a pandemic such as the COVID-19. It is a very crucial point to sustain the safety climate of an organization and society when people are allowed to come back to work after the event. On the other hand, the safety society must be ready to face the challenges in the era of the Fourth Industrial Revolution. The engineer and designer of a smart machine should possess relevant competencies to ensure the sustainability of the safety climate in the organization. Therefore, future research should be conducted to make sure that we are ready to face any events and challenges in the future to maintain the sustainability of a safe society.

Author Contributions: Conceptualization, F.A.R., M.A.S. and K.A.; methodology, F.A.R. and A.A.; validation, I.L., M.N.A. and M.K.; formal analysis, F.A.R.; writing—original draft preparation, F.A.R.; writing—review and editing, A.A., M.B.C. and M.M.; supervision, K.A. All authors have read and agreed to the published version of the manuscript.

Funding: This research and the APC was funded by National University of Malaysia (SK-2021-011) & (DPK-2021-018).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to ethical restrictions.

Acknowledgments: The authors wish to thank all the research team members and families for their involvement in this study.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Available online: <https://www.ilo.org/global/topics/safety-and-health-at-work/lang--en/index.htm> (accessed on 2 January 2020).
2. Ghahramani, A.; Salminen, S. Evaluating effectiveness of OHSAS 18001 on safety performance in manufacturing companies in Iran. *Saf. Sci.* **2019**, *112*, 206–212. [[CrossRef](#)]
3. Available online: <http://www.dosh.gov.my/index.php/statistic-v/national-occupational-accident-fatality-rate-v> (accessed on 2 January 2020).
4. Axley, L. Competency: A concept analysis. *Nurs. Forum* **2008**, *43*, 214–222. [[CrossRef](#)] [[PubMed](#)]
5. Chang, S.H.; Chen, D.F.; Wu, T.C. Developing a competency model for safety professionals: Correlations between competency and safety functions. *J. Saf. Res.* **2012**, *43*, 339–350. [[CrossRef](#)] [[PubMed](#)]
6. ACSNI. *Organizing for Safety*; Advisory Committee on the Safety of Nuclear Installations, Study Group on Human Factors: London, UK, 1993.
7. Ferjencik, M.; Jalovy, Z. What can be learned from incidents in chemistry labs. *J. Loss Prev. Process Ind.* **2010**, *23*, 630–636. [[CrossRef](#)]
8. Li, S.; Fan, M.; Wu, X. Effect of Social Capital between Construction Supervisors and Workers on Workers' Safety Behavior. *J. Constr. Eng. Manag.* **2018**, *144*, 1–10. [[CrossRef](#)]
9. Arifin, K.; Jaafar, M.H.; Aiyub, K.; Rizal, M.; Izzuddin, M.; Ishak, S.; Shaharudin, M. Occupational Safety and Health (Osh) Management In Construction Industry: A Review. *Int. J. Occup. Saf. Ergonomics* **2017**, *24*, 493–506. [[CrossRef](#)]
10. Arifin, K.; Derahim, N.; Aiyub, K. Analisis Penilaian Iklim Keselamatan Pekerja Di Bahagian Operasi Sistem Pengangkutan Rel Bandar Malaysia (Analysis of Worker Safety Climate Assessment at Malaysia City Rail Management's Operation Division). *Akademika* **2020**, *90*, 103–113.
11. Daud, R.; Ismail, M.; Omar, Z. Identification of competencies for Malaysian occupational safety and health professionals. *Ind. Health* **2010**, *48*, 824–834. [[CrossRef](#)]
12. ANSI/ASSE. *Criteria for Establishing the Scope and Functions of the Professional Safety Position (ANSI/ASSE Z590.2-2003)*; ANSI/ASSE: Des Plaines, IL, USA, 2003.
13. Swuste, P.; Arnoldy, F. The safety adviser/manager as agent of organisational change: A new challenge to expert training. *Saf. Sci.* **2003**, *41*, 15–27. [[CrossRef](#)]
14. Saari, J. Risk assessment and risk evaluation and the training of OHS professionals. *Saf. Sci.* **1995**, *20*, 183–189. [[CrossRef](#)]
15. Pryor, P.; Hale, A.; Hudson, D. Development of a global framework for OHS professional practice. *Saf. Sci.* **2019**, *117*, 404–416. [[CrossRef](#)]
16. Arifin, K.; Abudin, R.; Razman, M.R. Penilaian iklim keselamatan persekitaran kerja terhadap komuniti kakitangan kerajaan di Putrajaya. *Malays. J. Soc. Space* **2019**, *15*, 304–320. [[CrossRef](#)]
17. Kadir, A.; Derahim, N. Dimensi iklim keselamatan rakan sekerja bagi sistem pengangkutan rel bandar. *Malays. J. Soc. Space* **2020**, *16*, 53–65. [[CrossRef](#)]
18. di Nardo, M.; Gallo, M.; Murino, T.; Santillo, L. System Dynamics Simulation for Fire and Explosion Risk Analysis in Home Environment. *Rev. Model. Simul. (IREMOS)* **2017**, *10*, 43–54. [[CrossRef](#)]
19. Karunanont, T.; Karwowski, W. Tacit knowledge of manufacturing workers and managers about learning environment, corporate safety culture and professional competences. *Int. J. Learn. Intellect. Cap.* **2011**, *8*, 459–483. [[CrossRef](#)]
20. Di Nardo, M.; Piotr, B.; Gallab, M.; Teresa, M.; Haoxuan, Y. The New Safety Trends: The Challenges through Industry 4.0. *WSEAS Trans. Environ. Dev.* **2022**, *18*, 255–267. [[CrossRef](#)]
21. Anastasi, S.; Madonna, M.; Monica, L. Implications of embedded artificial intelligence—Machine learning on safety of machinery. *Procedia Comput. Sci.* **2021**, *180*, 338–343. [[CrossRef](#)]
22. Page, M.J.; McKenzie, J.E.; Bossuyt, P.M.; Boutron, I.; Hoffmann, T.C.; Mulrow, C.D.; Shamseer, L.; Tetzlaff, J.M.; Akl, E.A.; Brennan, S.E.; et al. The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ* **2021**, *372*, n71. [[CrossRef](#)]
23. Zhou, Z.; Goh, Y.M.; Li, Q. Overview and analysis of safety management studies in the construction industry. *Saf. Sci.* **2015**, *72*, 337–350. [[CrossRef](#)]
24. Paul, J.; Criado, A.R. The art of writing literature review: What do we know and what do we need to know? *Int. Bus. Rev.* **2020**, *29*, 101717. [[CrossRef](#)]
25. Khan, K.S.; Kunz, R.; Kleijnen, J.; Antes, G. Five steps to conducting a systematic review. *J. R. Soc. Med.* **2003**, *96*, 118–121. [[CrossRef](#)] [[PubMed](#)]
26. Brosseau, L.M.; Fredrickson, A.L.; Nachreiner, N.M. Graduate proficiency assessment using a competency-based learning model. *J. Occup. Environ. Med.* **2008**, *50*, 1029–1034. [[CrossRef](#)] [[PubMed](#)]
27. Dingsdag, D.P.; Biggs, H.C.; Sheahan, V.L. Understanding and defining OH&S competency for construction site positions: Worker perceptions. *Saf. Sci.* **2008**, *46*, 619–633. [[CrossRef](#)]

28. Abudayyeh, O.; Asce, M.; Dibert-deyoung, A.; Asce, S.M.; Jaselskis, E.; Asce, A.M. Analysis of Trends in Construction Research: 1985–2002. *J. Constr. Eng. Manag.* **2004**, *130*, 433–439. [[CrossRef](#)]
29. Okun, A.H.; Guerin, R.J.; Schulte, P.A. Foundational workplace safety and health competencies for the emerging workforce. *J. Saf. Res.* **2016**, *59*, 43–51. [[CrossRef](#)]
30. Li, S.; Wu, X.; Wang, X.; Hu, S. Relationship between Social Capital, Safety Competency, and Safety Behaviors of Construction Workers. *J. Constr. Eng. Manag.* **2020**, *146*, 04020059. [[CrossRef](#)]
31. Liang, K.; Fung, I.W.H.; Xiong, C.; Luo, H. Understanding the factors and the corresponding interactions that influence construction worker safety performance from a competency-model-based perspective: Evidence from scaffolders in China. *Int. J. Environ. Res. Public Health* **2019**, *16*, 1885. [[CrossRef](#)]
32. Sigmann, S. Chemical safety education for the 21st century—Fostering safety information competency in chemists. *J. Chem. Health Saf.* **2018**, *25*, 17–29. [[CrossRef](#)]
33. Mkpát, E.; Reniers, G.; Cozzani, V. Process safety education: A literature review. *J. Loss Prev. Process Ind.* **2018**, *54*, 18–27. [[CrossRef](#)]
34. Pryor, P. Developing the core body of knowledge for the generalist OHS professional. *Saf. Sci.* **2019**, *115*, 19–27. [[CrossRef](#)]
35. Amyotte, P.R.; Berger, S.; Edwards, D.W.; Gupta, J.P.; Hendershot, D.C.; Khan, F.I.; Mannan, M.S.; Willey, R.J. Why major accidents are still occurring. *Curr. Opin. Chem. Eng.* **2016**, *14*, 1–8. [[CrossRef](#)]
36. Başağa, H.B.; Temel, B.A.; Atasoy, M.; Yıldırım, İ. A study on the effectiveness of occupational health and safety trainings of construction workers in Turkey. *Saf. Sci.* **2018**, *110*, 344–354. [[CrossRef](#)]
37. Ghahramani, A.; Khalkhali, H.R. Development and Validation of a Safety Climate Scale for Manufacturing Industry. *Saf. Health Work* **2015**, *6*, 97–103. [[CrossRef](#)] [[PubMed](#)]
38. Goh, Y.M.; Tan, S.; Lai, K.C. Learning from the Bhopal disaster to improve process safety management in Singapore. *Process Saf. Environ. Prot.* **2015**, *97*, 102–108. [[CrossRef](#)]
39. Lim, K.H.; Teng, C.S. University engagement to improve safety education. *Process Saf. Prog.* **2021**, *40*, 12–17. [[CrossRef](#)]
40. Mannan, M.S.; Reyes-Valdes, O.; Jain, P.; Tamim, N.; Ahammad, M. The Evolution of Process Safety: Current Status and Future Direction. *Annu. Rev. Chem. Biomol. Eng.* **2016**, *7*, 135–162. [[CrossRef](#)]
41. Stocco da Silva, L.H.; Abreu Rodrigues, L.C.; de Nunes Diogenes, A.; Tedeschi Gomes Abrantes, A.C.; Baptista, A.; de Araújo Ponte, H. A risk reduction approach for academic research labs: A case study on naphthenic corrosion. *J. Loss Prev. Process Ind.* **2020**, *64*, 104061. [[CrossRef](#)]
42. Tamim, N.; Scott, S.; Zhu, W.; Koirala, Y.; Mannan, M.S. Roles of contractors in process safety. *J. Loss Prev. Process Ind.* **2017**, *48*, 358–366. [[CrossRef](#)]
43. Baybutt, P. Insights into process safety incidents from an analysis of CSB investigations. *J. Loss Prev. Process Ind.* **2016**, *43*, 537–548. [[CrossRef](#)]
44. Bush, D.; Chang, C.; Rauscher, K.; Myers, D. Essential Elements for Effective Safety and Health Education in Postsecondary Construction Career Technical Education. *New Solut.* **2019**, *29*, 53–75. [[CrossRef](#)]
45. Provan, D.J.; Dekker, S.W.A.; Rae, A.J. Bureaucracy, influence and beliefs: A literature review of the factors shaping the role of a safety professional. *Saf. Sci.* **2017**, *98*, 98–112. [[CrossRef](#)]
46. Shaheen, M.; Azam, M.S.; Soma, M.K.; Kumar, T.J.M. A competency framework for contractual workers of man-ufacturing sector. *Ind. Commer. Train.* **2019**, *51*, 152–164. [[CrossRef](#)]
47. Tappura, S.; Nenonen, S.; Nenonen, N. Developing Safety Competence Process for Vocational Students. In Proceedings of the International Conference on Human Systems Engineering and Design, Reims, France, 25–27 October 2018; Springer International Publishing: Berlin/Heidelberg, Germany, 2019. [[CrossRef](#)]
48. Baybutt, P. The Meaning and Importance of Process Safety Competency. *Process Saf. Prog.* **2015**, *25*, 326–330. [[CrossRef](#)]
49. Hardison, D.; Behm, M.; Hallowell, M.R.; Fonooni, H. Identifying construction supervisor competencies for effective site safety. *Saf. Sci.* **2014**, *65*, 45–53. [[CrossRef](#)]
50. Wu, T.C. The roles and functions of safety professionals in Taiwan: Comparing the perceptions of safety professionals and safety educators. *J. Saf. Res.* **2011**, *42*, 399–407. [[CrossRef](#)]
51. Young, C.W.; Hodges, K.J. Process Safety Management Mentoring: Subjects to Convey and the Methods for Conveying Clyde. *Process Saf. Prog.* **2012**, *25*, 326–330. [[CrossRef](#)]
52. Biggs, H.C.; Biggs, S.E. Interlocked projects in safety competency and safety effectiveness indicators in the con-struction sector. *Saf. Sci.* **2013**, *52*, 37–42. [[CrossRef](#)]
53. Nykänen, M.; Sund, R.; Vuori, J. Enhancing safety competencies of young adults. A randomized field trial (RCT). *J. Saf. Res.* **2018**, *67*, 45–56. [[CrossRef](#)]
54. Nykänen, M.; Salmela-Aro, K.; Tolvanen, A.; Vuori, J. Safety self-efficacy and internal locus of control as mediators of safety motivation—Randomized controlled trial (RCT)study. *Saf. Sci.* **2019**, *117*, 330–338. [[CrossRef](#)]
55. Arifin, K.; Wan Isa, W.M.Z.; Zaini, Z.-A.H.; Sahimi, A.S. Persepsi Terhadap Pelaksanaan Pengurusan Keselamatan Dan Kesehatan Pekerjaan Oleh Kakitangan. *J. Soc. Sci. Humanit.* **2021**, *18*, 198–212.
56. Mazlina Zaira, M.; Hadikusumo, B.H.W. Structural equation model of integrated safety intervention practices affecting the safety behaviour of workers in the construction industry. *Saf. Sci.* **2017**, *98*, 124–135. [[CrossRef](#)]

57. Silvestre, B.S.; Gimenes, F.A.P. A sustainability paradox? Sustainable operations in the offshore oil and gas industry: The case of Petrobras. *J. Clean. Prod.* **2017**, *142*, 360–370. [[CrossRef](#)]
58. Available online: <http://www.hse.gov.uk> (accessed on 3 January 2022).
59. Nik Mansor, N.R.; Arifin, K.; Awang, A.; Jarmin, R.; Mohamed, Z.; Sahimi, A.S.; Derahim, N. Biological Risk and Occupational Safety: Health among Nurses. *Asian J. Environ. Hist. Herit.* **2019**, *3*, 11–18.
60. Rauscher, K.J.; Myers, D.J.; Miller, M.E. Work-related deaths among youth: Understanding the contribution of US child labor violations. *Am. J. Ind. Med.* **2016**, *59*, 959–968. [[CrossRef](#)]
61. Skiba, R. Characteristics of Effective Health and Safety Training Environments and Trainers in Australian Vocational Education and Training. *Int. J. Vocat. Educ. Train. Res.* **2020**, *6*, 22–28. [[CrossRef](#)]
62. Ismail, Z.S.; Arifin, K. Analisis Keberkesanan Komunikasi dalam Meningkatkan Keselamatan dan Kesihatan Pekerjaan di Universiti Penyelidikan di Malaysia. *Akad. J. Sains Sos. Dan Kemanus. Asia Tenggara* **2019**, *89*, 183–194.
63. Available online: <http://www.inshpo.org/work> (accessed on 3 January 2020).
64. Colombo, S.; Golzio, L.E.; Bianchi, G. The evolution of health-, safety- and environment-related competencies in Italy: From HSE technicians, to HSE professionals and, eventually, to HSE managers. *Saf. Sci.* **2019**, *118*, 724–739. [[CrossRef](#)]
65. Hale, A. From national to European frameworks for understanding the role of occupational health and safety (OHS) specialists. *Saf. Sci.* **2019**, *115*, 435–445. [[CrossRef](#)]
66. Morrison, D.T.; Fecke, M.; Martens, J. Migrating an incident reporting system to a CCPS process safety metrics model. *J. Loss Prev. Process Ind.* **2011**, *24*, 819–826. [[CrossRef](#)]
67. Saleh, J.H.; Pendley, C.C. From learning from accidents to teaching about accident causation and prevention: Multidisciplinary education and safety literacy for all engineering students. *Reliab. Eng. Syst. Saf.* **2012**, *99*, 105–113. [[CrossRef](#)]
68. Eljack, F.; Kazi, M.K. Process safety and abnormal situation management. *Curr. Opin. Chem. Eng.* **2016**, *14*, 35–41. [[CrossRef](#)]
69. Leong, W.D.; Teng, S.Y.; How, B.S.; Ngan, S.L.; Lam, H.L.; Tan, C.P.; Ponnambalam, S.G. Adaptive analytical approach to lean and green operations. *J. Clean. Prod.* **2019**, *235*, 190–209. [[CrossRef](#)]
70. Arifin, K.; Juhari, M.L.; Khairil, M.; Mahfudz, M.; Samad, M.A. Faktor Organisasi dalam Menyumbang Kepada Kemalangan Pekerjaan Industri Pembinaan Rel Mass Rapid Transit (MRT) di Malaysia. *Akademika* **2021**, *91*, 17–32.
71. Arifin, K.; Wan Isa, W.M.Z.; Zaini, Z.-A.; Sahimi, A.S. Tahap Kesedaran Kakitangan Awam Terhadap Aspek Keselamatan dan Kesihatan di Tempat Kerja. *J. Soc. Sci. Humanit.* **2021**, *18*, 229–242.