Systematic Literature Review on Indicators Use in Safety Management Practices Among Utility Industries

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Abstract

Due to inadequate safety management systems, workers in utility industries are exposed to occupational accidents. Accordingly, it is necessary to characterise and compares the available literature on indicators used in safety management practices in the utility industries. The systematic literature review was based on the Preferred Reporting Items for Systematic Reviews and Meta-analysis statement. This study considered 25 related studies from Web of Science and Scopus databases. Further review of these articles resulted in three main themes of performance indicators, namely driven leading indicators, observant leading indicators, and lagging indicators consisting of 15 sub-themes. Future studies should consider researching a more comprehensive range of utility industries, measuring subjective and objective indicators, integrating risk management into safety management practices, and validating the influence of leading indicators on safety outcomes. Also, researchers recommend including accidents, fatalities, lost time injuries, and near misses in safety outcomes.

1 Introduction

The International Labour Organization (ILO) estimates that about 6,000 workers die, 340 million workplace accidents, and 160 million people suffer from work-related illnesses worldwide due to inadequate working conditions (ILO 2018). One of the industries contributing to this statistic is the utility industry, which consists of water, electricity, and gas utilities that provide essential services to commodity providers and other industries contributing to economic and social growth. Workers in the utility industry are subject to risks associated with their work activities and surroundings. In 2018, 405 fatal cases and 101,393 non-fatal cases of accidents were recorded by ILO in the utility industry globally (ILO 2018). As a result, occupational accidents cause a burden on the injured individual and society, including monetary costs such as wages lost and medical expenses, potential lifelong disability, and reduced quality of life (Fordyce et al. 2016). Even with various programmes implemented by government authorities at the national level and organisations, the number of accidents at work is still high (Irwan Ibrahim et al. 2010). Thus, the effort implemented to control unsafe actions and conditions in the workplace is insufficient (Clarke 2006). Accidents can be avoided by ensuring the safety level implemented in the organisation is maintained and improved from time to time through measuring indicators that proactively affect safety performance.

Safety performance is conventionally monitored by lagging indicators such as accident rates, fatal accident rates and dangerous occurrences, even though failure focused control measures are less effective in driving continuous improvement efforts (Sinelnikov et al. 2015; Guo and Yiu 2016; Bitar et al. 2018). The lagging indicators method measures failures compared to current safety conditions and should not be considered a direct measurement of the level of safety in a working system (Lingard et al. 2017) because incidents are rare occurrences with a low probability, making the accident frequency statistically unreliable due to variance restrictions (Hopkins 2009). The rare occurrence of incidents does not mean that the workplace is safer than other places where accidents occur, and it is not a clear performance indicator for hazard or risk management (Cadieux et al. 2006; Dekker and Pitzer 2016). Therefore, lagging indicators that measure weakness rather than safety and ignore the different exposures of risks inherent in work activities should not be considered a direct measure of safety level in a working system (Thompson et al. 1998; Cooper 2000; Arezes and Sérgio Miguel 2003; Lofquist 2010; Lingard et al. 2017). Recent research is more focused on proactive action by measuring safety levels through OSH activities that bring safety management systems up to date towards the desired safety goals, enabling organisations to anticipate safety issues and potentially reduce OSH incidents (Grabowski et al. 2007; Hollnagel 2008; Reiman and Pietikäinen 2012; Sheehan et al. 2016; Lingard et al. 2017).

Safety management is frequently considered a sub-system in overall organisational management and is implemented through many forms of safety management practices, the mechanism incorporated into an organisation to control hazards at work (Labodová 2004; Vinodkumar and Bhasi 2010). Safety management consists of the procedure, planning, information management, and supervision which play significant roles in reducing occupational accidents (Jaafar et al. 2017b). On the other hand, a lack of a safety management system can lead to workplace accidents, among the most common causes of industrial disasters such as the Bhopal gas leak (Gupta 2002; Chouhan 2005; Vinodkumar and Bhasi 2010). As a result, it is necessary to detect any deterioration in OSH management systems and quantify the amount of accident risk and how it changes over time (Kjellén 2009; Sinelnikov et al. 2015; Lingard et al. 2017). There are two indicators when reviewing safety management procedures: positive indicators that show potential for improvement and negative indicators that serve as early warning signs of management system failures. This proactive indication can help detect and manage safety issues before they turn into an incident or cause harm (Hinze et al. 2013; Sinelnikov et al. 2015; Sheehan et al. 2016; Lingard et al. 2017). Proactive indicators can also be used as benchmarks for current practice to demonstrate continuous progress over time, monitor safety performance tolerance levels, and take action when these tolerance levels are breached (OECD 2008; Sinelnikov et al. 2015; Tang et al. 2018). However, reporting practices for occupational safety and health (OSH) vary by industry and workplace sector, depending on organisational structure, technology, and type of activity (Dağdeviren and Yüksel 2008; Sheehan et al. 2016). Further research is needed to establish more effective OSH performance indicators and assist businesses in implementing them (Pawłowska 2015).

Although the importance of evaluating proactive indicators is growing, the literature on the utility industry is very scattered. As a result, this study aims to close the gap in identifying indicators used in measuring safety performance in the utility industry and their links with safety outcomes to promote safety in the utility industry. This study aims to conduct a systematic literature review by grasping the concept of safety indicators, measuring techniques, identifying indicators of safety management practices used in utility industries, and the associations between indicators.

2 Methodology

2.1 Systematic Searching Strategies

Three main processes in the systematic searching strategies process are the identification, screening, and eligibility based on PRISMA adopted from Moher et al. (2009).

[Fig. 1 about here]

2.1.1 Identification

Identification is a search process using the study's main keywords, namely safety indicator, safety management practices, and utility industries which relied on keywords developed based on the research question suggested by Okoli (2015). To provide more options for selecting databases in the search for more related articles for the review, searching processes used any synonym, associated term, and variation. The identification process relied on past studies, keywords recommended by guidelines and keywords recommended by experts. Scopus and Web of Science databases were used in this research, using enriched existing keywords and developed full search strings shown in Table 1. The searching process in these two databases resulted in 807 articles.

Table 1
The search string

Database	Search string
Web of Science	TOPIC: ("safety indicators" OR "key safety performance indicators" OR "safety performance indicators" OR "safety performance outcomes" OR "safety performance" OR "OHS performance" OR "safety outcome indicators" OR "leading indicator" OR "lagging indicator") Refined by: TOPIC: ("safety management systems" OR "safety management practices" OR "safety system practices" OR "safety management programs" OR "safety programs" OR "risk management" OR "safety measures") AND TOPIC: (utilities OR water OR electrical OR electricity OR "electrical supply" OR "power supply" OR "power transmission" OR "electric transmission" OR gas OR "sanitary services")
Scopus	(TITLE-ABS-KEY ("safety indicators" OR "key safety performance indicators" OR "safety performance indicators" OR "safety performance outcomes" OR "safety performance" OR "OHS performance" OR "safety outcome indicators" OR "leading indicator" OR "lagging indicator")) AND (("safety management systems" OR "safety management practices" OR "safety system practices" OR "safety management programs" OR "safety programs" OR "risk management" OR "safety measures")) AND (utilities OR water OR electrical OR electricity OR "electrical supply" OR "power supply" OR "power transmission" OR "electric transmission" OR gas OR "sanitary services"))

[Table 1 about here]

2.1.2 Screening

This study screened all 807 selected articles by selecting the criteria for article selection, which was completed automatically using the database's sorting function. The search was limited from 2000 to May 2021. The authors removed 19 articles that were duplicates from the selected articles. Furthermore, only articles with empirical data published in a journal were included in the review to ensure their quality. Additionally, only items written in English were included in the review to minimise misunderstandings. The inclusion and exclusion criteria shown in Table 2 were used to include 321 articles and exclude 467 articles to achieve the study's objectives.

Table 2
The inclusion and exclusion criteria

Criteria	Inclusion	Exclusion
Publication timeline	2000 - May 2021	1999 and before
Document type	Article (with empirical data) and review	Conference proceedings, chapters in book, book series, books, etc.
Language	English	Non-English
Nature of the study	i. Measurement of current safety level	i. Research of method/process system
	ii. Safety management practices in industries	ii. Not related to safety indicators
	iii. Safety outcomes	iii. Not related to utilities industries

[Table 2 about here]

2.1.3 Eligibility

Eligibility involved personally reviewing the retrieved articles to guarantee that all the remaining articles after the screening process met the research criteria. This procedure was accomplished by reading the title and abstract and skimming through the papers. The elimination process was based on unclear methodology, non-safety management practice indicators, conducted in non-utilities industries, not related to the safety and health field, and published as a chapter in a book. As a result, 242 articles were removed, and 79 were chosen.

2.2 Quality appraisal

The remaining articles were assessed to ensure that the content was high quality. The remaining articles were categorised into three categories: high, medium, and low, with high and moderate papers being reviewed (Petticrew and Roberts 2006; Shaffril et al. 2020). This approach yielded 9 high-ranking articles, 16 moderate-ranking articles, and 54 low-ranking articles. As a result, articles with a low ranking were eliminated, leaving only 25 articles suitable for examination.

2.3 Data abstraction and analysis

This research study chooses the qualitative strategy to synthesise or analyse integrative data (Whittemore 2005). The researcher reviewed all 25 publications attentively, focusing on the abstract, findings, and discussion sections. Data abstraction was carried out based on the research questions, implying any data from the evaluated study that can answer the research question and were then entered into a table. Thematic analysis was then used to identify indicators and sub-indicators within the abstracted data based on noticing patterns and themes, clustering, counting, noting similarities, and relationships (Braun and Clarke 2006).

The first stage in thematic analysis is to produce indicators by looking for patterns in the abstracted data of all the articles reviewed for similarity. Based on a comparison of the conceptual theory of indicators for similarity, the comparable and abstracted data were pooled into three main indicators. The three sets of data were further analysed and synthesised, revealing another 15 sub-indicators. The data was divided into three main indicators: safety management practices acting as a driven leading indicator, safety performance behaviour acting as an observer leading indicator, and safety outcomes acting as a lagging indicator. There were seven sub-indicators in the safety management practices group, four in the safety performance group, and four in the safety results group.

3 Result

3.1 Temporal and spatial distribution

The review consisted of identification, screening, eligibility, and included processes, thus obtaining 25 selected articles related to the research question. The review's main indicators were safety management practices, safety performance behaviour and safety outcomes, and resulted in 15 sub-indicators, as shown in Table 3. Then, seven sub-indicators under safety management practices that act as driven leading indicators were identified: management commitment, involvement of workers, hazard identification and assessment, hazard prevention and control, training and education, evaluation and improvement, and communication and coordination. Meanwhile, the indicators of safety performance behaviour acting as an observant leading indicator consisted of four sub-indicators: safety motivation, safety knowledge, safety compliance, and safety participation. Lastly, the safety outcomes indicators that served as lagging indicators were identified, consisting of four sub-indicators: occupational accidents, occupational fatal accidents, near misses, and lost time injuries.

Table 3
The groups and sub groups

Nos	Authors	Year	Country	Driven Leading Indicators (Safety Management Practices)							Observant Leading Indicators (Safety Behaviour)				Lagging Indicators (Safety Outcomes)			
				MC	WI	HI	HC	T.E.	EI	CC	SK	SM	SC	SP	OA	FA	NM	LT
1	Barker	2021	Canada	/	/		/	/	/	/		/	/					
2	Zarei et al.	2021	Iran	/	/	/	/	/		/								
3	Sarkheil	2021	Iran	/				/	/						/			/
4	Zwetsloot et al.	2020	Netherlands	/	/	/	/	/	/	/								
5	Al Mazrouei et al.	2020	United Arab Emirates	/	/			/	/	/								
6	Janackovic et al.	2020	Serbia	/		/	/	/	/	/								
7	Ahmed Naji et al.	2020	Malaysia	/	/		/	/	/					/	/	/	/	/
8	Rajabi et al.	2020	Iran	/	/			/	/		/	/	/	/				
9	Mazrouei, Khalid, Davidson, et al.	2019	United Arab Emirates	/	/				/	/								
10	Mazrouei, Khalid, & Davidson	2019	United Arab Emirates	/									/					
11	Casey et al.	2019	Australia	/	/	/	/	/	/	/			/	/	/		/	
12	Skład	2019	Poland	/					/				/	/				
13	Santos et al.	2019	Brazil	/	/	/	/	/	/	/								
14	Tsalis et al.	2018	Greece		/		/	/							/	/	/	/
15	Mousavi et al.	2018	Italy	/	/	/	/	/	/	/			/	/	/	/	/	
16	Dartey-Baah & Addo	2018	Ghana	/									/	/				
17	Shea et al.	2016	Australia	/	/	/	/	/	/	/		/	/	/				
18	O'Neill et al.	2016	Australia												/	/		/
19	Podgórski	2015	Poland	/	/	/	/	/	/	/								
20	Becker	2014	Canada						/									
21	Øien et al.	2011	Norway	/		/		/	/									
22	Jiang et al.	2010	China	/	/		/	/			/	/	/	/	/		/	
23	Christian et al.	2009	United States	/		/	/			/	/	/	/	/	/			
24	Yule et al.	2007	United Kingdom	/	/			/					/				/	
25	Liggett	2006	United States	/		/	/	/		/								
Safety Management Practices				Safety Performance Behaviour								Safety Outcomes						

Nos	Authors	Year	Country	Driven Leading Indicators (Safety Management Practices)							Observant Leading Indicators (Safety Behaviour)				Lagging Indicators (Safety Outcomes)			
				MC	WI	HI	HC	T.E.	EI	CC	SK	SM	SC	SP	OA	FA	NM	LT

MC = Management Commitment	SK = Safety Knowledge	OA = Occupational Accident
WI = Workers Involvement	SM = Safety Motivation	FA = Occupational Fatality Accident
HI = Hazard Identification & Assessment	SC = Safety Compliance	NM = Near Misses
HC = Hazard Prevention & Control	SP = Safety Participation	LT = Lost Time Injury
TE = Training & Education		
EI = Evaluation & Improvement		
CC = Communication & Coordination		

[Table 3 about here]

The total number of articles published each year is displayed in Fig. 2. According to the graph, the maximum number of articles on safety management practice indicators in the utility industry was published in 2019 and 2020, with 5 articles (20%) each year. The distribution of publications fluctuated during the decade, with only one article published each year from 2006 to 2015 and then increasing in 2016. However, due to the review research being conducted in May 2021, the number of publications released in 2021 appears to be declining. It is expected that more articles will be published throughout the rest of the year. No papers were published from 2000 until 2005, then none in 2008, 2012, 2013, and 2017. The fluctuation trends in the number of published articles showed that researchers focused on proactive actions to anticipate safety issues and potentially reduce OSH incidents.

[Fig. 2 about here]

Figure 3 shows the total number of articles according to their country of origin. Most of the studies were conducted in Australia with 3 articles (12%), Iran with 3 articles (12%), and the United Arab Emirates with 3 articles (12%), followed by Canada with 2 articles (8%), Poland with 2 articles (8%), and the United States with 2 articles (8%). Most countries only published one article: Brazil, China, Ghana, Greece, Italy, Malaysia, Netherlands, Norway, Serbia, and the United Kingdom.

[Fig. 3 about here]

The review articles published were focused on general sectors with 10 papers (40%), followed by the gas utility sector with 9 papers (36%), and the electricity utility sector with 6 papers (24%). In their sampling, the articles that researched multiple or various industries, including the utility sectors, were included in this systematic review and were known as the general sector due to their suitability for the utility industry's safety management practices. From the 25 articles selected, most of the studies were conducted on driven leading indicators with 22 papers (85%), followed by observant leading indicators with 10 papers (38%), and lagging indicators with 8 papers (31%).

Leading indicators were measured through three types: passive, objective, and subjective. Most of the studies focused on subjective measurement with 20 articles (77%), followed by objective measurement with 6 articles (23%), and passive measurement with 2 articles (8%) from the 25 articles selected. Leading indicators research was distinguished into two phases: the development phase, which included defining, developing, or measuring, and the progressive phase through validation testing of leading on lagging indicators. Based on the selected articles, most of the studies were in the development phase with 18 articles (72%) and the progressive phase with 7 articles (28%).

3.2 Driven Leading Indicators

This study's on safety management practices were a group as the driven leading indicators. They were assessed through seven indicators: management commitment, workers' involvement, hazard identification and assessment, hazard prevention and control, training and education, evaluation and improvement, and communication and coordination.

Management commitment is an internal safety factor that relates to how senior management appears to prioritise safety issues, communicates well, and acts effectively in an organisation that values safety (Al Mazrouei et al. 2019a). Thematic analysis conducted in this research shows that 22 articles (85%) studied management commitment. Indicators for successful implementation of safety management systems depend on top management to develop safety policies; OSH leadership; visible commitment; and safety as a core value can shape the safety climate and performance to influence positive and lasting effects on safety.

Workers' involvement in safety can improve safety performance in an organisation as workers are the best-qualified people to make improvement suggestions because they are the people closest to the job. The thematic analysis found that 15 articles (58%) studied workers' involvement in safety management practices. Workers' involvement can be measured through the level of involvement encouragement, empowerment for safety, worker consultation, and removing barriers for workers' involvement that will lead to their 'ownership' towards safety.

The analysis found that only 11 articles (42%) discussed hazard identification and assessment practices in safety management. Hazard identification and assessment are important in identifying and verifying hazards to support the efficient functioning of safety management systems. Through this practice, prevention of accidents or similar undesirable events from reoccurring can be achieved. This practice is measured through four indicators: identifying existing hazards, workplace inspections, accident investigation, and hazard assessment.

Hazard prevention and control are essential in ensuring adequate hazard controls are implemented and operated effectively. Thematic analysis shows that 14 articles (54%) studied hazard prevention and control. There are four indicators used in assessing hazard prevention and control practices: planning, implementing, managing, and verifying hazard controls. This practice can lead to proactively improving, ensuring implementation, continuous implementation, and verifying control effectiveness.

Training and education were the second most studied in the review, consisting of 18 articles (69%) out of 25 papers. This practice can be enhanced through management commitment towards safety training that leads workers to gain knowledge, awareness and ability to recognise hazards, thus increasing safety levels. Thus, training and education are measured through four indicators: management roles in training, the effectiveness of workers' training, training on hazard identification and control, and safety awareness.

The safety management systems require evaluating the implementation and corrective actions on documented and implemented measures. This practice was studied in 16 articles (62%) from the selected review papers, which study performance evaluation of safety programmes, safety audits, identification of weaknesses, and identification of opportunities. It is important to keep track of performance appraisals and audits, which is essential to detect and describe safety programmes and management conditions. Weakness identification is important to avoid adverse safety incidents following unsuccessful work operations; thus, continuous improvement can be implemented by controlling and reviewing activities so that performance goals and indicators remain relevant.

Communication and coordination help organisations manage safety issues and progress related issues between organisations with diverse objectives from potential hazards and accidents. This practice is studied in 13 articles (50%) selected and can be measured through four indicators: management communication, safety reporting, supervisory communication, and OSH coordination. Effective safety communication and coordination between managers and workers are important to communicate safety problems or concerns that lead to a positive safety climate. Also, proactive supervisors will emphasise supervisory monitoring practices by being committed to safety, thus ensuring workers and contractors follow safety rules.

These safety management practices and their indicators are in detail in Table 4.

Table 4
The indicators of safety management pratices.

Practices	Indicators	Leading Indicators	References
Management Commitment	Safety policy	- a clear safety vision and objectives as important work priorities; - implementation and maintenance of safety policy by managers and workgroups; - workers' knowledge and awareness of safety policy; - provision of guidelines to establish procedures and control; and - the number of policy reviews and updates.	(Dartey-Baah and Addo 2018; Al Mazrouei et al. 2019b; Skład 2019; Zwetsloot et al. 2020; Barker 2021).
	Management leadership	- inspiring and motivating subordinates through words and actions; - gaining trust through charisma and being exemplary; - having committed and competent management who are intrinsically motivated to improve and promote safety; and - OSH issues are in top management meeting agendas	(Dartey-Baah and Addo 2018; Al Mazrouei et al. 2019b; Skład 2019; Zwetsloot et al. 2020; Barker 2021).
	Visible management	- active engagement and promotion; - providing assistance and support for improvement; - implementing workers suggestions; - identifying and monitoring workers for deviations and errors; - informal interactions inside and outside the workplace; - emphasis on safety procedures and policies; - setting individual and company safety goals; - regular two-way communication; - safety walkthroughs by top managers; and - rating of management commitment in OSH management.	(Yule et al. 2007; Podgórski 2015; Shea et al. 2016; Dartey-Baah and Addo 2018; Al Mazrouei et al. 2019b; Casey et al. 2019; Janackovic et al. 2020; Rajabi et al. 2020; Zwetsloot et al. 2020).
	Core values	- provision of adequate funds and resources; - procedures, training programmes, and competence selection; - high priority for safety alongside efficiency and productivity; and - percentage of budget spent on OSH improvement activities.	(Podgórski 2015; Shea et al. 2016; Casey et al. 2019; Skład 2019; Al Mazrouei et al. 2020; Janackovic et al. 2020; Zarei et al. 2021)

Practices	Indicators	Leading Indicators	References
Workers' Involvement	Encouraging involvement	- leader engagement with workers; - workers' understanding and commitment to values and goals; - sufficient money allocation; - workers' are recognised, valued, and rewarded - open-door policy; - OSH issues and suggestions are taken seriously by management; - having effective OSH committees; and - meetings commissioned on OSH issues.	(Jiang et al. 2010; Podgórski 2015; Mousavi et al. 2018; Tsalis et al. 2018; Al Mazrouei et al. 2019b, 2020; Casey et al. 2019; Ahmed Naji et al. 2020; Zwetsloot et al. 2020; Barker 2021).
	Empowerment for safety	- active participation in safety decision making; - permitting workers to make safety decisions in the absence of supervisor; - shared responsibility and accountability for making safety decisions; - workers participate proactively in safety efforts and monitoring of the workplace; - OSH improvements proposed by workers or their representatives; and - risk assessment activities conducted with workers' involvement.	(Podgórski 2015; Shea et al. 2016; Casey et al. 2019; Barker 2021; Zarei et al. 2021).
	Worker consultation	- workers' perceptions towards OSH; - consulting on safety issues directly with workers; - collaboration and shared planning; - seeking information from workers; - support in ensuring task objectives is achieved; - consultation in developing procedures; and - allowing workers to make suggestions for the improvement.	(Jiang et al. 2010; Shea et al. 2016; Casey et al. 2019; Rajabi et al. 2020).
	Removing barriers for involvement	- improving the organisational policy regarding workers' participation in safety; - equal status distinctions to all workers in giving input and information on safety; - providing timely feedback; - rating effectiveness involvement; and - OSH incentives and the allocated budget.	(Jiang et al. 2010; Podgórski 2015; Mousavi et al. 2018; Casey et al. 2019; Rajabi et al. 2020; Barker 2021).

Practices	Indicators	Leading Indicators	References
Hazard Identification and Assessment	Identifying existing hazards	- addressing workers' to all hazards associated with the workplace; - workers' understanding of the hazards and how to protect themselves; - integrating OSH in pre-work briefings on identified specific hazards and risks; - assessing hazards through job safety analysis; - consideration of ergonomic factors, reviewing designs, standards and regulations; and - identifying any risks before internal changes are made such as introducing new technologies, machinery and materials, or work processes.	(Liggett 2006; Podgórski 2015; Mousavi et al. 2018; Zwetsloot et al. 2020).
	Workplace inspections	- identifying hazards associated with work pressure which influence safety performance; - identifying hazards associated with psychosocial, physical or physiological factors; - identifying hazards associated wiyth production pressures; - verifying regular maintenance of all equipment; and - ensuring hazards are controlled and equipments are installed correctly and safe.	(Liggett 2006; Christian et al. 2009; Shea et al. 2016).
	Accident investigation	- identified hazard through reports of accidents and safety issues; - identifying root causes of the incident; - evaluating the quality of the frameworks, procedures, or interventions implemented; - adequate follow-up of reported unplanned events; - increase in the reporting rate; - the quality of incident investigation and analysis; - how lessons learned are communicated; and - measuring the ratio between accidents that occurred and near misses reported.	(Christian et al. 2009; Santos et al. 2019; Ahmed Naji et al. 2020; Zwetsloot et al. 2020).
	Hazard assessment	- integrating risk management in the OSH management that includes risk assessments; - workers' involvement in hazard assessments; - helping workers to perceive the risks associated with the job, the accident potential, physical hazards, and job safety; - assessing safety levels on human, organisational and environmental indicators; and - informing workers of the results of risk assessments due to changes introduced.	(Christian et al. 2009; Podgórski 2015; Shea et al. 2016; Casey et al. 2019; Janackovic et al. 2020).

Practices	Indicators	Leading Indicators	References
Hazard prevention and control	Planning hazard controls	- proactively improving OSH from the design phase; - integrating risk and OSH management; - response to human performance problems; and - planning for the job and task.	(Liggett 2006; Øien et al. 2011; Shea et al. 2016; Zwetsloot et al. 2020)
	Implementing hazard controls	- selective hiring based on fitness for the job; - implementing working procedures or interventions; - executing temporary structures; - timely corrective actions, maintenance and checking false reports; and - numbers of controls implemented based on hierarchy.	(Christian et al. 2009; Jiang et al. 2010; Podgórski 2015; Shea et al. 2016; Casey et al. 2019; Ahmed Naji et al. 2020; Janackovic et al. 2020; Barker 2021)
	Managing hazard controls	- the awareness of employees of current risk levels, controls, and conditions; - written OSH procedures and safe working; - assessing behaviour and human error; - equipment maintenance to safe standards; and - the number of safety grievances addressed and resolved.	(Liggett 2006; Jiang et al. 2010; Podgórski 2015; Mousavi et al. 2018; Tsalis et al. 2018; Casey et al. 2019; Janackovic et al. 2020; Zarei et al. 2021).
	Verifying hazard controls	- enforcing non-compliance; - standardisation of work procedures; - supplying workers with personal protective equipment, correct tools and equipment; - using precisely installed equipment; and - reviewing and evaluating corrective actions.	(Liggett 2006; Podgórski 2015; Mousavi et al. 2018; Casey et al. 2019; Santos et al. 2019).
Training and eductaion	Management roles in training	- training provisions that inspire positive attitudes and an energetic environment; - time allocation and planning for safety training; - providing adequate safety training; - maintaining training records; - investing in workers' training and knowledge; - managers participated in OSH courses; and - workers are trained on their duties and responsibilities.-	(Yule et al. 2007; Podgórski 2015; Shea et al. 2016; Tsalis et al. 2018; Al Mazrouei et al. 2019b, 2020; Santos et al. 2019; Ahmed Naji et al. 2020; Janackovic et al. 2020).
	Effectiveness of workers' training	- the numbers of workers trained; - safety induction for new recruits and contractors; - improvement in qualifications through skills, competency, and knowledge; - continuous development with regular and refresher training; and - workers are trained for critical positions and qualified before commencing work.	(Jiang et al. 2010; Podgórski 2015; Mousavi et al. 2017; Al Mazrouei et al. 2019b; Santos et al. 2019; Ahmed Naji et al. 2020; Janackovic et al. 2020; Zwetsloot et al. 2020).

Practices	Indicators	Leading Indicators	References
	Training on hazard identification and control	- the ability of workers to assess hazards and control measures in the workplace; - workers familiarisation with procedures, standards, practices, and equipment; - adequate training for responses and anticipation to a variety of threats or emergencies; and - safety skills across multiple domains.	(Yule et al. 2007; Jiang et al. 2010; Al Mazrouei et al. 2019b, 2020; Casey et al. 2019; Zarei et al. 2021).
	Safety awareness	- workers level of awareness of hazards; - workers' participation in safety OSH courses; - workers attitudes towards safety; - safety performance enhancement; and - workers awareness on their duties and responsibilities.	(Liggett 2006; Podgórski 2015; Al Mazrouei et al. 2019b, 2020; Rajabi et al. 2020; Barker 2021).
Evaluation and improvement	Performance evaluation of safety programmes	- the effectiveness of management targeted processes and programmes on safety goals; - safety standards compliance performance; - OSH improvement goals in delivering results; - budget spent on plans, quality and effectiveness of OSH improvement; and - safety data collection.	(Podgórski 2015; Casey et al. 2019; Ahmed Naji et al. 2020; Janackovic et al. 2020; Zwetsloot et al. 2020; Barker 2021).
	Safety audits	- structured process in gathering information on pre-determined protocols; - evaluate OSH programs and management systems; - validating workers competency to ensure the sustainability of preventative and control measures; - compliance on OSH regulations and standards observed in the organisation; - audit conducted by external, experienced and assertive auditors.	(Becker 2014; Podgórski 2015; Santos et al. 2019; Skład 2019; Janackovic et al. 2020; Barker 2021).
	Identification of weaknesses	- investigations to uncover causes of incidents and near misses that include human performance issues and quality management observations; - investigations into nonconformities for corrective actions; - completion of corrective measures in due time; and - statistical reviews of occupational injuries.	(Øien et al. 2011; Shamim et al. 2019; Skład 2019; Ahmed Naji et al. 2020; Al Mazrouei et al. 2020; Janackovic et al. 2020).

Practices	Indicators	Leading Indicators	References
	Identification of opportunities	- evaluating high-quality work to improve job security and role overload; - measuring the effectiveness and sustainability of OSH promotions and sharing lessons learned with other parts of the business; - periodically reviewed and improved operational procedures and OSH instructions; - positive feedback and recognition for past performance given; - nonconformities investigated for the potential for improvement; and - assessments made for technological solutions available.	(Podgórski 2015; Shea et al. 2016; Casey et al. 2019; Skład 2019; Janackovic et al. 2020; Rajabi et al. 2020; Zwetsloot et al. 2020; Barker 2021).
Communication and coordination	Management communication	- regular communication and interaction in achieving safety goals; - sharing safety information by two-way and open discussions; - information flow and dissemination on work management and actual practices; - quantification of the communicational capacity of workers; - communication through verbal instruction, brochures, emails, or bulletins; - communication through formal and informal communication and consultation; and - external OSH informational materials distributed internally.	(Podgórski 2015; Shea et al. 2016; Mousavi et al. 2018; Al Mazrouei et al. 2019b; Casey et al. 2019; Janackovic et al. 2020; Barker 2021; Zarei et al. 2021).
	Safety reporting	- applying scrutiny and transparency in reporting; - protection for workers reporting OSH issues or problems; - the number of external OSH reports; - sharing information on accidents or near misses; and - communicating workers' ideas and views on solutions for improving safety.	(Liggett 2006; Podgórski 2015; Shea et al. 2016; Santos et al. 2019; Skład 2019).
	Supervisory communication	- regular interactions and guidance; - training supervisors on hazards; and - supervisors valuing safety as reflected in communication, encouragement, and consequences.	(Liggett 2006; Christian et al. 2009; Al Mazrouei et al. 2019b, 2020).

Practices	Indicators	Leading Indicators	References
	OSH coordination	- pre-planning jobs; - planning and organisation of work; - evalution of OSH risks during procurement of hardware and services such as maintenance; - managing contractor such as safety meetings attendancy; - monitoring contractor safety performance through safety assessments, field inspections, safe work practice audits and safety-related audits; and - the quality of communication between the workgroup and stakeholders.	(Christian et al. 2009; Mousavi et al. 2018; Santos et al. 2019; Ahmed Naji et al. 2020; Zwetsloot et al. 2020).

[Table 4 near here]

3.3 Observant Leading Indicators

One method that can be used to observe the effectiveness of programmes or activities is by measuring employee safety behaviours. In this systematic literature review, the author has identified two main indicators in observant leading indicators: proximal safety antecedents and safety behaviours. Proximal safety antecedents consist of safety knowledge and safety motivation, and safety performance consists of safety compliance and safety participation. Most of the studies focused on safety compliance with 11 articles (42%), followed by safety participation with 8 articles (31%), safety motivation with 5 articles (19%), and safety knowledge with 3 articles (12%).

Safety knowledge is the awareness of proper methods for performing safe behaviours as proximal antecedents of safety performance or mediators of the relationship between personality traits or job and related organisational factors and safety performance (Christian et al. 2009; Jiang et al. 2010; Rajabi et al. 2020). Safety knowledge is measured through a scale of six items, namely workers knowing how to perform the job safely, how to use safety equipment and standard work procedures, how to maintain or improve safety and health in the workplace, how to reduce the risk of accidents and incidents in the workplace, the associated hazards and necessary precautions, and reporting potential hazards noticed in the workplace (Rajabi et al. 2020). Another proximal antecedent of safety performance was safety motivation, which refers to the enthusiasm to implement safety behaviours and the courage associated with those behaviours (Christian et al. 2009; Rajabi et al. 2020). Safety motivation is measured through a scale of three items: efforts to maintain or improve personal safety, the importance of maintaining safety at all times, and the importance of reducing the risk of accidents and incidents in the workplace (Shea et al. 2016). In meta-analysis studies, the safety climate was positively related to safety knowledge and safety motivation, both being related to predicting safety performance which indirectly influences accidents and injuries (Christian et al. 2009). Workers' health and safety can be improved through investment in knowledge and training that encourage safe behaviour (Yule et al. 2007; Jiang et al. 2010).

Safety performance has been conceptualised as individual behaviours with a measurable criterion proximally related to psychological factors more than accidents or injuries that can be distinguished into safety compliance and participation (Christian et al. 2009). Safety compliance refers to workers' behaviour in following safety policies and procedures towards meeting work safety standards, such as complying with personal protective equipment requirements, carrying out tasks safely, obeying safety regulations, and using correct procedures (Dartey-Baah and Addo 2018). On the other hand, safety participation refers to workers' behaviour in helping create an atmosphere supportive of safety that moves beyond procedures to assist colleagues, engage in voluntary safety activities, promote safety and its principles, take safety initiatives, and improve workplace safety (Dartey-Baah and Addo 2018). Safety practices and leading indicators have positive and strong associations with safety compliance and safety participation (Shea et al. 2016; Casey et al. 2019; Rajabi et al. 2020).

3.4 Lagging Indicators

The authors identified the lagging indicators that represent the safety outcomes based on the review papers: occupational accidents, occupational fatality accidents, near misses, and lost time injuries. Most of the lagging indicators studied were occupational accidents in 8 articles (31%), followed by lost time injuries in 5 articles (19%), occupational fatal accidents in 4 articles (15%) and near misses in 4 articles (15%).

Occupational accidents are referred to as accidents that result in injuries needing medical attention (Christian et al. 2009). The reduction of occupational accidents is considered the final goal or outcome of safety efforts in an organisation (Mousavi et al. 2018). Occupational accidents are the outcomes of many factors, including unsafe behaviour, which was a direct trigger factor with injuries representing low base-rate and count variables (Jiang et al. 2010) with most organisational measured injury rates (Tsalis et al. 2018). Occupational accidents can also be measured by recordable injuries resulting in lost time, recordable injuries requiring medical treatment, and incident rates based on severity and frequency (O'Neill et al. 2016; Ahmed Naji et al. 2020). It was found that only 5 papers discussed or mentioned lost time injuries as a lagging indicator. The fatality was mentioned as the second type of severity related to high-consequence injury and illness resulting in death (O'Neill et al. 2016; Tsalis et al. 2018; Ahmed Naji et al. 2020).

Another lagging indicator is measured through lost time injury. There are two ways of reporting lost time: lost-time injuries, which refer to the subset of work-related injuries which result in 'lost time' due to work absence and lost time injury frequency rate, which is defined as the number of lost time with work-related injuries (fatalities and lost workday cases) per 1,000,000 work hours (O'Neill et al. 2016; Sarkheil 2021). However, some firms calculated lost time injury frequency rates based on U.S. Occupational Health and Safety Administration Guidance, which uses 200,000 hours as the denominator (O'Neill et al. 2016). Prior research had labelled lost-time injury as a lagging indicator (O'Neill et al. 2016; Tsalis et al. 2018; Ahmed Naji et al. 2020; Sarkheil 2021; Zarei et al. 2021).

Near misses are lagging indicators resulting from inadequate safety efforts and define as an unplanned incidents with short-term results that do not result in an accident or injury (Jiang et al. 2010; Mousavi et al. 2018). However, research shows that workers tend to under-report near misses, causing the relationship between these variables and their predictors to be attenuated (Jiang et al. 2010). Near misses can also be considered a leading indicator and measured by the number of near misses investigated (Ahmed Naji et al. 2020).

4 Discussion

4.1 Current practices and progress

The number of published articles regarding indicators used in safety management practices in the utility industries has increased in recent years, from 2000 until 2021. The increasing numbers of published papers show that there has been a high awareness that safety lagging indicators such as injury rates have limited use in preventing future injuries. Thus, proactive measures through predictive measurements can provide early warnings of potential hazards to improve future performance (Guo and Yiu 2016; Salas and Hallowell 2016; Lingard et al. 2017). For this reason, there is a need to proactively measure and identify the adequacy of safety management practices at an early stage to predict any deterioration of safety management system implementation, thus contributing to positive safety outcomes.

Most papers were published in the United Arab Emirates, Iran, and Australia. The United Arab Emirates and Iran published papers focused on the gas utility industry, the primary players in the oil and gas industries (Dudlák 2018; Al Mazrouei et al. 2019a). As a leading country in the oil and gas industry, it is essential to ensure supply or productivity is guaranteed in occupational safety and health to avoid disasters or accidents that will disrupt the production process. Thus it is vital to ensure the effectiveness of a safety and health management system that can eliminate injuries, adverse health impacts, and damage at the operational level, thus improving the productivity of workers and their physical and mental well-being and workplace satisfaction (Sarkheil 2021). Thus, showing the importance of proactive indicators in reducing unwanted events in the workplace through the implementation of safety management practices as proactive efforts.

The majority of the selected articles were studied to identify and develop driven leading indicators. These indicators are essential in assessing and improving the functioning of sociotechnical systems as part of an organisational safety management process (Reiman and Pietikäinen 2012) that contains safety antecedents as input into safety efforts and measures of any actions to produce the output that can directly or indirectly influence safety performance (Christian et al. 2009; Mousavi et al. 2018). Leading indicators contain input and activity elements that are critical for safety decisions in the organisation to achieve safety objectives (Grabowski et al. 2007; Hollnagel 2008; Pawłowska 2015; Mousavi et al. 2018). Thus, safety management practices are considered the antecedent of the safety climate for organisations to improve safety performance. The extensive distribution of studies in the systematic literature review of safety management systems among utility industries indicates that the development phase of leading indicators is very encouraging. This phase involves the identification, development, and measurement of leading indicators. Thus, leading indicators are well defined in ensuring that safety management systems are maintained comprehensively through activities conducted in an organisation.

Another finding was that most of the reviewed papers studied subjective indicators in measuring leading indicators. The subjective data is often obtained through surveys or questionnaires with advantages in collecting relative measurements and perceptions such as quality. The main drawback is that these indicators are difficult and expensive to manage even when data sets are obtained, monitored and maintained in the same way as organisations maintain objective performance data (Phimister et al. 2004; Grabowski et al. 2007). Nevertheless, subjective measurement was often used in measuring the level of safety in an organisation in the research (Zohar 1980; Hayes et al. 1998; Flin et al. 2000; Mearns et al. 2001, 2003; DeJoy et al. 2004). Subjective measurement is based on perceptions towards activities implemented in studying a programme's effectiveness in reaching workers as a target group in organisations. It shows that subjective measurement through a perception measurement scale is the appropriate method for collecting proactive indicators that measure the quality of activity implementation.

Management commitment is an internal factor of an organisation related to self-regulation that significantly influences the safety behaviour of workers and is essential for the success of safety management systems (Brown et al. 2000; Casey et al. 2019; Arifin et al. 2020). This study found that safety management practices focused on management commitment practices as the leading indicators for measuring safety levels in organisations showing that an effective safety management system relies on top management developing company policies and setting resources. It supported stable, consistent, and fair OSH leadership in management commitment impacted OSH management system effectiveness to the greatest extent (Jaafar et al. 2017a; Skład 2019). Low accident rates are also associated with administration showing inspirational motivation by fostering safety goals, promoting safety, and motivating workers to engage in safety behaviours (Barling et al. 2002; Hale et al. 2010; Tappura and Nenonen 2016; Tappura et al. 2017; Arifin et al. 2020). The top management has the final say in decision making as consultation with workers is only supplementary in getting more information towards making the final decision. Authentic OSH leadership always puts safety as a priority and core value in organisations to ensure the safety of workers in the workplace.

Observant leading indicators are another leading indicator related to safety management practices through thematic analysis. These indicators are defined as indicators that provide insights into the dynamic systems in the form of questions regarding the activities taking place, the capabilities, skills and motivations of personnel, routines, and practices, as well as the potential of the organisation for safety (Reiman and Pietikäinen 2012) which individual behaviour is an important performance to measure to observe the effectiveness of safety activities implemented by organisations (Neal and Griffin 1999; Mousavi et al. 2018; Arifin et al. 2020). Most review papers found that safety management practices positively predict safety compliance and safety participation, showing observant leading indicators are important indicators in reducing occupational injuries and accidents.

Lagging indicators are the results of activities or events that aim to reduce accidents and injuries through safety efforts within the organisation (Reiman and Pietikäinen 2012; Mousavi et al. 2018). Safety outcomes are measurable and clear to the organisation, and they include negative performance indicators such as the number or frequency of accidents at work, the cost of compensation to workers, the number of days not worked due to occupational accidents and the number of occupational diseases (Christian et al. 2009; Pawłowska 2015). The most studied lagging indicators in the selected papers were occupational accidents, followed by occupational accident fatalities, lost time injuries, and near misses. Accidents result from numerous factors, and individual unsafe behaviour is one of the most direct trigger factors. The severity of an accident is measured by its effect on injuries and property damage. Briefly, an incident analysis will show something about accidents, such as weaknesses in OSH programs and activities.

4.2 Limitations and challanges

Based on the current thematic analysis results, the number of selected review papers on safety management practices in the utility business is still modest and has only increased in recent years. Compared to other utility industries such as water utilities, electrical or power utilities, and sanitary services, most papers are published in the gas utility field. Thus, indicating a gap in the research implemented in these industries that need to be investigated. Since OSH reporting procedures vary by industry and workplace, additional research is required to identify OSH performance indicators that are more auspicious and can assist firms in implementing them (Pawłowska 2015; Sheehan et al. 2016). Future research is needed in a broader range of utility industries, which may have more informal OSH standards and procedures by adapting or benchmarking tools across different safety management activities.

Compared to subjective measurements, passive and objective indicators were less studied in measuring safety management practices. Passive indicators designate the likelihood of safety performance being achieved, usually through binary feedback, instead of objective indicators that measure the frequency and subjective indicators that measure the quality of execution that may change over time (Hinze et al. 2013; Alruqi and Hallowell 2019). The main reason objective indicators were less studied could be that the quality of existing systems or activities may not be measurable through objective measurements. Furthermore, objective indicators are likely to be manipulated and distorted to improve the appearance of the organisation (Grabowski et al. 2007). However, future research should measure both objective indicators for key performance indicators of activities implemented and subjective indicators of the quality of the activities. Along with that, indicators selection should be based on specific, measurable, accountable, reasonable, and timely criteria.

The practices of hazard identification and assessment were under-presented in the publications selected for this study. This practice is an initial step in risk management to identify the causes and mechanisms of undesirable events by assessing the likelihood of the event and the severity caused by the event. Therefore, systematic planning in eliminating or reducing safety hazards is essential in safety management to improve the safety climate (Trethewy et al. 2003; Arifin et al. 2016; Juhari and Arifin 2020) that depend on proactive, ongoing processes and assessment of hazard elements (Arifin et al. 2011). Inadequate hazard identification is one of the key contributing causes of fatal workplace accidents, affecting corporate values such as ethics and profit. Accordingly, it is important to integrate risk management practices into the safety management system to increase the effectiveness of implementing this system in reducing accidents.

Based on the research conducted, occupational accidents resulting in injuries received more interest in the papers selected. They were supported by Tsalis et al. (2018), who found that most organisations provided more information about injury rates. However, attention should be given to all types of accidents regardless of the degree of damage or loss, such as fatalities, occupational accidents, lost time, and near misses. Accidents that do not result in injury or damage to equipment and materials still need attention as they are signs of future accidents. Also, near-miss reporting should be considered a lagging indicator since luck is often the only difference between a near miss and a fatality (Toellner 2001). Future studies should incorporate occupational accidents, fatal occupational accidents, lost time injuries and near misses as safety outcomes.

This study found an inadequate correlation between driven leading indicators, observant leading indicators, and lagging indicators. It can be seen through the progress of research, which shows that studies focused on developing indicators that included defining, developing, and measuring the indicators. On the contrary, the analysis focused on progressing the indicators that study the relationship between driven leading indicators and observant leading indicators or when lagging indicators are small in number. Future studies should focus on validating the influence of leading indicators in safety management practices toward safety outcomes.

5 Discussion

The present study reviewed 25 articles on indicators used in safety management practices in the utility industries, reflecting an understanding of current practices and progress. This study also revealed the potential use and the gaps in the knowledge of the use of indicators in safety management practices, plus several subject areas that can be researched further. It was found that the number of studies on proactive measurement in the utility industries has increased in recent years. Most of the studies were conducted in the United Arab Emirates, Iran, and Australia. Furthermore, three main indicators that represented the use of indicators in safety management practices among utility industries were identified based on the systematic review performed. The most researched indicators were driven leading indicators, which were described as indicators that assess and improve the functioning of sociotechnical systems as part of organisational safety management. There was an imbalance in terms of the type of area researched for sectors in the utility industry. Most of the studies focused on gas and electrical utilities compared with water utilities and sanitary services. Also, most of the research focused on management commitment as an essential element in safety management practices, thus creating an imbalance in practices. The majority of the study focused on identifying, developing, and measuring leading indicators. These findings indicate plenty of opportunities for discovery and new research for OSH practitioners, authorities, and researchers to explore in terms of the use of indicators to enhance safety management practices in the utility industry.

This systematic review paper confirms several limitations and gaps in the study of indicators used in safety management practices in the utility industries in recent years. Firstly, information on indicators used in safety management practices from other countries and sub-industries among utility industries is still lacking. Future research is needed in a broader range of utility industries, which may have more informal OSH standards and procedures by adapting or benchmarking indicators across different safety management practices. Also, there is still a lack of information on objective data measuring implementation instead of subjective data measuring perception. Thus, in future research, researchers may measure both objective indicators for key performance indicators of activities implemented and subjective indicators for the quality of the activities, which can change from time to time. Inadequate hazard identification and assessment practices in the utility industries were also reported in this study. As a result, researchers should incorporate risk management strategies into the safety management systems in future research. Occupational accidents that emphasise injury were the most reported lagging indicators used as safety outcomes in this research. Thus, there is a need to include occupational accidents, fatalities, lost time injuries, and near misses as safety outcomes in future studies. Finally, the development phase of research, which includes identifying, developing, and measuring indicators, was dominant compared to the progressive phase on the indicator used in safety management practices. Next, it is recommended for future studies that researchers explore the relationship between driven leading indicators and observant leading indicators towards lagging indicators. Therefore, further broadening this basic understanding through the integration of diverse research findings may assist the concerned parties in enhancing safety levels, such as OSH practitioners, authorities, and researchers in developing strategies that align with the needs, abilities, and interests.

Abbreviations

ILO, International Labour Organization.

Declarations

Competing interests.

The authors declare that they have no competing interest.

Ethical Approval.

Not applicable.

Consent to Participate.

Not applicable.

Consent to Publish.

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Authors Contributions.

MXMA designed, analyze, and drafted the manuscript. KA & AA coordinated this research and reviewed the manuscript. MAA & MK screening all the papers. MBC & MAS evaluate the quality of review paper. The authors read and approved the final manuscript.

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Figures

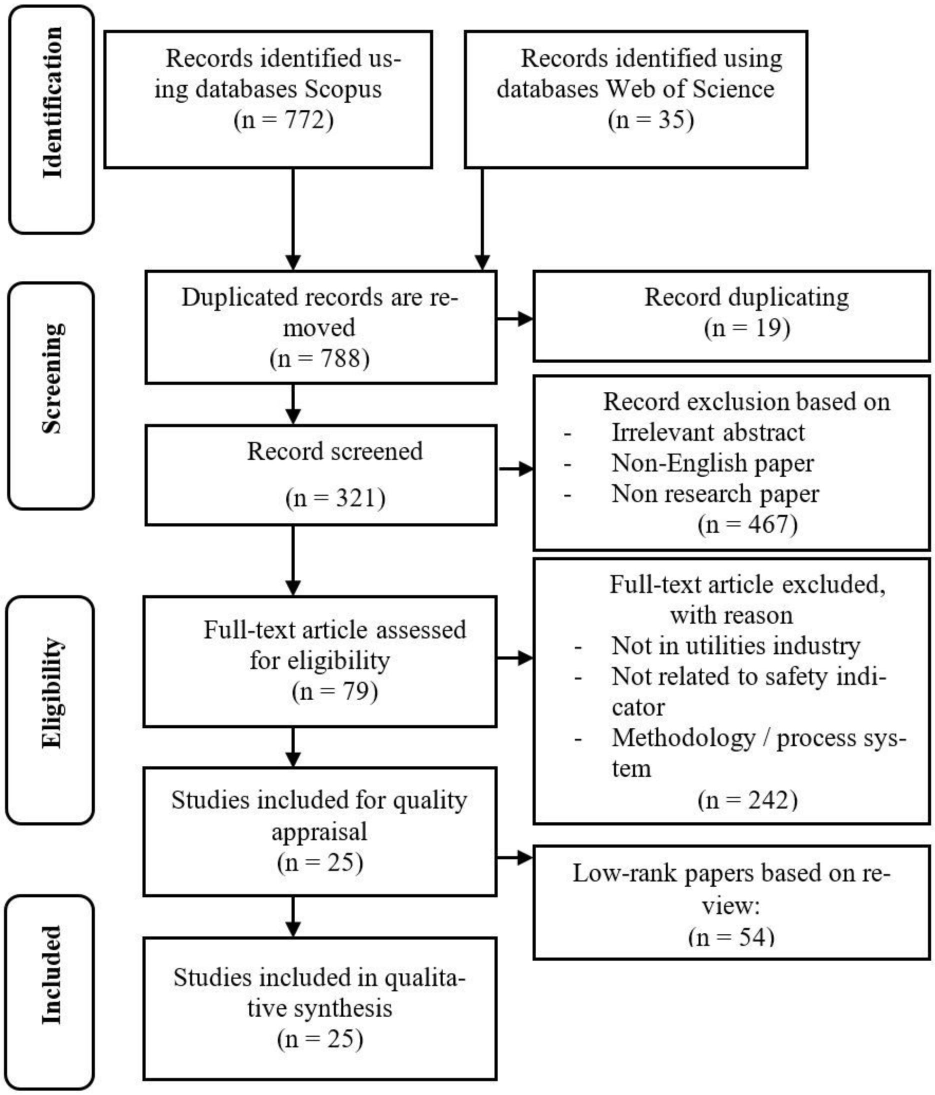

Figure 1

The flow diagram

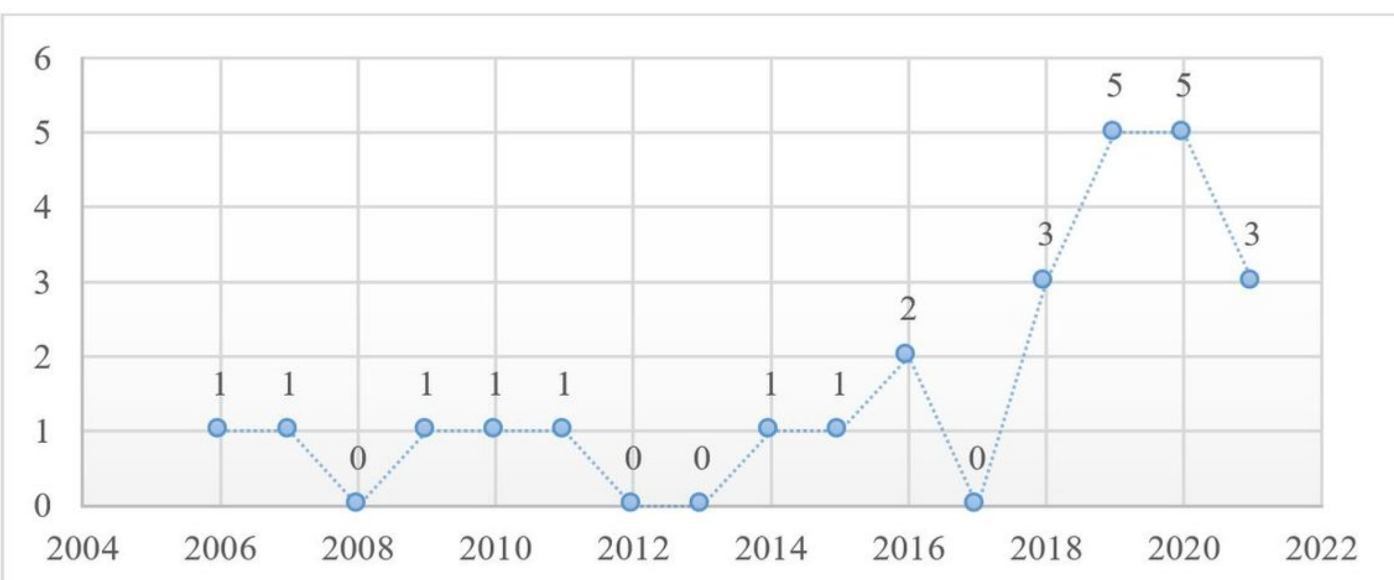

Figure 2

Numbers of reviewed papers selected by year published

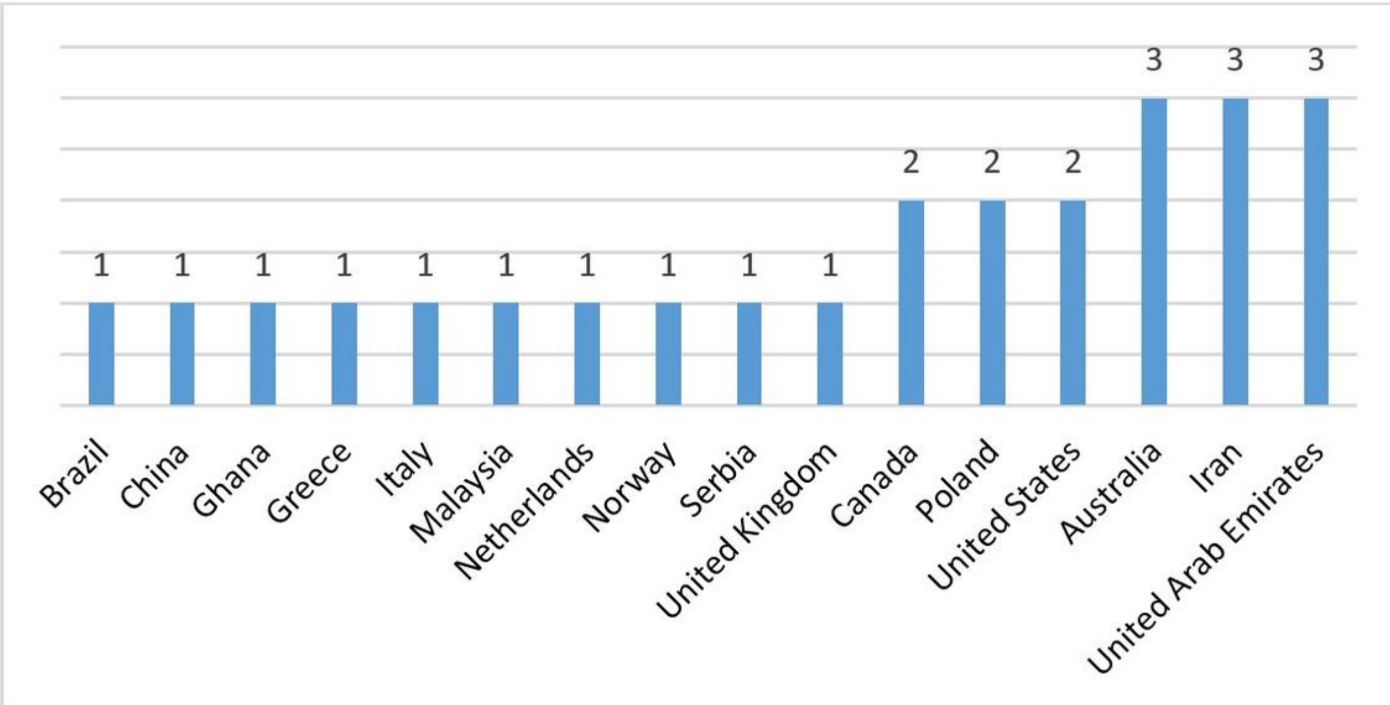

Figure 3

Numbers of reviewed papers selected by country