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REVIEW ARTICLE

Behavioural factors of safety culture in oil and gas industry: A systematic literature review

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Abstract - Oil and gas industry is one of the most emerging sectors in the world, however it is exposed to various risk and challenges. Due to its complicated operations and high-risk environment, it remains one of the most dangerous industries. However, there is a limited amount of literature addressing the factors that contribute to safety culture in the oil and gas industry. This study systematically reviews behavioural factors influencing safety culture in the oil and gas industry. A strong safety culture is critical for minimizing workplace hazards and enhancing operational efficiency. Using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology, this review identifies six key factors such as safety training, communication, management commitment, reporting, safety investment, and competency. The study highlights the importance of these behavioural dimensions in fostering a sustainable safety culture and suggests future directions for improving safety performance in the industry.

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1. Introduction

The oil and gas industry is a high-risk sector prone to accidents due to complex operations and hazardous environments. Poor safety culture has been identified as a significant contributor to workplace accidents and injuries. Most of these significant oil and gas accidents have been reported due to a poor safety culture. A weak safety culture impacts employee safety behaviour, leading to numerous accidents and injuries. Worker performance can only be enhanced by reinforcing the workplace safety culture. Thus, a robust safety culture is critical in the oil and gas industry and ensures that both management and employees prioritise safety at every level of operations, reducing the likelihood of accidents and fostering a safe working environment [1]. According to [2], safety culture refers to a collection of shared values (what is important) and beliefs (how things function) that, along with an organisation's structure and control systems, establish behavioural norms (the correct way to carry out tasks). Accidents and injuries can be reduced by creating a strong safety culture in the oil and gas industry. A positive safety culture is essential for the oil and gas industry to operate sustainably. Additionally, a strong safety culture can bring about favourable societal and economic outcomes for both workers and the broader community. This reflects the company's policies and all employees' commitment to upholding safety standards. Thus, it is unfortunate that achieving a strong safety culture is challenging due to various factors that affect safety in this industry [3].

The reciprocal safety culture model [4] presents a framework that acknowledges an interactive, reciprocal relationship within the behavioural dimension of safety culture. The behavioural dimension of safety culture focuses on the action's organisations must take to instil it among employees and top management alike. This model highlights "What People Do" in terms of individual and group values, attitudes, and perceptions regarding safety. Behavioural factors are important in evaluating safety behaviours in the oil and gas industry. For instance, motivated employees are more likely to follow safety rules under pressure. On the other hand, if employees feel detached from safety processes, they may overlook the importance of safety culture, increasing the risk of accidents. Studies have consistently shown that unsafe behaviours, such as ignoring safety regulations and failing to report incidents, contribute heavily to poor safety culture in the oil and gas industry [1]. Therefore, the importance of establishing a strong safety culture that emphasises safe behaviour cannot be overstated. This study aims to investigate the behavioural factors that influence safety culture in the oil and gas industry, with a focus on the Malaysian context. Addressing behavioural factors is key to building an environment that prioritises safety, minimises risks, and ensures employee well-being. To ensure the sustainable development of the oil and gas processing industry, fostering a behavioural safety culture remains a priority in oil and gas companies' strategies to minimise accidents.

Safety culture is a promising solution to reduce accidents and hazards in the oil and gas industry. Safety culture is emerging to avoid near-misses, injuries, accidents, and disasters. However, a comprehensive literature review on safety culture in the oil and gas industry remains lacking. Thus, a strong safety culture is essential to establishing a safe working environment and enhancing employee productivity. The industry faces multiple challenges, including offshore operations and exposure to hazardous substances, underscoring the importance of establishing and maintaining a strong safety culture to reduce accident risk and protect employees and the environment. It is recommended that the authors provide adequate information to enable the work to be replicated. Methods that have previously been published should be referenced, and only relevant modifications should be mentioned. Safety culture defines the shared attitudes and practices and is essential for preventing accidents because it influences both individual and group behaviours that contribute to unsafe practices. Research has shown that a positive safety culture is likely to result in improved safety outcomes, lower accident rates,

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and enhanced operational efficiency. Research in the oil and gas industry in Ghana demonstrates that effective safety culture improves overall safety performance and shows the importance of safety culture within organisations [5].

Besides the advantages of possessing a strong safety culture, maintaining it in the oil and gas industry will likely face challenges. For instance, factors like fatigue, lack of reporting awareness, and lack of safety training among employees can contribute to the persistence of unsafe behaviours. An interview study in the oil and gas industry demonstrated that long shifts and fatigue negatively affect employees' efficiency, increasing the likelihood of errors and accidents. Take, for instance, the need for ongoing fatigue management and regular safety culture assessments to ensure that safety practices are upheld consistently [6]. In short, a positive safety culture, supported by investment in safety training and competency and proper management commitment, encourages strong safety behaviours and the reporting of hazards. To further understand the safety culture in the oil and gas industry, various safety culture models have been advanced, each offering unique insights into the factors that sustain a strong safety culture. Several safety cultures models and theories have been developed, including Social Learning Theory [7]. Schein's Theory [8], Total Safety Culture or Geller's Theory [9], the Reason Safety Culture Model [10], Guldenmund's Three-Layered Organizational Culture [11], the Reciprocal Safety Culture Model [4] and the Reiners Model/P2T Model [12] as illustrated in Figure 1. All these models emphasise the psychological (how individuals feel), situational (what the organisation possesses), and behavioural (what individuals do) aspects as preventive strategies to minimise accidents and foster a strong safety culture across industries. Furthermore, these models indicate that establishing a robust safety culture in the oil and gas industry demands a collective commitment to the value of safety and active involvement in developing strategies to minimise risks and prevent accidents. For instance, the Norwegian Petroleum Safety Authority (PSA) promotes health, safety, and environment (HSE) culture across industries to foster a strong safety culture and, in turn, improve safety awareness in Norwegian offshore activities [13].

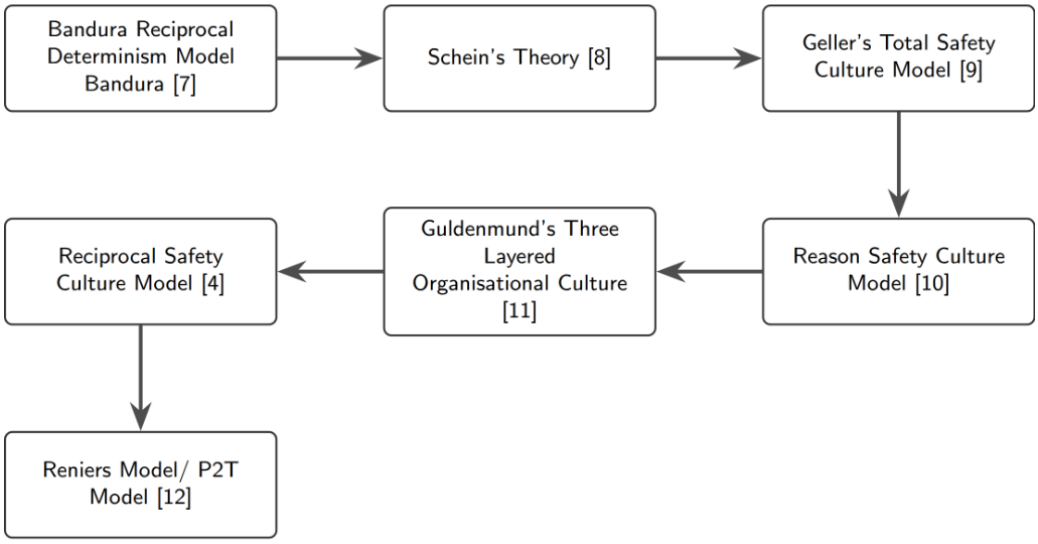

Figure 1. Various safety culture models

Despite numerous studies on the oil and gas industry, no systematic literature review (SLR) has been conducted to provide a comprehensive overview of the specific behavioural factors contributing to safety culture in the industry, as needed worldwide. The main research question guiding this systematic review is: What are the latest contributing behavioural factors to the safety culture required in the oil and gas industry? It is important to understand this and make suggestions to improve this sector, especially regarding industry hazards and accidents. Therefore, the objective of this SLR was to investigate the behavioural factors that contribute to safety culture in the oil and gas industry from 2020 to 2024, using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [14].

2. Materials and Methods

2.1 Identification Phase

Identification is the first stage of the systematic literature review process. The procedure involved identifying keywords for use in information searches. ScienceDirect, Scopus, and Springer were the databases selected for this case study. They were chosen because they are well known for publishing academic articles and are recognised as the leading citation indexing systems. This process yielded 52 articles from ScienceDirect, 125 from Scopus and 46 journals from Springer. The search string used for the three databases is shown in Figure 2.

3.2 Screening Phase

The second phase is the screening phase, which was applied to the 223 articles identified from the three databases using the search strings (as outlined in the identification phase). During the screening process, articles were included or excluded based on criteria determined by the authors, with assistance from the relevant databases. A publication timeline covering the years 2020 to 2024 was established based on the total number of relevant publications to be evaluated. The second

inclusion criterion, journal articles, was selected from both databases, excluding review articles and books, as they were not considered primary sources. Language was the third inclusion/exclusion criterion, and to avoid translation issues, all non-English language journals were excluded. Those inclusion and exclusion criteria are displayed in Table 1.

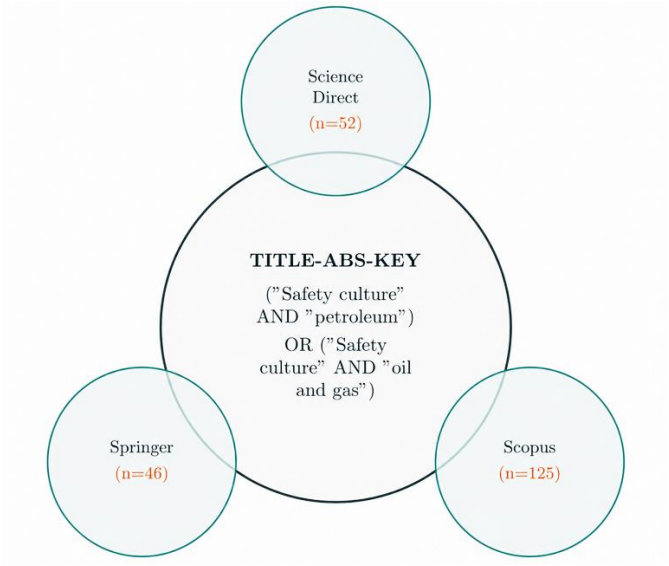

Figure 2. Search string and database used in the identification stage

Table 1. The criteria for inclusion and exclusion

Criteria	Inclusion	Exclusion
Publication timeline	2020 to 2024	2019 and before
Document type	Journal (research articles)	Conference proceedings, review articles, book series, books etc.
Language	English	Non-English

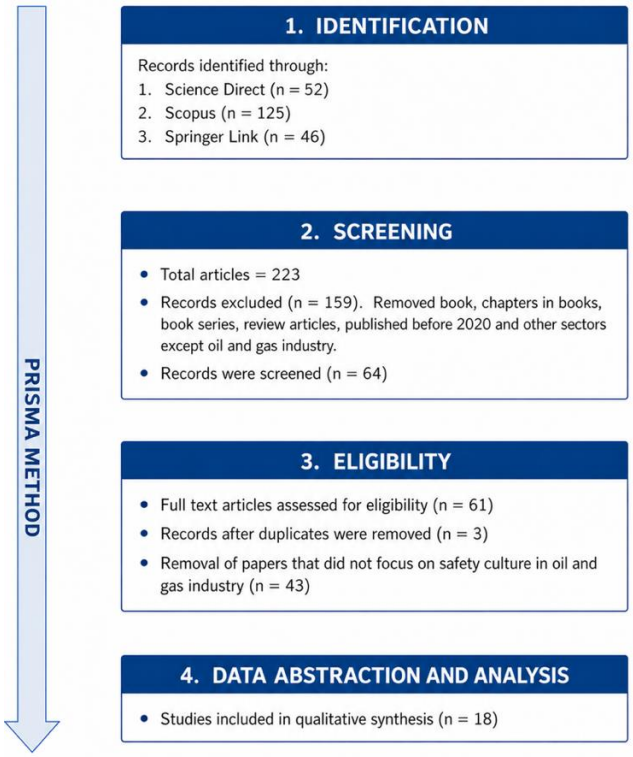

Figure 3. PRISMA method

3.3 Eligibility Phase

During the eligibility process, articles were manually excluded based on specific criteria. Duplicate documents were removed before the eligibility check. After eliminating 3 identical articles across all databases, 61 journals remained for further review. These were manually examined for relevance to safety culture in the oil and gas industry, applying both

the inclusion and exclusion criteria established in the previous screening phase. In the end, 18 journals were carefully evaluated and selected for the literature review on behavioural factors in safety culture in the oil and gas industry.

3.4 Data Abstraction and Analysis

The final stage involves data extraction and analysis. The 61 chosen articles were carefully assessed, reviewed, and analysed. The reviews focused on specific studies that were relevant to the research topic. At this stage, only 18 articles met the criteria and were analysed using thematic analysis as shown in Figure 4. [15]. A summary of the PRISMA process for the SLR study is provided in Figure 3.

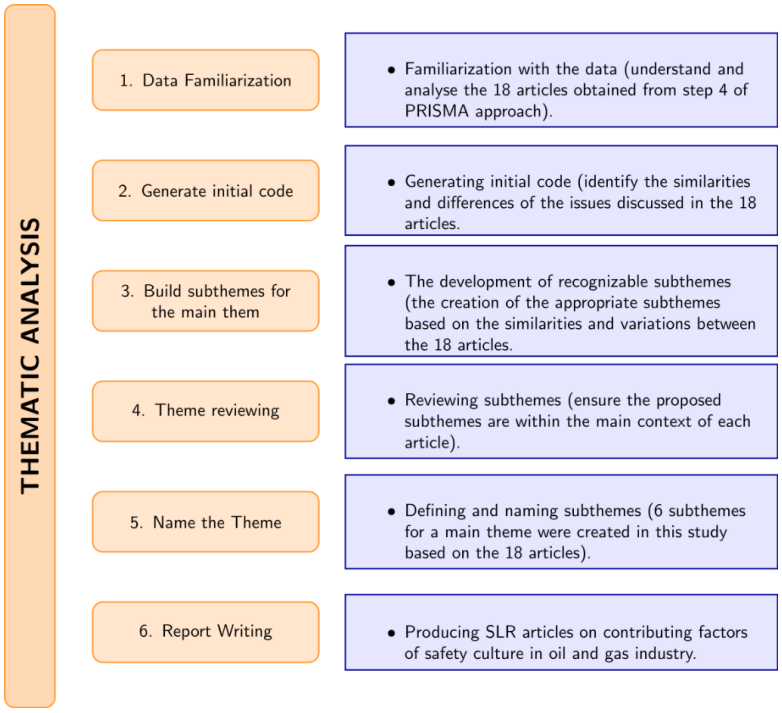

Figure 4. Thematic analysis [15]

3. Results and Discussion

Based on Table 2, a total of 18 studies from 10 different countries, which are Norway, Indonesia, the USA, China, Malaysia, Nigeria, India, Vietnam, the UAE, and Brazil, were analysed to identify key behavioural factors influencing safety culture in the oil and gas industry. The SLR identified studies published between 2021 and 2024 that reflect the increasing research interest in safety culture and its behavioural dimensions. Using the PRISMA methodology, an initial pool of 57 studies was identified, from which 16 were selected based on their relevance to safety culture in the oil and gas industry. A thematic analysis was applied, categorising the behavioural dimensions into six main themes: Management Commitment (MC), Safety Training (ST), Safety Communication (SC), Reporting (RE), Safety Investment (SI), and Safety Competency (SCO). The selected studies demonstrated varying emphasis on these factors, reflecting different safety priorities across regions. Among the behavioural dimensions, Management Commitment (MC) was the most frequently observed, appearing in 14 of 16 studies. This highlights the crucial role of leadership in fostering a strong safety culture by prioritising safety initiatives, enforcing policies, and ensuring compliance. Countries such as Norway, the USA, Malaysia, and Brazil particularly emphasised management's role in improving workplace safety through active leadership and engagement. Safety Training (ST) was identified in 13 studies, indicating that continuous education and skill development are essential in enhancing workers' safety awareness and adherence to protocols. Research from China, Indonesia, and India frequently highlighted training as a key factor in mitigating workplace hazards and improving safety performance.

Safety communication was evident in 12 studies, underscoring the importance of effective communication between management and workers for ensuring clear safety expectations, timely hazard identification, and knowledge sharing. Transparent communication practices were particularly emphasised in studies from Vietnam and Norway. Reporting (RE) was featured in 10 studies, emphasising the significance of a reporting culture that encourages workers to report hazards and incidents without fear of punishment. This aspect was more prominent in studies from Norway and the USA, where regulatory frameworks strongly support proactive hazard reporting systems. Safety Investment (SI) was discussed in 9 studies, reflecting the importance of allocating financial resources to safety equipment, training programs, and technological advancements to reduce risks. Countries like China and India highlighted the need for organisations to invest in modern safety tools and procedures. Lastly, Safety Competency (SCO) appeared in 8 studies, reinforcing the notion that employees with strong safety-related skills contribute significantly to a safer work environment.

Regionally, Norway and the USA demonstrated a stronger emphasis on management commitment and reporting systems, aligning with their stringent regulatory frameworks and proactive safety leadership. On the other hand, Malaysia

and Indonesia placed greater focus on safety training and competency, recognising the need for skill development and education in improving safety practices. Meanwhile, studies from China and India highlighted the role of safety investment and communication, reflecting a shift towards integrating advanced safety technologies and structured communication channels within their industries. Through thematic analysis as depicted in Figure 4, these primary themes emerged from the selected studies which are Leadership and Organizational Commitment, which highlights management's role in promoting safety culture; Employee Engagement and Training, which focuses on workforce education and skill enhancement; Communication and Reporting Systems, which emphasizes knowledge-sharing and hazard identification; and Investment in Safety Infrastructure, which underscores the financial and technological aspects of improving workplace safety. The findings of this review align with global trends, reinforcing the idea that strengthening behavioural dimensions is critical for fostering a sustainable safety culture in the oil and gas industry. Figure 5 summarises 6 key factors contributing to behavioural safety culture in the oil and gas industry. Detailed explanation was discussed in subtopics 5.1 to 5.6.

Table 2. Behavioural factors of safety culture in the oil and gas industry

Year	Country	Behavioural factors						Ref
		Management commitment	Safety training	Safety competency	Reporting	Safety investment	Safety communication	
2024	Indonesia	/	/		/		/	[16]
2024	USA	/	/	/		/	/	[6]
2024	Vietnam	/	/					[1]
2024	Malaysia	/	/	/	/	/	/	[19]
2024	Norway		/	/				[25]
2024	UAE		/	/	/		/	[26]
2023	China	/	/	/	/	/	/	[5]
2023	Nigeria	/	/					[20]
2023	Nigeria							[3]
2023	USA		/	/	/	/	/	[21]
2023	India	/	/		/	/	/	[22]
2023	Norway	/	/	/		/	/	[24]
2023	USA	/	/		/			[27]
2022	Norway	/	/		/			[18]
2021	Brazil	/	/	/	/	/	/	[28]
2021	Norway		/	/	/			[13]
2020	Malaysia		/					[17]
2020	Brazil		/		/	/	/	[23]

Figure 5. Behavioural factors contributing to safety culture in the oil and gas industry

3.1 Safety Training

Safety training involves management's dedication to providing staff with adequate training and competency courses. It equips employees with knowledge of preventive measures and procedures to minimise the risk of injury or fatality in the workplace. Moreover, safety training is essential to ensure that the culture of safety can be prioritised and practised consistently across all aspects of work and when handling any machines. Safety training enables workers to acquire the

essential knowledge and skills to uphold a safe work environment. A key objective of safety training is to ensure that employees are equipped to recognise potential hazards, respond to emergencies, and apply safety practices effectively. By consistently investing in comprehensive safety training, companies foster a proactive safety culture that emphasises knowledge and preparedness [27]. A comprehensive safety training program should not only focus on procedural knowledge but also on cognitive skills, such as decision-making under pressure. When combined with tools such as safety culture assessments, training can help identify and address gaps in workers' understanding, ensuring a holistic approach to risk mitigation. For example, safety walkthroughs and simulations help workers experience real-world scenarios in a controlled environment, allowing them to build confidence and proficiency in handling emergencies [27]. Moreover, training programs that integrate the latest technological advancements, such as cognitive systems and automation, prepare employees to adapt to increasingly complex systems in the oil and gas industry [21]. This approach emphasises the importance of early user involvement during technology adoption to maximise safety outcomes.

3.2 Safety Communication

Safety communication refers to the use of management channels such as emails, memos, safety briefings, bulletin boards, and reporting systems to ensure effective two-way communication between employees and employers. It is a critical factor in establishing a safety culture within the oil and gas industry. Strengthening communication platforms is essential to build a robust safety culture, as they facilitate mutual understanding between employees and the organisation. Transparent and open communication boosts safety engagement and helps reduce incidents by promoting a more open safety culture [18]. Effective communication is central to understanding worker perceptions of safety culture. This includes regular feedback on incident reports, updates on safety policy changes, and clear communication of organisational priorities regarding safety [21]. Open communication channels ensure workers feel empowered to report hazards and near-misses without fear of retaliation, thereby encouraging proactive participation in safety practices. The need for real-time communication systems, especially in high-risk environments like offshore platforms. These systems provide workers with up-to-date information on potential hazards and enable them to report incidents instantly, fostering trust and responsiveness within the organisation. Communication methods that incorporate visual aids, multilingual support, and digital tools can further enhance accessibility and clarity [25].

3.3 Management Commitment

Management commitment involves top management's dedication to ensuring that all employees adhere to the company's safety policies and regulations. This commitment is crucial in shaping and fostering a strong safety culture and mindset among oil and gas workers. The top management should set a good example for the workers. Moreover, a commitment to safety can be demonstrated by having a clear safety policy and regulations to ensure all staff understand and are aware of them. When management actively participates and supports safety initiatives, it establishes a solid safety climate and drives better compliance [17]. The involvement of management in emergency planning and response activities strengthens organisational resilience by fostering trust and alignment across all levels [26]. Active participation in safety drills, oversight of compliance audits, and the allocation of resources for safety equipment demonstrate leadership's prioritisation of worker safety. This visible commitment encourages employees to take safety seriously and integrate it into their daily routines. By incorporating safety performance metrics into organisational goals, management ensures accountability at all levels, creating an environment where safety is viewed as an integral part of operational success.

3.4 Reporting

Safety reporting involves using management-provided methods to report misconduct or unethical behaviour by workers or supervisors, either offline or online. Reporting systems encourage employees to take ownership of safety by actively participating in the identification and prevention of hazards. When employees choose not to report incidents, it signals a lack of commitment to safety culture. Over time, this can erode the collective sense of responsibility for workplace safety. Ignoring incident reporting can lead to costly accidents and increased liability for the organisation. Failing to address known hazards exposes the company to potential regulatory penalties and damages from lawsuits. Unreported hazards and systemic failures in incident reporting can result in recurring accidents, undermining organisational safety resilience [23]. Safety reporting is a cornerstone of effective safety culture in the oil and gas industry. It involves using management-provided methods to report misconduct, unethical behaviour, and potential hazards. These reporting mechanisms, available through offline or online channels, empower employees to actively engage in hazard identification and prevention. According to [23], the recurrence of hydrocarbon leaks (HCLs) on offshore platforms highlights systemic gaps in reporting and the lessons learned from past incidents. Encouraging employees to report incidents reflects their ownership of the safety culture and fosters proactive risk management. Conversely, the failure to report hazards signals a breakdown in safety communication, undermining collective accountability for workplace safety [23]. When safety incidents remain unreported, risks accumulate, potentially leading to costly accidents, regulatory penalties, and legal liabilities. Furthermore, studies on organisational resilience emphasise the role of open communication and feedback mechanisms in mitigating risks and adapting to dynamic challenges in complex systems [28]. Therefore, fostering an environment in which employees feel safe and encouraged to report concerns is essential to sustaining a strong safety culture.

3.5 Safety Investment

Safety investment refers to the allocation of resources towards employees, facilities, technologies, tools, and communication platforms related to production safety. It is also the responsibility of management to ensure a safe working environment for their employees. A positive work environment can encourage and motivate workers to follow safety protocols and adhere to regulations. Investing in safety training and education programs for workers, along with offering safety incentives to reward those who demonstrate strong commitment to safe work practices, can effectively promote and reinforce a positive safety culture. Prioritising safety investments aligned with goal-based regulations enables organisations to tailor solutions to their specific operational needs, ensuring compliance and effectively mitigating risks [24].

Safety investment represents an organisation's commitment to allocating resources toward safeguarding employees, improving facilities, and adopting advanced safety technologies. It encompasses tools, equipment, and communication platforms that directly impact production safety. Research by [24] highlights that goal-based regulations in the oil and gas sector encourage companies to tailor their safety investments to meet specific operational needs while maintaining compliance with safety standards. A critical component of safety investment is providing comprehensive safety training and education programs for workers, equipping them with the skills to handle risks effectively. Safety incentives, such as recognition and rewards for adherence to safe practices, reinforce positive behaviour and engagement. Moreover, creating a positive work environment that motivates workers to follow safety protocols ensures long-term compliance and risk reduction. Underscore the significance of integrating safety investments with adaptive organisational practices to enhance resilience, emphasising that the effectiveness of safety spending is measured by its ability to prevent accidents and foster a proactive safety culture [28].

3.6 Safety Competency

Safety competency encompasses employees' prior knowledge of safety practices, work experience, and ongoing safety training or education to enhance their professional skills. A worker's educational background and relevant experience are essential factors in safety competency. Employees with a strong educational foundation and pertinent work experience are more likely to understand the significance of a safety culture and prioritise safety in their daily tasks. Strengthening safety competency through targeted training and experience not only enhances individual awareness but also supports the broader organisational safety framework by reducing the likelihood of errors [23]. Safety competency is the foundation of effective risk management in the oil and gas industry. It involves integrating employees' prior knowledge of safety practices, relevant work experience, and ongoing safety training. Workers with robust educational backgrounds and relevant industry experience demonstrate a heightened awareness of potential hazards and are more likely to prioritise safety in their daily operations [23]. Continuous training programs enhance safety competency by equipping employees with up-to-date knowledge and skills. Additionally, fostering a safety-oriented mindset within the workforce helps build resilience, as adaptive and skilled personnel are better equipped to address unexpected challenges [28]. Research by [23] highlights the importance of competency in aligning operational practices with regulatory expectations and minimising risk. By prioritising safety competency, organisations can ensure a workforce that is not only compliant but also proactive in fostering a strong safety culture.

4. Conclusions

This systematic review highlights the significance of behavioural factors in shaping safety culture in the oil and gas industry. Organisations must prioritise safety training, communication, and management commitment to foster a robust safety culture. Future research should explore additional factors and interventions to enhance safety culture further. Strengthening these behavioural dimensions will lead to safer work environments and reduced accident rates in the industry. A comprehensive safety culture requires an integrated approach that involves employees at all levels, from management to frontline workers. Industry stakeholders should collaborate to implement policies that support continuous learning and proactive safety measures. Moreover, organisations should invest in advanced safety technologies and conduct regular assessments to identify potential risks. By fostering an environment where safety is embedded into daily operations, companies can improve not only worker well-being but also overall productivity and sustainability. Future studies should also examine how emerging technologies and digital safety management systems can contribute to a more resilient and adaptive safety culture in the oil and gas industry.

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Declaration of Competing Interest

The author declares no conflicts of interest.

CRediT Authorship Contribution Statement
S.N.Ismail: Conceptualisation, Formal analysis, Visualisation, Supervision, Resources, Writing – revise and review
E. Jkatisan: Methodology, Investigation, Data curation, Writing - original draft.

Availability of Data and Materials
The data supporting this study's findings are available on request from the corresponding author.

Ethics Declarations
This study did not involve human participants or animals. Ethical approval was therefore not required.

Generative Artificial Intelligence Declarations
The authors claim that artificially intelligent-assisted technologies, such as generative AI, were not used to generate content, ideas, or theories. We have just utilised AI to enhance readability and refine the language. This was used with extreme human control and oversight. The authors take full responsibility for reviewing and approving the content.

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