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Scoping Review: Dominant Factors Influencing Safety Culture Maturity Levels

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ABSTRACT

Background: Safety Culture Maturity Levels are widely discussed topics when addressing the implementation of Safety Culture. Therefore, this study aimed to identify the dominant factors that determine the successful application of safety culture in organization. Safety culture was considered a primary element necessary for improving safety performance in an organization, alongside the implementation of Engineering and Safety Management Systems.
Method: This study used Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines for Systematic and Scoping Reviews, respectively. The framework focused on studies related to Safety Culture Maturity Levels, retrieved from two databases, namely EBSCOhost and Science Direct.
Results: The initial search in these two databases resulted in 741 studies, which were subsequently screened according to inclusion criteria, resulting in 14 studies. The inclusion of five supplementary studies led to a total of 19 reviewed articles. This scoping review identified dominant factors influencing safety culture maturity levels and showed a relationship or correlation between safety management systems and safety culture maturity levels.
Conclusion: The dominant factors influencing safety culture maturity levels were identified. Furthermore, there was a correlation between safety management systems and safety culture maturity levels. Further study can be conducted to determine the dominant factors that were consistent with local cultural contexts.

1. Introduction

A mature safety culture is essential to complement an excellent safety management system, ensuring good safety performance. In 2023, Total Recordable Incident Rate (TRIR) in 2023 was 0.84 (1), showing the need for more safety improvements. To enhance safety performance, relying solely on safety rules and norms is no longer sufficient. Following the Chernobyl nuclear disaster in 1986, the concept of safety culture has been extensively discussed and studied by safety science communities, psychologists, and other expert groups (2). Despite the widespread use, there is no universally accepted standard definition of this term, leading to the proposition of various definitions (3). According to these definitions, safety culture includes a shared set of values, perceptions, actions, and behaviors in organization that is consistent with policies, procedures, and initiatives aimed at enhancing safety performance (3). Furthermore, Cox (4) showed the concept of safety culture by adding collective beliefs, perceptions, and attitudes in the work environment related to safety. The implementation of a safety culture, such as management commitment, work environment, and worker participation, will help improve safety performance and manage work pressure on workers.

According to Cooper, the effective implementation of Safety Culture was believed to provide positive benefits for companies, including aspects of quality, reliability, competitiveness, and profitability (5). Safety culture has many definitions and can be concluded as a social construct that is used by industry and regulators to describe the management of organizations to avoid catastrophes and personal injuries (6). Safety culture does not operate in a vacuum, as the concept is connected to and affects other operational processes or organizational systems (7).

From a business perspective, the benefits of implementing safety culture in various aspects of a company include (5):

- Quality: Establishing a good safety culture improves work methods and reduces absenteeism, thereby enhancing the quality of work and resulting products.
- Reliability: Operational reliability is indirectly achieved through a robust safety culture. Some contributing factors include process reliability and increased human resource reliability due to reduced errors.
- Competitiveness: An improved safety culture positively impacts competitiveness. Better corporate governance positions the company at the forefront of competition in the industry.
- Company Profitability: A strong Safety Culture contributes to company profitability by minimizing losses and adding value to the organization in terms of structure and employee competence.

The implementation of a safety culture in organization naturally shapes safety culture. Maturity level of this organizational safety culture significantly determines the achievement of performance. Hudson proposes five levels of Safety Culture Maturity in organization (8), namely Pathological, Reactive, Calculative, Proactive, and Generative.

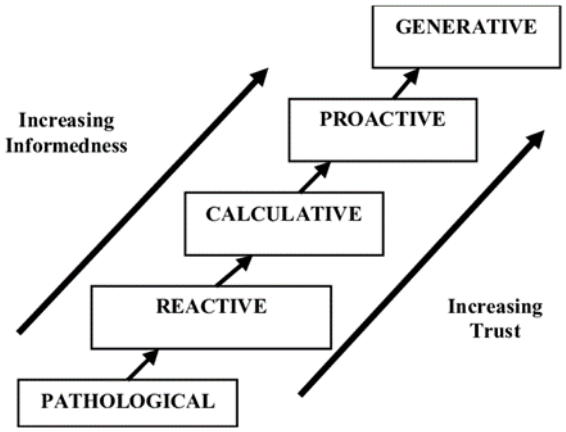

Figure 1. Safety Culture Maturity Ladder (8)

Some studies suggested that only a few companies (3.4%) among those that implemented structured safety management systems had highly mature processes for actively managing and mitigating risks. Oil and gas companies often show similar maturity levels but differ in injury rates. This shows that other contextual factors, such as operational pressures, and workforce engagement, play significant factors (9).

Several theories explain the dominant factors for the successful implementation of safety culture in organization. Lardner theory states that three dominant factors must be comprehensively addressed to reduce accident rates in organization (10), namely Engineering, Safety Management Systems, and Behavior (Safety Culture).

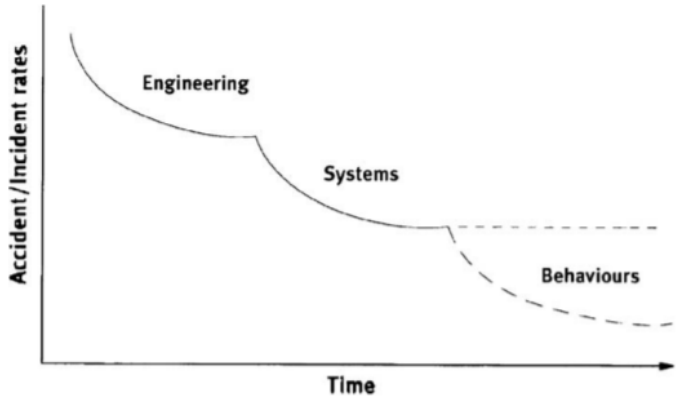

Figure 2. Safety Implementation Step (10)

These three elements should be integrated into a cohesive program. The majority of organizations implemented management systems and safety culture programs separately. Therefore, there is a need to determine the strength of the correlation between safety culture and safety management systems in the context of improving performance in organization.

This scoping review attempts to identify correlations between Safety Culture implementation (measured through Safety Culture Maturity Levels) and Safety Management Systems. Furthermore, the scoping review focused on Safety Culture Maturity Levels specifically for companies in the oil & gas industry and the related dominant factors. This selection is due to oil and gas companies being considered to operate with unique characteristics, such as high cost, high technology, and high risk (11). Therefore, the selection was expected to have better Safety Culture Maturity Levels compared to other similar industries.

2. Method

This scoping review used Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) protocol (12). This method differs from others by allowing for replication, scientific rigor, and transparency (13). Based on the focus, the following questions were formulated:

i. What are the dominant factors in safety culture maturity levels?
ii. Is there a relationship between safety culture maturity levels and the implementation of safety management systems?

2.1. Search Strategy and Sources

Search strategy facilitates a comprehensive and structured search for relevant studies or references. Through the study protocol, all relevant literatures were extracted and examined. This scoping review used the Participant, Concept, Context (PCC) tool to develop the study questions.

Table 1. PCC Strategy for Research Questions

Participant	Oil & Gas Companies
Concept	Safety Culture
Context	Safety Culture Maturity Levels

The keywords for this scoping review can be found in Table 2.

Table 2. Keywords of Scoping Review

Bahasa	English
Tingkat Kematangan Budaya Keselamatan	Safety Maturity Level
Model Kematangan Budaya Keselamatan	Safety Maturity Model
Ketangguhan Keselamatan	Safety Resilience
Sektor Industri	Industry/Industrial

Search strategy for this scoping review includes all related studies, such as journals, reports, and textbooks published over the last 7 years (2017 – 2023) using two databases, namely EBSCOhost and Science Direct. The search method used Boolean logic, as shown in Table 3.

Table 3. Search Stategy in Database

Topik	EBSCOhost	Science Direct
Safety Maturity Level	Safety Maturity Level OR	Safety Maturity Level OR
	Safety Maturity Model OR	Safety Maturity Model OR
	Safety Resilience AND Oil & Gas Company	Safety Resilience AND Oil & Gas Company

Initial filtering for the EBSCOhost database search includes: "Full text" for study availability, Published Date: January 2017 – December 2023 (last 7 years), and Language "English and Indonesian". The Science Direct database search used initial filters: "Subscribed Journal", publication year "2017-2023", and Language "English and Indonesian".

In addition to these two database sources, five other pre-selected studies were added to the final search results. These five studies were chosen based on discussions and input from experts to complement the selection based on predetermined criteria.

Table 4. Inclusion/Exclusion Criteria

Criteria	Inclusion	Exclusion
Participants	Oil & Gas Company	Industries other than Oil & Gas Companies
Concept	Safety Culture	Patient Safety
Context	Safety Culture Maturity Levels	Organizational Maturity Level
Year	2017 - 2023	Before 2017
Text Availability	Free Full Text	Abstract and Full text
Article Types	Research article, Systematic Review, Project Report	Meta-analysis, blogs, Guidelines, Letter
Language	English, Indonesia	Languages other than English and Indonesian

2.2. Inclusion/Exclusion Criteria

The next stage includes screening or filtering all obtained studies through inclusion and exclusion criteria. All selected studies must meet the criteria of being published in the last 7 years and related to the topic of Safety Culture Maturity in the oil and gas industry. Table 4 shows the inclusion and exclusion criteria for this scoping review.

2.3. Data Grouping

All studies selected based on the established inclusion and exclusion criteria were read and analyzed in depth. Data from each study was grouped into a framework that will facilitate data extraction.

The following is the framework developed for this scoping review:

1. Author
2. Title
3. Publication year

4. Country
5. Safety Maturity elements: dominant aspects of safety culture that shape safety culture maturity
6. Method of measuring Safety Maturity
7. Relationship between Safety Maturity Level (SML) and Safety Management System (SMS)

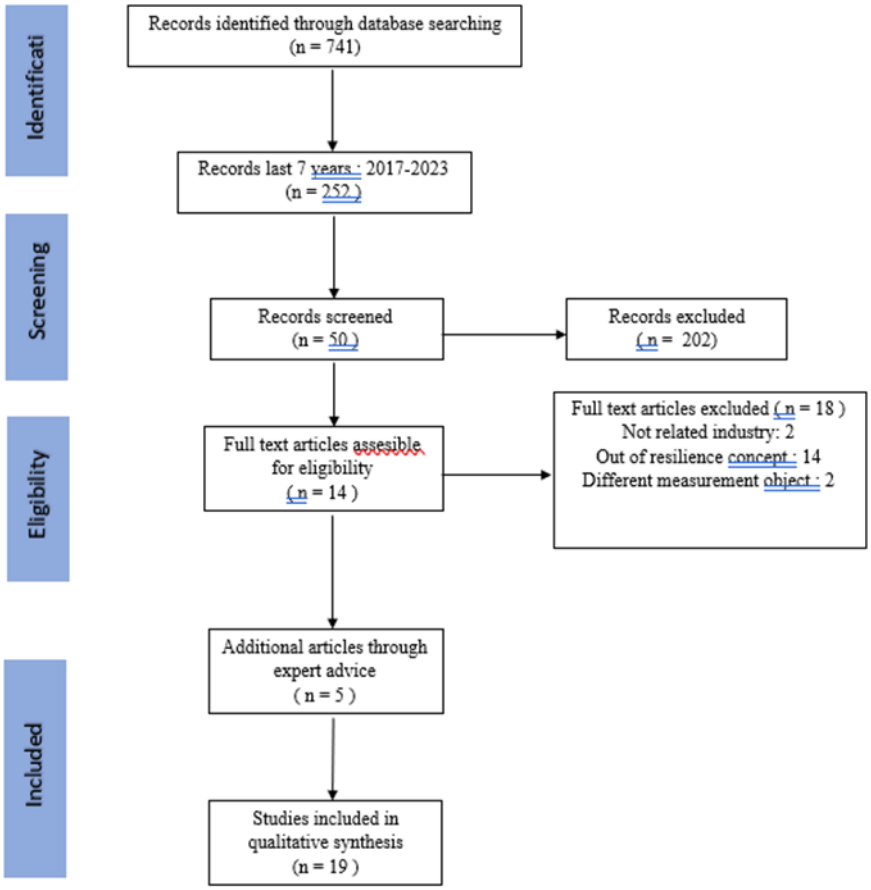

Figure 3. Study Selection with Prisma Diagram

Study Selection Diagram was developed using the following processes:

1. The author conducted searches in electronic databases (EBSCOhost and Science Direct) for two weeks (from August 5, 2024, to August 16, 2024).
2. The initial search using keywords yielded 741 studies.
3. Screening for studies published in the last 7 years led to a total of 252.
4. Further screening based on free full-text availability and title relevance showed 50 studies meeting the criteria, while 202 did not.
5. Abstract and content screening resulted in 14 studies meeting the criteria, with 20 excluded from this scoping review for clear reasons.
6. To the 14 selected studies, 5 were added based on expert input criteria to complement this scoping review.
7. In the final stage of article selection, 19 studies were obtained for review according to the predetermined objectives.

3. Result

Data were extracted data to answer the study question "Is there a strong relationship between Safety Culture and Safety Management Systems in shaping Safety Culture Maturity?". Table 5 shows the result of data extraction:

Tabel 5. Dominant Factors Shaping Safety Culture Maturity

No	Author	Title	Year	Country	Method	Elemen Safety Maturity	Measurement	Correlation Between SML and SMK
1	Kalteh, Salesi, Cousins, Mokarami	Assessing safety culture in a gas refinery complex: Development of a tool using a sociotechnical work systems and macro ergonomics approach	2020	Iran	Theoretical Framework and Questionnaire	Organization (Safety Management Systems, Training, Peer Support); Job & Task; Workers; Equipment and Tools; Work Environment	Questionnaire	Yes
2	da Silva, Amaral	Critical factors of success and barriers to the implementation of occupational health and safety management systems: A systematic review of literature	2019	Brazil	Systematic Literature Review	Support for the safety management system, promotion, commitment, and participation of all workers; development of proactive management; reduction in accident rates; and adequate financial resource allocation.	Literature Review	Yes
3	Stemn et.al	Examining the relationship between safety culture maturity and safety performance of the mining industry	2019	Australia	Literature Review	People : Care and respect, Safety commitment and audit, Employee involvement and Coaching; System : Safety Leadership, Policy and Commitment, Risk Management, Regulatory Requirement, Target and Measurement, Communication, Operation Control, Training, Audit and Review, Learning From Incident	Questionnaire	Yes
4	Jean Christophe le Coze	How safety culture can make us think	2019	France	Literature Review	Promotion methods, programs, models.	Literature Review	Yes
5	Filho, et al	Maturity models and safety culture: A critical review	2018	UK	Literature Search	Communication, management commitment, safety training, incident reporting, worker involvement, accident analysis, audits, and periodic reviews.	Literature Review	Yes
6	Swuste, et al	Occupational safety and safety management between 1988 and 2010 Review of safety literature in English and Dutch language scientific literature	2020	Belanda	Literature Study	Safety intervention, behavior intervention, accident prevention intervention	Questionnaire	Yes
7	Paul R. Schulman	Organizational structure and safety culture: Conceptual and practical challenges	2020	USA	Literature Study	Responsibility for risks arising from work, strategies for handling errors and accidents, and the equitable distribution of safety personnel across different work locations	Literature Study	Yes
8	Yorio, et al	Safety culture across cultures	2019	USA	Literature Study	Organizational safety culture: Normative (management) Pragmatic (behavioral) Anthropological (values, beliefs, attitudes)	Literature Study	No
9	Jorge Walter	Safety management at the frontier: Cooperation with contractors in oil and gas companies	2017	Argentina	Mixed Method	Senior staff, supervision, project management, risk management, and the role of contractor workers.	Survey	

No	Author	Title	Year	Country	Method	Elemen Safety Maturity	Measurement	Correlation Between SML and SMK
10	Khalid, et al	Safety Management System (SMS) framework development – Mitigating the critical safety factors affecting Health and Safety performance in construction projects	2021	UK	Literature Study	Safety Policy; Safety Assurance; Risk Management; Safety Promotion	Survey	Yes
11	Terry L. Mathis	Safety Excellence Maturity Model	2019	USA	Report	Strategy; Leadership; Safety Manager; Engagement; Culture Competence; Metrics	Literature Study	No
12	Vladimir Ivensky	Optimizing Safety	2017	USA	Peer Review	Engineering Control; Management Systems; Human	Literature Study	Yes
13	Djunaidi, et al	Analysis of the Safety Resilience Implementation in the Maritime Industry at Public and Private Companies (A Case Study in Indonesia)	2021	Indonesia	Semi Quantitative	Anticipation Ability; Learning Ability; Monitor Ability; Response Ability	Interview and document review	Yes
14	Jaaskelainen, et al	Maturity Analysis of Safety Performance Measurement	2019	Finland	Literature Review	Performance Measurement; Commitment; Use of Performance Measurement	Literature Review	Yes
15	Vongvitayapirom, et al	Safety Culture Maturity Model: A Case Study of PTTEP		Thailand	Document Review and Pilot Test	Leadership, ownership, Communication	Questionnaire	Yes
16	Bezalel, et al	Validating And Weighting The Importance Of The Safety Maturity Drivers Of The Sustainable Health And Safety Maturity Model	2018	Canada	Literature Review	22 element Safety Maturity Drivers (SMD)	Literature Review	Yes
17	Niresh Behari	Assessing process safety culture maturity for specialty gas operations: A case study	2019	Canada	Document Review and Interview	Leadership; Safety Management System;	Interview	Yes
18	Jahangiri, et al	Safety culture maturity and resilience engineering in an oil drilling industry: A comparison study among government-owned and private companies	2021	Iran	Comparison Study	Ability to respond, ability to monitor, ability to learn, ability to anticipate	Questionnaire	Yes
19	Bascompta, et al	Safety culture maturity assessment for mining activities in South America	2018	Spanyol	Quantitative	Information, Organizational Learning, Involvement, Communication, Commitment	Questionnaire	Yes

4. Discussion

From the various studies discussed in this scoping review, the data obtained were grouped to answer the questions, as listed in Table 5.

For question 1, the dominant factors of safety culture maturity levels in an organization were grouped as follows:

- **System:** availability and support of safety management systems, budget allocation (14), job descriptions, training (15), promotion (16), efforts to reduce accident rates, even distribution of workers (17), organization (18), risk management (19,20) communication (21), safety policy (20), 22 elements of Safety Maturity Drivers (SMD) (22).
- **People:** active participation of all workers (19), proactive management (15), caring and respectful attitudes (23), commitment, leadership (23–25), intervention (26), responsibility, worker participation, and competence (17).
- **Procedure:** regulations (23), measurement (27), accident and failure handling (28), engineering control (29), anticipation (30), monitoring, engineering control (31).

4.1 System

System refers to the infrastructure, technology, and processes in organization that support a safety culture. This includes the design, implementation, and evaluation of existing safety systems, known as Safety Management System, as follows:

- **Safety Policy:** Clear and comprehensive policies supporting workplace safety practices.
- **Safety Technology:** Equipment and technology supporting occupational safety implementation.
- **Reporting and Monitoring:** Systems for reporting incidents, accidents, or potential hazards, and mechanisms for monitoring and evaluating safety performance.

The better the system implemented in organization, the higher the level of safety culture maturity. This was shown by improved safety performance and strength in preventing accidents or incidents.

4.2 People

People refers to the behavior, attitudes, knowledge, and skills of workers in supporting a safety culture. Humans are an essential component of safety system built by an organization, including:

- **Safety Awareness:** Workers level of understanding and attention to safety risks in the workplace.
- **Leadership Commitment:** Organizational leaders with a high commitment to safety serve as role models for other workers.
- **Worker Involvement:** Active participation of workers in safety programs, such as training, discussions, and hazard identification in the work environment.

Safety culture maturity was greatly influenced by the extent to which people in organization actively participate and take responsibility for safety, both for workers and facilities.

4.3 Procedure

Safety procedures are guidelines or instructions implemented to ensure that work or activities are carried out safely, including:

- **Standard Operating Procedures:** Standards or guidelines formulated to perform tasks or jobs safely.
- **Emergency Procedures**: Instructions for handling emergency situations such as incidents, explosions, or other accidents.
- **Compliance with Regulations:** Conformity of procedures with safety standards and government regulations related to occupational safety.

Good procedures ensure that each task is carried out in the safest manner, reducing the risk of accidents and increasing productivity. The level of safety culture maturity greatly depends on the design, comprehension, and adherence in organization. All the efforts can be started by strong leadership in one organization (32). Lack of the three factors, namely system, people, and procedure can cause poor safety culture implementation and contribute to accidents in any organization (33).

To improve safety culture maturity, organizations should prioritize ongoing training, promote open communication about safety concerns, and foster leadership commitment to safety. A well-developed safety culture was essential for promoting a safe work environment, enhancing employee satisfaction, and ensuring long-term organizational success. In addition, organization needs a firm effort to achieve the appropriate safety culture maturity levels. This includes work toward becoming a 100% reporting culture, developing safety awareness with meaningful safety rules, ensure the leaders know how to develop safety culture (34).

4.4 Formation of Safety Culture Maturity through Dominant Safety Culture Factors

Safety Culture Maturity concept has evolved into a model called Safety Culture Maturity Model. This evolution consists of five levels, namely Pathological, Reactive, Calculative, Proactive, and Generative. The evolution also includes 10 elements (10), namely Visible management commitment, Safety communication, Productivity versus safety, Learning organization, Health, and safety resources, Participation in safety, Shared perception about safety, Trust between management and frontline staff, Safety training, as well as Industrial relation and job satisfaction. These elements were grouped into three broad categories, namely systems, people, and procedures.

From the various factors studied, appropriate work programs can be developed to effectively build safety culture in organization based on the dominant factors shaping safety culture. Safety culture maturity levels were measured to observe the implementation of safety culture in an organization, The results of this measurement will undoubtedly produce gaps that must be followed up with work programs.

For research question 2, all the studies reviewed agree that there was a correlation between the implementation of safety management systems and safety culture maturity. The quantitative extent of this correlation between safety management systems and culture maturity levels is not yet clearly illustrated. Therefore, further studies are required to obtain quantitative data on the correlation between safety management systems and safety culture maturity levels.

5. Conclusion

In conclusion, the dominant factors for safety culture maturity levels significantly determined the success of the organization in building a safety culture. Various dominant factors were grouped into three major parts, namely **system, people, and procedure**. Each organization could develop programs appropriate to local conditions to build a safety culture effectively.

There was a close relationship between safety management systems and safety culture maturity levels. This result was consistent with the opinion of Lardner from the Keil Centre that efforts to improve safety performance in the modern era required three aspects, namely **engineering, safety management systems, and behavior** (10). However, the limitation of this scoping review was the inability to explain the relationship between safety management systems and culture maturity levels in an organization. The result showed the possibility of further studies on the correlation between safety management systems and culture maturity levels. The hypothesis confirmed a strong correlation between these two elements, leading to a proposed integration of safety culture programs into safety management systems. This integration aimed to enhance safety performance and improve safety culture in organization.

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